Acerca de este libro

Esta es una copia digital de un libro que, durante generaciones, se ha conservado en las estanterías de una biblioteca, hasta que Google ha decidido escanearlo como parte de un proyecto que pretende que sea posible descubrir en línea libros de todo el mundo.

Ha sobrevivido tantos años como para que los derechos de autor hayan expirado y el libro pase a ser de dominio público. El que un libro sea de dominio público significa que nunca ha estado protegido por derechos de autor, o bien que el período legal de estos derechos ya ha expirado. Es posible que una misma obra sea de dominio público en unos países y, sin embargo, no lo sea en otros. Los libros de dominio público son nuestras puertas hacia el pasado, suponen un patrimonio histórico, cultural y de conocimientos que, a menudo, resulta difícil de descubrir.

Todas las anotaciones, marcas y otras señales en los márgenes que estén presentes en el volumen original aparecerán también en este archivo como testimonio del largo viaje que el libro ha recorrido desde el editor hasta la biblioteca y, finalmente, hasta usted.

Normas de uso

Google se enorgullece de poder colaborar con distintas bibliotecas para digitalizar los materiales de dominio público a fin de hacerlos accesibles a todo el mundo. Los libros de dominio público son patrimonio de todos, nosotros somos sus humildes guardianes. No obstante, se trata de un trabajo caro. Por este motivo, y para poder ofrecer este recurso, hemos tomado medidas para evitar que se produzca un abuso por parte de terceros con fines comerciales, y hemos incluido restricciones técnicas sobre las solicitudes automatizadas.

Asimismo, le pedimos que:

+ *Haga un uso exclusivamente no comercial de estos archivos* Hemos diseñado la Búsqueda de libros de Google para el uso de particulares; como tal, le pedimos que utilice estos archivos con fines personales, y no comerciales.

+ *No envíe solicitudes automatizadas* Por favor, no envíe solicitudes automatizadas de ningún tipo al sistema de Google. Si está llevando a cabo una investigación sobre traducción automática, reconocimiento óptico de caracteres u otros campos para los que resulte útil disfrutar de acceso a una gran cantidad de texto, por favor, envíenos un mensaje. Fomentamos el uso de materiales de dominio público con estos propósitos y seguro que podremos ayudarle.

+ *Conserve la atribución* La filigrana de Google que verá en todos los archivos es fundamental para informar a los usuarios sobre este proyecto y ayudarles a encontrar materiales adicionales en la Búsqueda de libros de Google. Por favor, no la elimine.

+ *Manténgase siempre dentro de la legalidad* Sea cual sea el uso que haga de estos materiales, recuerde que es responsable de asegurarse de que todo lo que hace es legal. No dé por sentado que, por el hecho de que una obra se considere de dominio público para los usuarios de los Estados Unidos, lo será también para los usuarios de otros países. La legislación sobre derechos de autor varía de un país a otro, y no podemos facilitar información sobre si está permitido un uso específico de algún libro. Por favor, no suponga que la aparición de un libro en nuestro programa significa que se puede utilizar de igual manera en todo el mundo. La responsabilidad ante la infracción de los derechos de autor puede ser muy grave.

Acerca de la Búsqueda de libros de Google

El objetivo de Google consiste en organizar información procedente de todo el mundo y hacerla accesible y útil de forma universal. El programa de Búsqueda de libros de Google ayuda a los lectores a descubrir los libros de todo el mundo a la vez que ayuda a autores y editores a llegar a nuevas audiencias. Podrá realizar búsquedas en el texto completo de este libro en la web, en la página `http://books.google.com`

This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

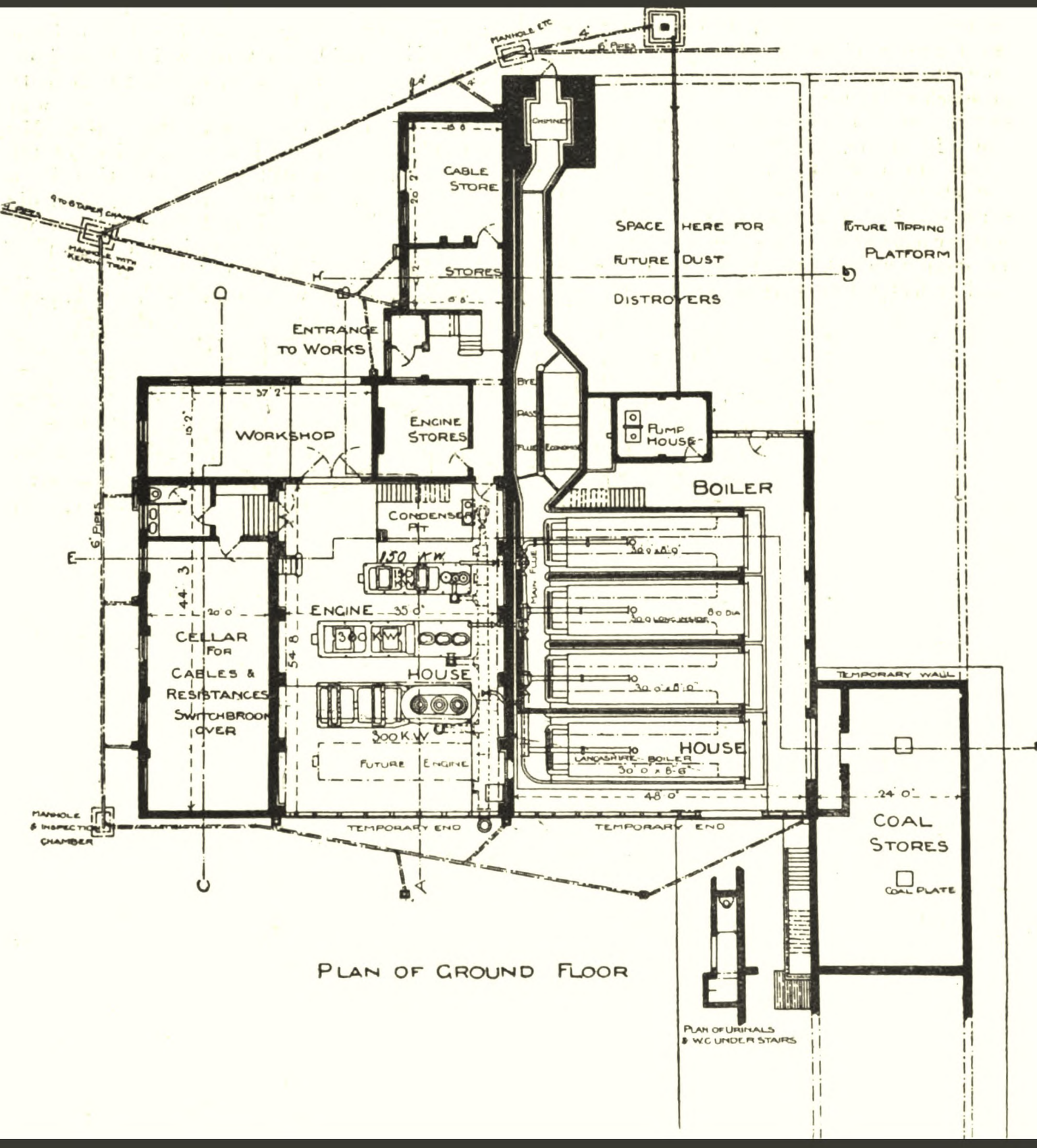
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

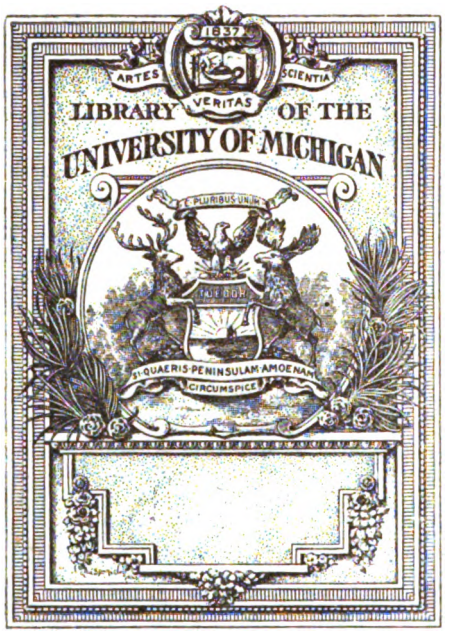
About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



The Electrical engineer

Digitized by Google



Digitized by Google

TK
1
.E327

Digitized by Google

Digitized by Google

SUPPLEMENT TO "THE ELECTRICAL ENGINEER," DEC. 28, 1900.

THE

ELECTRICAL ENGINEER.

A WEEKLY JOURNAL OF ELECTRICAL ENGINEERING,

WITH WHICH IS INCORPORATED

"ELECTRIC LIGHT."

VOL. XXVI. (NEW SERIES.)

FROM JULY 6, 1900, TO DECEMBER 28, 1900.

LONDON:
Printed and Published for the Proprietor by BIGGS & Co., at "THE ELECTRICAL ENGINEER" Offices, 139-140, Salisbury-court, Fleet-street, E.C.

1900.

Digitized by Google

INDEX TO VOL. XXVI. (New Series.)

NOTE.—General Articles, Correspondence, and Companies' Meetings are indicated by heavier type (thus, 290) than the Notes and Business Notes, references to which are shown by light type (thus, 290).

A.

Accidents, etc., 140, 141, 145, 181, 211, 246, 247, 248, 285, 322, 326, 355, 358, 362, 399, 427, 464, 505, 579, 613, 645, 680, 715, 706, 752, 786, 798

Accumulators, etc.:
for Boats, 219
Efficiency of, 217
Electrolytic Cell, A New, 398
Fitz-Gerald, D. G., Review of Work by, 739
at Gloucester Works, 84
at Guernsey Works, 302
Lead, The, 184
at Leith Electricity Works, 222
Loofah, The, 470
Questions and Answers on, 243, 280, 456
for Ships, 794
Submerged, 400
Switch for, 615
for Traction, 76, 147, 400, 472, 507, 580, 795
Voltaic Cells, A. G. Dell, 158

Acetylene, 695, 758
Agencies, 104, 392, 393, 427, 465
Air Ships, 577, 794
Air Storage, 291
Alloys, Nature of, 401
Alternating-Current Switches, Sparking at, 149
Alternating-Currents, The Resistance Offered by Iron Conductors to, 741
Alternating Supply Works, Reduction of Light-Load Losses in, H. Boot, 13
Alternators, *see* DYNAMOS, ETC.
Aluminium, 136, 289, 397
American Coal Strike, 542
American Exhibition, 1, 544
American Patents, 721, 796, 880
Andrews, L., Connecting Service Cables, 526, 572
Andrews, L., Distribution of Electricity to Scattered Areas, 45
Appointments, 685; also see PERSONAL
Appointments Vacant, 31, 68, 104, 176, 212, 284, 320, 356, 428, 464, 500, 536, 571, 607, 644, 680, 715, 752, 788, 824, 860, 896, 924

Arc Lamps:
Alternate-Current, Carbons in, 722
Bremer, The, 192, 229, 267
New Alternating, 866
Questions and Answers on, 315, 782
Report on Photometric Value of, 201
Submarine, A, 455

Aron Meter Company's Paris Exhibit, 320
Arrangement of the Distributing Network, C. A Gillie, 764, 796, 834
Automatic Fire Alarms, 218
Automobiles, 1, 30, 37, 38, 39, 145, 181, 183, 321, 325 355, 361, 433, 485, 497, 505, 507, 542, 608, 616, 649, 651, 688, 703, 704, 725, 757, 822

B.

Bacterial Light, 543
Baily, Prof., A Lecture-Room Volt and Ammeter, 453

Balance-Sheets and Reports of Electricity Works:
Aberdeen Accounts, 388
Blackpool Tramroad Company, 244
Bristol Accounts, 205, 286
Bury, 71, 205
Cardiff Accounts, 633
Cheltenham, H. Kilgour, 908
Edinburgh Accounts, 557
Hampstead Accounts, 142, 429
Hastings Accounts, 142
Higgens, T. W. B., on Traction at Chelsea, 53
Leeds Accounts, 604
London County Council (Traction Report), 167
Manchester Accounts, 208
Nottingham Accounts, 107
Oldham Accounts, 460
St. Pancras Accounts, 346
Sheffield (Mr. Fedden's Report), 709
South Shields Accounts, 388
Sunderland, 70
Truro (F. H. Headley), 461
Tunbridge Wells Accounts, etc, 637
Yarmouth Accounts, 59

Ballistic Oscillometer, 826
Barker, J. H., A Combination Integrating Wattmeter and Maximum-Demand Indicator, 335
Barmen-Vohwinkle Suspended Railway, The, 841, 873
Barnsley Electricity Works, 402
Battle of Systems, 219
Becquerel Rays, The, 472
Behrend, B. A., Factors which Determine the Design of Monophase and Polyphase Generators, 597, 670, 704, 727
Behr, F. J., Manchester and Liverpool Railway Brakes and Signals, 382
Binnie, Sir A., Address to Mechanical Section of British Association, 344
Black Electricians, 689
Blackpool and Fleetwood Tramroad, T. G. Lumb, 199
Boilers, Prevention of Scale in, E. D. Summerfield, 91
Boot, H., Electricity Supply for Lighting, etc., 453
Boot, H., Reduction of Light Load Losses in Alternating Supply Works, 13
Bose, Prof. J. C, Similarity of Effect of Electrical Stimulus on Inorganic and Living Substances, 370
British Canals, 579
Bruges Harbour Works, 296
Buenos Ayres, Electric Lighting at, 585
Burglary, 105
Bury St. Edmunds Electricity Works, 618

C.

Cable Splicing, 505
Calculation Simplified, 737
Calorimeter for Measuring the Wetness of Steam, A New Form of, Prof. J. Goodman, 337
Capacity, An Adjustable, 111
Carbon, Electrochemical Equivalent of, 398
Carus-Wilson, Prof., Polyphase Electric Traction, 805, 843, 906

Catalogues, etc.:
Allgemeine Elektricitäts-Gesellschaft, 616
Ashmore, Benson, and Co., 356
Berghaus and Young, 888
Braulik, G., 588
British Thomson-Houston Company, 239, 320, 608, 753
British Westinghouse Company, 239, 321, 608, 644, 681
Brown, Boveri, and Co., 357
Campbell Gas-Engine Company, 608
Davies, Kent, and Stewart, 888
Edison and Swan Company, 32, 556
Electrical Company, 752
Electrical Transmission Company, 600
Fairbanks Company, 32
Ferranti, Limited, 361
Fowler, J., and Co., 32
General Electric Company, 238, 572, 608
Gibbs and Son, 681
Guthrie and Son, 357
Hall and Co., 572
Henley, W. T., 644
Improved Glow Lamp Company, 142
Johnson and Phillips, 465, 538
Ledward and Co., 177
Mather and Platt, 465
Morley Engineering Company, 608
Offord and Jennings, 889
Pond Machine Tool Company, 925
Poth and Co., 240
Reavell and Co., 178
Renewable Lamp Company, 538
Simplex Steel Conduit Company, 305
Spencer, J., 240, 644
Sunbeam Lamp Company, 588
Worthington Pumping Engine Company, 428

Cathode Rays, 327, 724
Chamen, W. A., Electricity Supply, 731
Coal, Substitute for, 360
Coal Weighing, 111
Coats, A., High-Speed Reciprocating Engines, 477, 524, 533
Coherers, 113, 217
Colours in Artificial Light, 181
Combination Integrating Wattmeter and Maximum Demand Indicator, J. H Barker, 335
Combined Management of Tramway and Lighting Departments, R. C. Quin, 11

Companies' Meetings, Reports, etc.:
Aberdare Electric Lighting, 319
Accumulator Industries, 465
Aluminium, 126
Amazonia Rubber, 427
Andes Development, 284
Anglo-American Telegraph, 104, 138, 173, 499
Aron Meter, 751, 754, 856

Companies' Meetings, etc. (*continued*):
Bastian Meter, 33
Birmingham and Aston Tramways, 173
Blackpool, St. Annes, etc., Tramroad, 922
Blackpool Tramroad, 244, 323
Boston Consolidated Copper and Gold, 858
Brisbane Tramways, 502
Bristol Tramways and Carriage, 139
British Columbia Electric Railway, 101, 926
British Electric Street Tramways, 642, 775
British Electric Traction, 106, 176, 502, 676
British Electric Transformer, 173, 215
British and Foreign Electrical Vehicle, 752, 895
British Insulated Wire, 103
British Motor, 284
British Power, Traction, and Lighting, 464
British Thomson-Houston, 135
British Westinghouse Electric and Manufacturing, 785
Brompton and Kensington Electricity Supply, 177, 860
Browett-Lindley, 68
Calcutta Electric Supply, 609
Calcutta Tramways, 101
Caledonian Electric Power, 722
Cape Copper, 356
Cape Electric Tramways, 243, 640, 645, 713, 749
Cavehill, etc., Tramway, 244
Central London Railway, 173, 214
Charing Cross and Strand Electricity Supply, 140, 248
Chelsea Electricity Supply, 896
Chili Telephone, 215
Chloride Electrical Storage, 353
City of Buenos Tramways, 464
City of London Electric Lighting, 65, 104
City and South London Railway, 136 172, 749, 788
Castner Electrolytic Alkali (U.S.A.), 176
Castner-Kellner Alkali, 607
Columbia Motor, 680
Colwyn Bay Electric Light and Power, 607
Commercial Cable, 824
Compagnie Generale de Traction (of Paris), 140
Consolidated Telephone Construction, etc., 605
Copper Mines of Mount Lyell West, 857
County of London and Brush Provincial, etc., 141
Crompton and Co., 68, 136, 173
Croydon Tramways, 282, 355
Cuba Submarine Telegraph, 571, 605
C. V. Lamp, 211
Derbyshire, etc., Electric Power Company, 925
Direct Spanish Telegraph, 427
Direct United States Cable, 68, 101, 135, 536
Direct West India Cable, 503
Douglas Southern Electric Tramways, 893
Douglas, W., 752
Dublin United Tramways, 173, 716
Eastern Extension Telegraph, 68, 464, 640, 676, 788
Eastern Telegraph, 69, 137, 499
Edison and Swan, 105, 137, 172
Edmundson's Electricity, 34, 64
Electric Automobile Syndicate, Limited, 176
Electric Construction, 34, 101
Electric and General Investment, 643, 924
Electric Incandescent Lamp Regenerating, 427
Electric Power Distribution, 714
Electric Railways, 569
Electric Resistance and Heating, 892
Electric Street Car Manufacturing, 610
Electric Trades Supply, 680
E.P.S., 30, 31, 64
Electrical Vehicle, 750
Electro-Ceramic Syndicate, 465
Electromotion Corporation, 249
Finchley Electric Lighting, 319
Friswell's Automobile Palace, 248
Gardner Electric Drill, 217
General Electric, 527
General Electric Company of Ireland, 751
Globe Telegraph and Trust, 68, 136, 464
Glover, W. T., and Co., 892
Griffiths, W., and Co., 679
Halifax, etc., Cable, 503
Hampstead Electricity Supply, 644
Hawaiian Tramways, 503
Henley's, W. T., Telegraph Works, 176, 212, 323, 893
Hove Electric Lighting, 211
Imperial Tramways, 248
Improved Electric Glow Lamp, 896
India Rubber, etc., 320, 892
Indo-European Telegraph, 571
Internationale d'Electricite, 248
Johnson Electrode Germicide, 248
Johnson-Lundell, 16
Kalgoorlie Electric Power, etc., 320, 856
Keighley Tramways, 320

Digitized by Google

Companies' Meetings, etc. (*continued*):
Kidderminster Electric Lighting, etc., 680
Kinsburgh Motor Construction, 607
Lancaster and District Tramways, 320
Leamington and Warwick Tramways, 323
Liverpool Overhead Railway, 136, 173, 245
London Electric Omnibus, 922
London Electric Warehouse, 680
Marconi's Wireless Telegraph, 353, 856, 892
Metropolitan Electric Supply, 176
Metropolitan Railway, 135, 215
Meyra Electric, 176, 465
Mordey-Fricker Meter, 284
Napier Motor, 283
National Electric Supply, 215
National Telephone Company, 101, 106, 172
Nernst Electric Light, 357, 891, 915
Newcastle Electric Supply, 501, 538
New General Traction, 570
New St. Helens Tramway, 538
North Metropolitan Tramways, 246
North Staffordshire Tramways, 139
Notting Hill Electric Lighting, 141, 172
Oriental Telephone, 536
Paisley Tramways, 215
Parker, T., 34
Perfect Light, 751
Potteries Electric Traction, 176
Rand Central Electric Works, 135, 173, 176
Recording Telegraphs, 503
Reno Inclined Elevator Syndicate, 176
Reuter's Telegram, 535
Roadway Autocar, 751
Rogers and Gowlett, 284
St. Helens Cable, 640, 824
St. James's and Pall Mall Electric Light, 103
Smithfield Markets Electric, 215
Solar Aluminium Parent, 248
South African Lighting, 643
South Staffs Tramways, 101
Stock Exchange (settling Days, &c.), 32, 69, 104, 140, 177, 212, 248, 284, 320, 356, 427, 464, 501, 536, 572, 608, 644, 715, 752, 788, 824, 860, 896, 924
Stockport Tramways, 245
Sussmann's Electric Miners' Lamp, 499
Telegraph Construction, 161
Typewriting Telegraph, 532
Union Light and Power, 925
United River Plate Telephone, 103
Vivograph Syndicate, 571
Walker and Wallsend Gas, 715
Waterloo and City Railway, 173, 244
West African Telegraph, 34
Western Telegraph, 605
West India and Panama Telegraph, 643, 712
Willans and Robinson, 466
Windermere, etc., Electric, 323
Wirral Railway, 323
Yorkshire Electric Power, 680
York Tramways, 215

Companies, New, 33, 70, 104, 141, 608, 789, 813, 855, 927
Companies' Shares, New Issues, 31, 69, 141, 212, 574, 679, 682, 787, 823, 826
Companies' Stock and Share List, see each Issue
Companies' Traffic Returns, see each Issue
Complete Specifications Accepted, see each Issue
Concerts, see Dinners, etc.
Cooling Towers, 326, 465
Copper Electrodes, 865
Cordite, 757
Cork Foundations, 794

Correspondence:
Advertisements for Tenders, 668
British Electric Street Tramways Company, 775
Bury St. Edmunds Works, 668
Conduit *v.* Trolley, 235
Correction, 342
Director Question, The, 76, 740
Electricity, Nature of, 271
Electric Shocks, 311
Electromagnetic Induction, 307, 343, 379, 415, 451, 485, 523, 556, 595
Jandus Arc Lamp Action, 235, 271
Manchester Contracts, 708
Municipal Trading, 883
Walder Bros. and Co., 311
Nernst Electric Light Company, 915
Rating of Incandescent Lamps, 667, 739
River Trip, The, 127
Steam Alternator Test, 883
Sun, The Path of the, 559, 595
Swansea Tramways, 91

Cramp, W., The Tendency of Modern Dynamo Design, 475

D

Davey, Paxman, and Co.'s Works, 272, 303
Dawson, W., Recent Tramway Construction, with Special Reference to the Deneribe System, 375
Deard's Glazing, 681
Development of the Density Factor, C. Turnbull, 875
Dinners, etc., 104, 285, 703, 758, 789, 811, 876
Distributing Network, Arrangement of the, C. A. Gillin, 764, 798, 834
Distribution of Electricity, L. Andrews and G. Wilkinson, 45, 47
Donkin, B., An Improved Glass Revealer, 588
Dowson Electric Radiators, 665
Duddell, W., On Rapid Variations in the Current through the Direct-Current Arc, 882, 886, 915

Dynamos, Motors, etc.:
Alternate-Current Induction Motors, A. C. Eborall, 87, 129, 159
Alternators Connected in Parallel, 614
at Barnsley Works, 466
at Blackpool-Fleetwood Tramways Station, 200
Bucking of Large Shunt-Wound Motors, 759
at Bury St. Edmunds Works, 634
Commutators of, 435, 614
Companies Manufacturing, see COMPANIES' MEETINGS, ETC.

Dynamos, etc. (*continued*):
Continuous Current, for Widely Varying Voltages designed by M. Lanhoffer, 512
Design, Philosophy of, 555, 562, 654, 734, 762, 836, 870
Distortionless Commutator, A, 614
Factors which Determine the Design of Monophase and Polyphase Generators, B. A. Behrend, 597, 670, 704, 727
at Glasgow Works, 438
at Gloucester Works, 82
at Guernsey Works, 152, 302
at Leigh Electricity Works, 222
at Liverpool Electricity Works, 550
Milking Boosters, 757
at Paris Exhibition, 56, 119, 136, 264, 374
Polyphase Motors, 257, 687
Price Lists of, see CATALOGUES, ETC.
Questions and Answers on, 98, 207, 278, 315, 350, 383, 458, 493, 528, 566, 602, 635, 707, 745, 814, 853, 913
at Rathmines Electricity Works, 366
Rotary Converters, Hunting in, 616
at Rothesay Electricity Works, 150
for Southport Tramways, 114
Steam Alternator Test, 883
for Sunderland Tramways, 295
for Swansea Tramways, 6
at Taunton Electricity Works, 297, 330
Tendency of Modern Design, W. Cramp, 475
Thermo-Electric Motor, A, 255
Turbo-Alternator, A Large, 93
Westinghouse, 516
Witting Bros., 574

E.

Earle, H. A., Relative Advantages of Direct-Current and Three-Phase Distribution for Small Installations, 766
Earth's Magnetism, The, 147, 365
Eborall, A. C., Alternate-Current Induction Motors, 87, 129, 159
Edison Again (Electricity Generated without Coal), 325
Editing (*Invention's* Statement), 509
Educational Articles, 793
Effects of Strain on the Thermo-Electric Qualities of Metals, M. Maclean, 311, 349
E. L. B. System of Lighting, 596

Electric Lighting:
at Abercarn, 645, 824
at Aberdare, 789
at Aberdeen, 33, 103, 177, 248, 284, 321, 358, 383, 427, 499, 824, 860, 897, 924
at Abersychan, 140
at Aberystwyth, 823
at Accrington, 67, 176, 585, 643, 713
at Airdrie, 536, 573, 681
at Aldershot, 213, 859, 924
at Alfreton, 249, 392
at Alloa, 466, 897
at Alnwick, 104, 247, 356, 607
in America, 73, 545
at Arbroath, 285, 751
at Ashton, 105, 249, 427, 537, 715, 788
at Ashton-in-Makerfield, 607
at Aspatria, 140
at Aspull, 393, 896
at Aston, 30, 67, 789
in Australia, 40, 541, 790
at Aylesbury, 713, 861, 924
at Ayr, 393, 574, 783, 860, 896
at Bacup, 896
at Balby, 825
at Ballymena, 283
at Banbury, 69, 536, 897
at Bangor, 211, 857, 427, 753
at Barking, 31
at Barnard Castle, 896
at Barnet, 248, 356, 427
at Barnsley, 402, 465, 499, 645, 685, 751, 753
at Barnstaple, 283, 859
at Barrow, 212, 427, 825, 859
at Barry, 571, 607, 925
at Basingstoke, 103, 571
at Bath, 68, 106, 140, 320, 357, 643, 923, 925
at Batley, 67, 393, 429, 644
at Battersea, 176, 285, 394, 788, 896
at Beckenham, 70, 213, 535, 607, 775
at Bedford, 427, 535, 713, 751, 824
at Belfast, 30, 141, 212, 357, 500
in Belgium, 290, 397
at Berkhampstead, 43, 500, 789
at Bermondsey, 69, 537, 571, 608, 645, 789, 897
at Berwick, 752
at Beverley, 247, 643, 859
at Bexhill-on-Sea, 31, 283, 925
Bills for, 2, 32, 104, 140, 178, 214, 752, 754, 789, 790, 824
at Blaston, 644
at Bingley, 924
at Birkenhead, 356, 537, 645, 859
at Birmingham, 68, 141
at Birstall, 30, 680, 751, 752
at Bishop Stortford, 105, 464
at Blackburn, 69, 285
at Blackheath, 32
at Blackhill, 428
at Blackpool, 67, 283
at Blackrock, 284
at Blairgowrie, 67, 283, 571, 609, 681, 753
at Bognor, 247
at Bolton, 247, 357
in Bombay, 830
at Bo'ness, 105, 284
at Bootle, 434, 681
at Boston, 607, 859
at Bournemouth, 69, 140, 607, 715, 823, 824
at Bradford, 31, 67, 69, 103, 141, 356, 392, 538, 753
at Braintree, 247
at Branksome, 393
at Brechin, 428
at Brecon, 284
at Bridgwater, 680, 752
of Bridgwater House, 672

Electric Lighting (*continued*):
at Brierley Hill, 536
at Brighouse, 33, 177, 283, 789
at Brighton, 70, 103, 393, 466, 571, 573, 716, 789, 861, 925
at Bristol, 178, 205, 287, 464, 681, 860, 897
at Bromley, 68
at Bromsgrove, 752
at Broughty Ferry, 67
at Budapest, 899
at Buenos Ayres, 585
at Burgess Hill, 213, 860
at Burnley, 320, 824
at Burton, 105, 571, 896
at Bury, 71, 205, 247, 320, 859
at Bury St. Edmunds, 319, 394, 537, 618, 668
at Buxton, 67, 284, 464, 859
at Calcutta, 577
at Calverley, 356
at Camborne, 68, 427, 645
in Canada, 253
at Cannock, 104, 464
at Canterbury, 535, 571, 714
at Cardiff, 69, 105, 185, 248, 500, 537, 633, 681, 752, 824, 831, 861, 896
at Carlisle, 104, 284
at Carmarthen, 464, 499
at Carnarvon, 358, 393, 753
at Carnoustie, 500
at Castle Donington, 69
at Castleford, 607
of Chapel Royal, St. James's, 680
at Charlton, 30
at Cheadle, 751
at Chelmsford, 357
at Cheltenham, 30, 357, 751, 896
at Chesham, 105, 788
at Chester, 284, 607
at Chesterfield, 67
at Chester-le-Street, 177
at Chichester, 141, 177
in China, 614
at Chiswick, 68, 141, 320, 572
in the City (London), 69, 140, 178, 215, 284, 573, 646, 723, 752, 789, 925
at Clayton-le-Moors, 860
at Cleethorpes, 392, 751
at Clitheroe, 465
at Clydebank, 751
at Coatbridge, 104
at Cockermouth, 140
at Colchester, 31, 178, 214, 538, 824
at Colne, 212, 499, 751
at Colwyn Bay, 427, 572, 643
Committees for, 718, 754, 757, 780, 814, 856, 922
Companies' Meetings, see COMPANIES' MEETINGS, ETC.
Companies' Stock and Share List, see each Issue
on the Congo, 613
at Consett, 67, 284, 536, 861
Contracts Open for, see TENDERS WANTED AND ACCEPTED
at Cork, 73, 105, 177
at Coventry, 30, 924
at Craigo, 465
at Crewe, 67, 176, 356
at Criccieth, 645, 824
at Crieff, 68, 319, 751
at Crook, 537
at Croydon, 31, 68, 141, 753, 823, 925
at Cullen, 140
at Cupar-Fife, 68, 141
Cure by, 903
at Dalkeith, 70, 859
at Darlington, 67, 211, 319, 392, 897
at Dalry, 247
at Derby, 68, 283, 501, 573, 824
at Devonport, 32, 358, 427
at Dewsbury, 356, 643
at Dollar, 427, 754
at Doncaster, 824
at Dorchester, 105, 247, 571, 923
at Dorking, 105
at Douglas, 392
at Dover, 104, 140, 177, 211, 283, 643, 751, 789, 924
at Driffield, 393
at Dublin, 2, 321, 788, 896
at Dudley, 393, 536, 682, 825
at Dumbarton, 103
at Dumfries, 321
at Dundee, 643
at Dunstable, 104, 788
at Durham, 427
at Eaglescliffe, 393
at East Barnet, 105, 714, 859
at Eastbourne, 313, 566, 607, 788
at East Grinstead, 30, 714
at East Ham, 714, 824, 860
at East Molesey, 393, 534, 860
at Ebbw Vale, 283
at Eccles, 211, 393, 536, 607, 680, 825
at Eccleston, 924
at Edinburgh, 141, 499, 557, 607, 788, 824, 860
at Edmonton, 751
at Egremont, 31, 177
the E. L. B. System of, 596
at Elland, 212, 681
at Enfield, 357, 428, 500
at Epsom, 103, 924
at Esher, 104
Extensions of, 292, 401
at Fakenham, 211
at Falkirk, 69, 536, 643
at Farnham, 535
at Farsley, 751
at Felixstowe, 393
at Filey, 31
at Finchley, 30, 105, 713, 826
at Fleetwood, 319
Free Wiring, Report on, H. Kilgour, 303
at Friern Barnet, 30, 285, 499, 571
at Frome, 607, 788
at Fulham, 31, 104, 400, 754, 826, 859
at Gainsborough, 104
v. Gas, 37, 74, 253, 263
in Germany, 146, 220, 685, 759
at Glasgow, 140, 142, 211, 249, 283, 410, 438, 475, 573, 643, 859

202593

Digitized by Google

Electric Lighting (*continued*):
at Gloucester, 30, 67, 78, 125, 215, 321, 357, 401, 646, 924
at Gillingham, 321
at Golborne, 212, 393
at Gomersal, 68
at Goole, 319, 393, 751, 861
at Gourock, 644
at Grangemouth, 571, 758
at Grantown, 505
at Gravesend, 104, 178
at Grays, 571
at Great Horwood, 859
in Greece, 253
at Greenock, 211, 284
at Grimsby, 104
in Guernsey, 152, 361
at Guildford, 499, 680
at Hackney, 428, 465, 560, 645, 861
at Halifax, 30, 285, 356
at Ham, 141, 924
at Hammersmith, 32, 178, 859, 924
at Hampstead, 103, 142, 213, 248, 393, 429, 499, 571, 751, 825, 923
at Hampton, 465
at Hampton Wick, 283
at Hanley, 32, 320, 465, 824
at Harrogate, 465, 578
at Harrow, 177, 465, 825
at Harwood, 67
at Hastingden, 358
at Hastings, 69, 142, 526, 537, 928
at Hawick, 356
at Hebburn, 896
at Helensburgh, 68, 824
at Hendon, 644
at Hereford, 31, 500, 714
at Hestwall, 30
at Heywood, 427, 572, 826, 897
at Hoddesdon, 357, 680, 751
in Holborn District, 105
at Holyhead, 680
of H.A.C. Barracks, 607
at Horsham, 105, 428
at Hornsey, 178, 536, 572
of Hotel Cecil, 283
at Hove, 211, 578
at Huddersfield, 607, 645, 926
at Hull, 30, 213, 247, 248, 284, 571, 823, 924
at Hunstanton, 896
at Hunsworth, 392
at Huntingdon, 212, 751
at Ilford, 30, 356, 607, 714, 751, 825, 897
at Ilfracombe, 30, 859
at Ilkley, 824
at Ince, 427, 571
in India, 37, 146, 580
and Insurance Companies, 903
at Inverness, 67, 104, 714, 788, 824
at Islington, 103, 537, 571, 682, 788, 860, 897
in Japan, 867
at Keighley, 319, 701
at Kelso, 68, 356
at Kendal, 211
at Kensington, 141, 715 783, 825
at Keswick, 177
at Kidderminster, 30, 103, 320
at Killarney, 248
at Kilmarnock, 105
at King's Lynn, 249, 427, 714, 896
at King's Norton, 680
at Kingston-on-Thames, 211, 248, 681, 859, 925
at Kingstown (Ireland) 284
at Kingswinford, 427
at Kirkcaldy, 859
at Knottingley, 428, 571
at Lancaster, 67, 140, 176, 789
at Largs, 68
at Larne, 31, 896
at Launceston, 571
at Leamington, 30, 67
at Leeds, 30, 283, 500, 604, 644, 751, 752, 789, 898
at Leicester, 176, 465
at Leigh (Lancs), 682
at Leith, 211, 222, 356, 859
at Lewes, 30, 169
at Leyton, 859
at Lichfield, 105, 607, 713, 896
of Lighthouses, 469
at Limehouse, 30
at Limerick, 67, 714
at Littlehampton, 860
at Liverpool, 319, 325, 357, 546
at Llandaff, 393
at Llandudno, 140, 320, 789
at Llanelly, 69, 285
at Loftus, 104
and London County Council, 33, 68 104, 141, 178, 537, 572, 645, 682, 715, 790, 860, 898
at Londonderry, 573
of London Docks, 645
at Long Eaton, 67, 356, 753, 925
at Longton, 392
at Lowestoft, 428, 537, 753
at Ludlow, 923
at Lurgan, 356
at Luton, 140, 423, 499, 644, 789, 924
at Lymington, 30, 465, 499, 859
at Lyndhurst, 789
at Lynton, 393
at Lytham and St. Annes, 68, 535, 897
at Macclesfield, 211, 500, 572
at Maidenhead, 211, 425
at Maidstone, 105, 319, 571, 751
at Manchester, 70, 106, 206, 310, 617, 627, 630, 631, 666, 671, 714, 754, 813, 867, 896
at Mansfield, 607, 644
at Maryport, 140, 319
at Melksham, 609
at Melrose, 789
at Meltham, 536
at Melton Mowbray, 104
Method of Charging for, 861
and Metropolitan Asylums Board, 177
at Mexborough, 31, 356, 753
at Middlesbrough, 393, 537, 715, 859
and Middlesex County Council, 925
at Milnrow, 427
Electric Lighting (*continued*):
of Mines, 925
at Mitcham, 924
at Moffat, 536
at Monmouth, 141
at Montrose, 825
at Morecambe, 104, 573
at Morley, 535, 715
at Nairn, 896
at Nantwich, 67, 212, 283, 574, 924
at Neath, 67, 643
at Nelson, 177, 499, 861
at Newark, 31, 356, 788
at New Brancepeth, 427
at Newburn, 30
at Newbury, 141, 357, 751, 924
at Newcastle-on-Tyne, 256, 533, 823
at Newcastle-under-Lyme, 212
at Newington, 68, 571
at New Malden, 248
at Newmarket, 177
at Newport, 394, 571, 681, 859
at New Swindon, 536
at Newton-in-Makerfield, 238
in New Zealand, 925
at Normanton, 607, 714
at Northfleet, 465, 607
at Norton (Malton), 499, 572
at Nottingham, 107
at Nuneaton, 105, 319, 393, 465, 896
at Oban, 105, 283, 609, 643, 714
at Oldham, 460, 571
at Ormskirk, 464
at Otley, 680
at Paddington, 211, 465
at Padstow, 30
at Paignton, 103, 715, 751
at Paisley, 536, 609, 643
in Paris, 901
at Partick, 31, 645
at Pateley Bridge, 608
at Pemberton, 211, 824
at Penistone, 140, 249
at Penzance, 572
at Perth, 248, 573
at Pickering, 30, 536, 680
at Plumstead, 681
at Pocklington, 680, 860
at Pontefract, 68, 608
at Pontypool, 248
at Pontypridd, 499, 644
at Poplar, 141, 464, 499, 515, 571, 643
at Portsmouth, 106, 214
Provisional Orders, etc., for, 31, 76, 473, 495, 644, 680, 715
at Pudsey, 67, 897
at Pwllheli, 141. 211
at Radstock, 789
at Rathmines, 283, 320, 366, 714
at Rhyl, 247
at Richmond (Yorks), 67, 183
at Rickmansworth, 501
at Ripon, 356, 571, 645, 924
at Rochdale, 69, 140, 247, 427, 571, 644, 860
at Rochester, 571, 896
at Romford, 714
at Rotherham, 214, 357, 859
at Rotherhithe, 571
at Rothesay, 150
at Rowley Regis, 610, 751
at Royton, 607
at Rugby, 69
in Russia, 861
at Ryde, 248
at St. Albans, 211, 358, 500
at St. Andrews (Fife), 67
at St. Annes, 212, 859
at St. Austell, 897, 924
at St. George (Hanover-square), 211, 321, 536, 574
at St. Luke's, 74
at St. Marylebone, 109, 537, 541, 568, 578, 722, 824, 861
at St. Pancras, 113, 213, 346 356, 824
at Sale, 714, 859
at Salford, 30, 67, 141, 213, 429, 573, 682
at Saltburn, 357, 714, 824
at Scarborough, 284
at Scunthorpe, 321
at Seaham Harbour, 357
at Selsey, 753
at Sevenoaks, 211, 573, 607, 859
at Sheffield, 69, 248, 359, 393, 573, 682, 709, 715, 824, 859, 912
at Shildon, 105, 140, 789, 923
at Shipley, 213, 643
of Ships, 104, 146, 192, 573, 796
at Shoreditch, 535
at Shoreham, 714
at Shrewsbury, 140, 247, 356
at Skipton, 681, 753
at Sleaford, 607, 714, 924
at Sligo, 825
at Smethwick, 573
at Soothill Nether, 427
at Southampton, 826
at Southend, 249, 753
at Southgate, 176, 465, 644, 714
at Southport, 30, 106, 248
at South Shields, 388, 896
at Sowerby Bridge, 68
in Spain, 146
at Spalding, 68, 211
at Stafford, 213, 643, 860
at Standish, 751
at Stanley, 356
at Stepney, 825
at Stirling, 319, 500, 572, 752, 860
at Stockport, 213, 285, 321
at Stockton, 69, 211, 571, 680, 859, 881
at Stoke Newington, 714 866, 897
at Stoke-on-Trent, 824, 896
at Stourbridge, 177
at Stranraer, 68
at Stratford-on-Avon, 536, 607, 643, 751, 923
at Stratton and Bude, 644
at Stroud, 68, 506, 537, 571
at Sudbury, 103, 177, 865, 535, 571
at Sunbury, 537, 825
Electric Lighting (*continued*):
at Sunderland, 70, 500, 536
Supply for, etc., H. Boot, 453
at Sutton Coldfield, 213
at Swadlincote, 897
at Swanage, 177, 427
at Swansea, 248, 356, 423, 825, 860, 898, 925
at Swindon, 105
at Tamworth, 30
at Taunton, 233, 297, 330, 427, 897
at Teddington, 105, 427, 753, 923
Tenders for, *see* TENDERS WANTED AND ACCEPTED
at Tettenhall, 104
at Tewkesbury, 140, 466
of Theatres, 329, 737, 901
at Thornhill, 69, 393, 715
at Thurlstone, 176, 393
at Tiverton, 394
at Todmorden, 643
at Tonbridge, 67, 896
at Torquay, 211, 321
at Tottenham, 753
of Trains, 213, 829
at Tredegar, 356
at Trowbridge, 69, 427, 571, 714, 751
at Truro, 427, 461
at Tunbridge Wells, 213, 284, 637
at Tynemouth, 493
at Upholland, 896
at Uxbridge, 140
of Victoria Embankment, 179, 393
at Wakefield, 30, 69, 571, 897
at Walker, 177, 464
at Walmer, 681, 859
at Wallsend, 211, 897
at Walsall, 69, 106, 249, 284, 427, 464, 573, 714, 897
at Walton, 70, 680, 753
at Wandsworth, 644
at Warrington, 67, 356, 643, 823
at Warwick, 105, 896
at Waterford, 721
at Watford, 356, 535
at Wealdstone, 571
at Wearmouth, 859
at Wednesbury, 643, 682
at Wellingborough, 248, 680
at Wellington, 140, 465, 680
at West Bromwich, 30, 106, 500, 535, 608, 681
at West Ham, 394, 751
at West Hartlepool, 643
at Weston-super-Mare, 571
at Whitby, 393, 571
at Whitechapel, 33, 68, 213, 825
at Whitehaven, 247, 427, 714, 897
at Wicklow, 356, 536
at Wigan, 356, 499, 644, 645, 860
at Willesden, 55, 141, 788
at Wimbledon, 283, 319
at Wimborne, 104
at Winchester, 213, 752
at Windermere, 323
at Wisbech, 427, 464, 607
at Woking, 607
at Wolverhampton, 67, 104, 644, 681
at Wombwell, 140, 824
at Woodford, 67
at Woolwich, 751, 924
at Worcester, 394, 499, 537, 607
at Worksop, 105, 283, 643, 714, 751
at Wormit, 608
at Worthing, 33, 608, 824
at Wrexham, 30, 212, 283, 320, 429, 501, 682, 824
at Wycombe, 319
at Yarmouth, 59, 753
at Yeadon, 105, 248, 321, 393, 860
at York, 499, 824, 861

Electric Traction:
at Aberdeen, 29, 175, 282, 355, 391, 502, 534, 643, 678, 793, 821, 926
Accidents, *see* Accidents
at Accrington, 391
by Accumulators, 76, 147, 400, 472, 507, 580, 795
at Acton, 29
Advantages of, 794
at Airdrie, 862
in America, 73, 96, 147, 163, 181, 182, 217, 219, 220, 321, 363, 397, 434, 436, 543, 544, 666, 757, 902
at Ashton, 545, 570, 894
and Asphalte Pavements, 290
at Aspull, 391
at Audenshaw, 534, 678, 860
in Australia, 37, 40, 147, 148, 175, 470, 502, 535, 760, 790
in Austria, 109, 217, 794, 809
Automatic Brakes for, 182
at Ayr, 66, 247, 282, 894
Baker-street and Waterloo Railway, 702, 717
at Bardsley, 464
Barmen-Vohwinkle Suspended Railway, 341, 373
at Barnsley, 17
at Barrow, 175, 822
at Barton, 103
at Bath, 103, 139, 210, 716, 749, 926
at Battle, 247
Beddgelert Light Railway, 355
at Belfast, 642
Bills for, 32, 66, 75, 103, 104, 140, 178, 214, 750, 752, 754, 790
at Bilston, 321
at Bingley, 569
at Birkdale, 282, 534, 821
at Birkenhead, 321, 862
at Birkenshaw, 926
at Birmingham, 66, 175, 534, 569, 679, 787
at Birstall, 678
at Blackburn, 822
at Blackpool, 29, 175, 199, 211, 244, 322, 323, 355, 737, 923
at Bolton, 29, 139, 246, 426, 502, 642, 678, 716, 894, 901, 924
at Bootle, 716, 822
at Bournemouth, 29, 139, 176, 246, 610, 717, 894
at Bowness, 391, 716
at Bradford, 66, 213, 246, 282, 321, 355, 391, 502, 609, 679, 749, 894
Brakes for, 182, 254, 436
at Branksome, 391, 642

Digitized by Google

Electric Traction (*continued*):
at Brierfield, 322, 569
at Brighton, 391, 426, 678, 926
at Bristol, 679, 811, 926
at Budapest, 217
at Burnley, 103, 210, 610, 822
at Burton-on-Trent, 247, 282, 679, 717
at Bury, 534, 641
at Calcutta, 139, 239
at Camborne, 66
in Canada, 509
at Cardiff, 426, 447, 502, 569, 642, 831, 845, 895
at Carlisle, 29
Carus-Wilson, Prof., Paper on, 805, 848, 906
at Castleford and Normanton, 750
Central London Railway, 103 139, 146, 149, 173, 175, 210, 214, 282, 326, 327, 363, 392, 398, 435, 482, 505, 507, 541, 643, 750, 829, 862, 926
in Ceylon, 577
Charing Cross and Hampstead Railway, 426, 570, 822, 862, 926
at Chelsea, 53, 54, 570
at Cheltenham, 391
in Cheshire, 210
at Chester, 464, 534, 569, 750, 822, 894
at Chester-le-Street, 750, 822
City and South London Railway, 172, 541, 609, 787
at Cleator Moor, 716, 787
at Cleckheaton, 717
at Cleethorpes, 750, 895
at Clontarf, 750
Closed-Conduit System, A, 543
at Clydebank, 749
at Coatbridge, 569, 750
at Colchester, 391, 716, 749, 894, 926
Committees for, 713, 754, 757, 780, 814, 855, 932
Companies' Meetings, *see* COMPANIES' MEETINGS, ETC.
Companies' Stock and Share List, see each Issue
Companies' Traffic Receipts, see each Issue
Conduit *v.* Trolley, 195, 235, 237
Contracts for, *see* TENDERS WANTED AND ACCEPTED
in Corea, 866
at Cork, 859
Corridor *v* Compartment Cars, 328, 342
at Coventry, 865
at Crewe, 355, 391, 749
at Croydon, 176, 503, 750
at Darlington, 66, 183, 283, 502, 641, 751, 822
at Darwen, 210, 321, 391, 534, 641, 822
Dawson, Mr., British Association Paper, 375
Derailment Prevention, 434
at Derby, 29, 66, 175, 210, 246
at Devonport, 139, 426, 464, 570
at Dewsbury, 66, 246
at Dover, 822
at Dublin, 173, 246, 819
at Dudley, 149, 211, 391, 502
at Dundee, 29, 66, 103, 139, 210, 426, 534, 610, 716, 787, 822, 862
in Durham, 139, 822
at East Ham, 502, 535, 859
at Eccles, 66, 534
at Edinburgh, 502, 569
at Erdington, 502, 534, 570, 678, 717
at Esher, 426, 894
at Falkirk, 463, 534, 642, 926
at Fleetwood, 29
at Folkestone, 67, 175, 425, 464, 534, 641, 678, 787, 926
in France, 217, 502, 579, 721, 787
and Fulham Vestry, 426
Gadsby, C. H., Paper on, 4
at Garston, 103
at Gateshead, 463, 787
in Germany, 76, 146, 217, 220, 254, 399, 442, 469, 472, 530, 609, 805, 841, 848, 873, 903, 906
at Glasgow, 5, 29, 67, 139, 210, 320, 463, 534, 678, 862, 894
at Glossop, 247, 569
at Gloucester, 29, 571, 642, 926
at Gosforth, 859
at Gosport, 246, 642, 717, 786, 823
at Govan, 67, 139, 426
at Gravesend, 29, 822
and Great Eastern Railway, 414, 425
Greatorex, A. W., Paper on, 902
at the Great Orme's Head, 355
in Greece, 861
at Greenock, 232
at Greenwich, 926
at Grimsby, 282, 750, 926
Guard Wires, 291
at Halesowen, 282
at Halifax, 103, 210, 320, 355, 642, 822, 894, 902
at Hampstead, 29, 569, 750, 787
at Hampton Wick, 535
at Hanley, 570
High-Voltage Trolley, 254
in Holland, 426
at Houghton-le-Spring, 446
at Huddersfield, 425, 464, 894
at Hull, 66, 355, 426, 569, 610, 679, 862, 926
at Huyton, 642, 678
at Hyde, 426, 502, 894
at Ilford, 391, 425, 786
at Ince, 246, 425
in India, 100, 139, 146, 239, 580
at Ipswich, 425, 607
in Isle of Man, 66, 393, 894
in Italy, 218, 725, 777, 829, 869
in Japan, 181, 722, 867
at Johnstone, 28, 391
at Keighley, 320, 894
in Kent, 679
at King's Norton, 502, 679, 822
at Kingston-on-Thames, 139, 502, 610, 749, 787, 821, 860, 927
at Kingswinford, 609
at Kirkcaldy, 29, 66, 139, 391
in the Lake District, 246, 434, 642, 749, 787, 822
at Lancaster, 103, 139, 320
Langdon, W., Paper on, 776, 800, 810, 851
at Leamington, 246, 323, 787, 822, 859
at Lee, 534
at Leeds, 283, 322, 355, 425, 534, 750, 752, 787
at Leicester, 895
at Leith, 391
Electric Traction (*continued*):
at Leigh, 570
Letter-Boxes on Tramcars, 355, 865
at Levenshulme, 822
at Lewisham, 534
Lifeguards for, 502, 610, 649
Light Railways, see Light Railways
at Lincoln, 29, 534
at Littleborough, 609
at Little Lever, 502, 822
at Liverpool, 29, 66, 139, 147, 173, 245, 325, 355, 380, 534, 569, 613, 649, 749, 822 853, 895, 901, 926
at Llandudno, 609
at Llanelly, 355, 679
Locomotives for, 442, 492
and London County Council, 53, 54, 110, 134 139, 169, 175, 210, 425, 464, 534, 569, 572, 610, 641 642, 678, 679, 751, 775, 885
London Railways Projected, 804
London United Tramways Scheme, 75, 103, 246, 391, 394, 433, 471, 535, 786, 787, 862
at Longton, 210
at Louth, 391
at Lowestoft, 534, 609, 641, 750, 822
at Lyndhurst, 29
at Lytham, 678
Magnetic Field Produced by, 899
at Maidstone, 175, 392, 610
at Manchester, 29, 175 380, 502, 570, 609, 642, 679, 788, 822, 862, 901, 926
at Maryport, 282, 321, 610, 787, 926
and Mersey Railway, 464
at Merthyr, 641
and Metropolitan Railways, 135, 148, 215, 326, 615, 736, 821, 829, 902, 926
at Middlesbrough, 750, 823
and Middlesex County Council, 29, 926
on Mont Blanc, Proposed Line, 829
at Morecambe, 139, 246
at Moss Side, 66, 103, 283, 569
at the Mumbles, 5
at Nantwich, 463
at Nelson, 66, 502, 861
at Newcastle, 66, 139, 183, 246, 355, 502, 642, 822, 894
in Newfoundland, 78
at New Maldon, 569, 862
at Newport, 66, 246, 394, 569, 716, 859
in New Zealand, 790
at Normanton, 679
at Northampton, 717
at Northfleet, 862
at North Shields, 750
at Northwich, 30
at North Wirral, 822
at Norwich, 175, 210, 282
at Nottingham, 322, 355, 502, 749, 822
at Oldham, 175, 463, 926
Overcrowding on Cars, 322, 895
at Paisley, 139, 175, 215, 321, 426, 502, 641, 678, 716, 787
Pearson Wing Trolley and Traveller, 272
at Perth, 569, 678, 750
at Plymouth, 534, 643
Polyphase, 805 848, 906
at Port Glasgow, 716
at Portrush, 29
at Portsmouth, 570, 613
at Preston, 322, 355, 464
at Prestwich, 246
Profits of, 4
and the Protection of Telegraph and Telephone Wires, 97
Provisional Orders, etc., for, 32, 66, 75, 103, 104, 178, 214, 355, 750, 752, 754, 790
Pyrenees Railways, Proposed, 470
at Queensbury, 391
Quin, R. C., Papers on, 11, 97
at Rawmarsh, 66, 926
at Reading, 66, 679, 862
at Redcar, 534
at Redditch, 425
at Redruth, 66
at Renfrew, 569
at Rhyl, 103, 642
at Richmond, 894
at Rochdale, 787, 861
at Royton, 282
in Russia, 146, 361
at St. Helens, 30, 210, 502, 538, 641, 861
at Salford, 66, 569, 896
at Scarborough, 716, 926
Schuckert System of, 690
at Seaforth Junction, 322
at Sedgeley, 282, 463, 894
at Sheffield, 175, 210, 282, 322, 391, 426, 610, 678, 679, 716, 749, 783, 862, 894
at Shipley, 534
at Smethwick, 609, 750, 894
South Ham Light Railway, 822
at Southampton, 175, 642, 895
and South-Eastern Metropolitan Tramways Company, 103, 926
at Southend, 103, 210, 249, 426, 821
South Lancs. Trams, 321
at Southport, 29, 85, 103, 114, 246, 282, 569, 823
at South Shields, 282
in Spain, 140, 392
on Staffordshire Tramways, 101, 29
Standard-Gauge Railways for, 832, 908
at Standish, 391, 862
at Stirling, 535, 569
at Stockport, 245, 861
at Stockton Heath, 66
at Stoke-on-Trent, 175, 822
at Stourbridge, 391, 926
at Stretford, 246
Strikes, 535, 543, 570, 645, 681
at Sunderland, 175, 210, 247, 282, 290, 294, 325, 341, 355, 392, 425, 749, 862
at Surbiton, 750, 786, 859, 895
and Surrey County Council, 787
at Swansea, 5, 7, 29, 66, 91, 103
at Swinton, 425
in Switzerland, 391
at Taunton, 609, 610, 714
Tenders for, *see* TENDERS WANTED AND ACCEPTED
at Teneriffe, 469, 701
at Tettenhall, 750
Electric Traction (*continued*):
at Thames Ditton, 426, 750
Ticket-Printing and Fare-Recording Machine, 322
at Torquay, 210, 425, 822
Traffic Receipts of Companies, see each Issue
and Trees, 182
Trolley Lubricator, 218
Trucks for, 535
at Truro, 461
at Tunbridge Wells, 787
at Turton, 534, 679
at Twickenham, 446
at Tynemouth, 183
at Tyneside, 751
on the Proposed Victoria and Putney Railway, 750
at Wakefield, 66
at Walker, 822
at Wallsend, 751
at Walsall, 786, 823, 895
at Wandsworth, 426, 503, 821
at Warrington, 246, 499, 678, 717, 822
Watering of Tramways, 534
Waterloo and City Railway, 173, 244, 852
at Waterloo-with-Seaforth, 247, 894
at Wednesbury, 425
at West Bromwich, 679, 822, 862
at West Ham, 642
at Wigan, 210, 391, 502, 534, 569, 641, 750, 822
at Willesden, 821
at Willington, 716, 894
at Wimbledon, 29, 823, 859
at Windermere, 426
at Wirral, 323
at Wolverhampton, 66, 672, 679, 747 785, 894, 922, 927
at Worcester, 714
at Workington, 391
at Worthing, 821
at Wortley, 822
at Wrexham, 139, 321, 355, 678
at Wycombe, 569
at Yeadon, 103
and Mr. Yerkes, 145, 392, 642
at York, 29, 215, 391, 751, 894
Young, J., Paper on, 5

Electrical:
Apparatus in Brazil, 541
Arc, The, 76
Belts, 685, 757
Boats, 178, 391, 485
Boom, The, 579
Canal Haulage, 470, 723
Cartridges, 181
Church Bells, 109
Comforts Wanted, 542
Company's New Showrooms, 479
Concrete Mixers, 217
Contacts, F. C. Mason, 771
Cooking, etc., 109, 434
Cranes, 181, 211, 249, 796
Discharge in Gases, 75
Dredgers, 761
Eel, 793
Engineers' Conference at Paris, 258, 291, 299
Exerciser, 503
Exports, American, 613
Exports, German, 1
Fans, 32, 142
Fire-Alarms, 218, 361, 572
Fire-Engines, 652
Fire Risks, 758
Force, Some Remarks upon the Cause and Nature of the, 265
Governors, 860
Heating, 601, 665
Hospital, An, 393
House Cooling, 148
Indicator at Clapham Junction, 541
Laboratory Work, 109
London Railways, Projected, 804
Log, An, 731
Mains, Practical Notes on, 726, 839, 872 905
Measuring Instruments, J. F. Stevens, 313
Men on Parade, 649
Motors *v* Gas Engines, 290
Ore Transporters, 112
Oscillations, Prof. Fleming, 771, 799, 844, 884
Piano-Note Recorder, 325
Potatoes, 147
Progress in Japan, 181, 722, 867
Pumps, 219, 793, 845
Safe-Breaking, Dangers of, 650
Shocks, 811
Shunting Pole, 793
Street Sweeping, 87
Supply for Lighting and Tramways, etc., H. Boot, 453
Supply Mains, Standard Sizes for, 416
Swingbridges, 715, 753
Transmission Company's Switch Gears, 600
Treatment, 289, 613
Tree Felling, 291
Water-Carts, 145
Waves, 293
Wiring, 4, 291, 526, 542, 572
Works Extensions and Luton Town Council, 650

Electrically-Actuated Issue of Tram Tickets, 362

Electricity:
in Agriculture, 37, 147, 866
in an American Hotel, 516
as a By-Product, 256
Distribution of, L. Andrews and G. Wilkinson, 45, 47
in Factories, 469
in Germany, 1, 184, 616
House Moving by, 577
in India, 239, 580
in the Industries, 217, 451, 462, 687
and Magnetism, 327
in Medicine, 88, 231, 253, 578, 613, 795
in Mining, 183, 214, 579, 653, 793, 903
Popularising, 364
on the Rand, 653
and Shipbuilding, 687
on Ships, 146, 221

Digitized by Google

Electricity (*continued*):
Some Notes on Dr. Shettle's Views of the Ultimate Nature of, 232, 271
Stage Effects, 329
Stimulus on Inorganic and Living Substances, Similarity of Effect of, 370
Supply, W. A. Chamen, 731
Supply for Lighting, etc., H. Boot, 453
and the Textile Industry, 217
and Wind Power, 615, 788

Electro-Balming, 181
Electrolysis by Alternating Currents, 795
Electrolysis of Fused Salts, 77
Electrolysis of Rails in Chicago, 219
Electrolytic Deposition, 398
Electrolytic Production of Gases, 382
Electromagnet, The Haab, 829
Electromagnets, Lifting, 868
Electromobiles, see Automobiles
Electrostatic Lines of Force, 110
Electro-Synthesis, 293
E.M.F., Standards of, J. Henderson, 121, 155
Employers' Liability, 111, 393
Engineering Progress Abroad, 902

Engines:
at Barnsley Works, 406
at Blackpool-Fleetwood Tramways Station, 200
at Bury St. Edmund's Works, 624
Campbell Gas, 608
Gas v. Motors, 290
at Glasgow Works, 433
at Gloucester Works, 82
at Guernsey Works, 152, 302
High-Speed Reciprocating, A. Coats, 477, 524, 553
at Leigh Works, 222
at Liverpool Works, 550
at Rathmines Works, 366
at Rotheesay Works, 150
Some Notes on Enquiries for, J. A. Seager, 127
for Southport Tramways, 114
Steam, Increasing the Efficiency of, 906
Steam Trials of, 110, 883
for Sunderland Tramways, 295
for Swansea Tramways, 6
at Taunton Works, 297, 330

English Electric Manufacturing Company's Works, 21, 41
Evolution of Switch Gears for High-Pressure Alternating Currents, W. E. Warrilow, 189, 224, 274, 307, 371, 417, 483, 511, 608
Extra Current, 613

F.

Fire-Alarm Systems, 218, 361, 572
Fire-Engines, Motor, 649
Fires, 68, 148, 177, 320, 417, 572, 896
Fleming, Prof., Electric Oscillations, 770, 799, 844, 884
Fletcher, S. L., Some Notes on Dr. B. C. Shettle's View of the Ultimate Nature of Electricity, 234, 271
Fraud, A, 427
French Prices, Rise in, 319
French Translation, 325
Fuel Gas, 541
Fuse Wire, 4

G.

Gases, The Occlusion of, 289
Gavey, J., Telegraph and Telephones at the Paris Exhibition, 729, 772
German Electrical Exports, 1
German Enterprise, 616
Gilbert, A. E., A Self-Driving Weight Motor, 688
Gillin, C. A., The Arrangement of the Distributing Network, 764, 798, 834
Glasgow Electricity Works, 410, 433, 474
Glasgow Exhibition, 813, 829
Gloucester Electricity Works, 78
Glover's Sports, 681, 714
Goodman, Prof. J. A., A New Form of Calorimeter for Measuring the Wetness of Steam, 337
Guernsey Electricity Works, 152, 301
Guide Books, 291

H.

Haab Electromagnet, The, 829
Helios Company's New Apparatus, 519
Helliwell's Glazing, 789
Hemingway-Coley Automatic Fuse, 35
Henderson, Dr., Standards of E.M.F., 121, 155
High-Vacua Testing, 831
High-Voltage Cables, 617, 685
High-Voltage Keyholder, 700
High-Voltage Supply, 326
Holly Gravity Return System, 164
Horse-Power Hour, Cost of, 255
Hospital Scandal, The, 370
House Cooling, 148
H_2O (Poetry), 147

I.

Illumination, Elements of, 293
Import Duties, 794
Impressions of American Tramway Practice, A. G. Le Rossignol, 96
Improved Glass Revealer, An, 563

Incandescent Lamps:
Companies Manufacturing, *see* COMPANIES' MEETINGS, ETC
Development of, 833
Edison, The, 32, 48, 556
for High Voltages, 685
Improved Glow Lamp Company's, 142, 896
Nernst, The, 289, 723, 798, 857, 891
New, 253, 543

Incandescent Lamps (*continued*):
Rating of, 561, 578, 657, 667, 739
Renewable Lamp Company's, 140, 588
Sunbeam Lamp, 538
Time Limit, A, 253

Indiarubber, 864, 581, 722, 924
Insulating Gloves, 74
Insulator, A Heated, 470
Insurance Rates, 903
International Electrical Congress, 270, 292
Ions, Discussion on, 452
Iron Conductors, Resistance Offered by, to Alternating Currents, 741

J.

Jointing Wires, 526, 542, 572

K.

Kapp, G., Measuring Tractive Effort, 551
Kershaw, J. B. C., Power Generation, etc., 564
Keyholder, A High-Voltage, 700
Kilgour, H., Report on Free Wiring, 808
Krupp's Works, 204

L.

Laing, Wharton, and Cunnington (New Firm), 924
Lancet Editorial, The, 760
Langdon, W., On the Supersession of the Steam by the Electric Locomotive, 776, 860, 846, 851, 879
Larmor, Dr., Address to the Mathematical and Physical Section of British Association, 339, 384

Leading Articles:
Baker-street and Waterloo, 702
Behind the Scenes, 126
Chelsea—London County Council and Tramways, 54
Common-Sense Principles, 738
Design of Railway Carriages, 342
Electric Lighting of London, 703
Electric Railways, 810, 846
End of the Century, 914
Finance, 532
From the International in 1878 to that in 1900, 198
Institution, The, 558
Maintenance and Guarantee, 594
Manchester and its Elective Auditor, 630, 666
Municipal Trading at the British Association, 378
Municipal Undertakings and Income Tax, 774
Olla Podrida, 18
Our Cousins from Across, 162
Paris Conference, The, 270
Postal Telegraph Finance, 450
Science and Practice, 882
Southern Railways, The, 414
Specifications, 486
Those Critics, 234
Unpunctuality, 306
Use of Mathematics, 666
Wireless Telegraphy, 90, 811

Lead Poisoning, Conference on, 1

Legal Intelligence:
Bird *v.* Dublin United Tramways Company, 672
British Electric Traction Company *v.* Commissioners of Inland Revenue, 784
Buchanan *v.* Bishop, 856
Cameron *v* Middleton, 747
Childs *v.* Atkins and Nisbett, 640, 784
Chloride Electrical Storage Syndicate *v.* Corporation of King's Lynn, 856
Coventry Gasfitting, etc., Company (Winding up), 640
Crystal Palace Company (Reduction of Capital), 135
Cunnington *v.* Fraser, 819
Cyclists' Lawsuit, A, 899
Dundee Tramway Company (Alteration of Memorandum of Association), 605
Fell *v* British Electric Traction Company, 179
G. N. R. *v.* G. N. and City Railway, 903
Guttapercha Corporation (In Liquidation), 323
Harness, C. B. (Bankruptcy of), 685
Hyde Corporation *v* Oldham, etc., Tramways, 64
Jandus Arc Lamp *v* Davy, 179, 235, 271
Leitch *v* National Conduit Company, 819
London County Council *v.* Inland Revenue Office, 868
London County Council *v.* National Telephone Company, 135, 717
London Electric Cab Company (Winding-up), 640, 715
London Electric Supply Corporation *v.* Butler, 605
London Gazette (Adjudications, etc.), 31, 67, 106, 140, 176, 212, 249, 283, 320, 356, 394, 428, 465, 500, 536, 572, 608, 715, 751, 788, 860, 924
Madras Electric Tramway Company *v.* Cooper, 747
National Electric Wiring Company *v.* Jones, 672
National Telephone Company *v* Exchange Telegraph Company, 605
Mercier's Patent Company *v.* New Flint Colliery Company, 747
O'Reilly *v.* Dublin United Tramways Company, 819
Postmaster-General *v.* Lock, 179
Recording Telegraph Company (Winding-up), 640, 714
St. James's Company *v.* Fisher, 605
South London Electric Supply Company (Smoke Summonses), 640, 856
Thomson-Houston Company *v.* Lorain Steel Company, 176
Trade Unions, Liability of, 393
Wolverhampton Corporation *v.* British Electric Traction Company, 672, 747, 785, 922

Legal Relationship of the Supply Company to the Consumer, 153
Leigh Electricity Works, 222
Lifting-Electromagnets, 868
Light Cure, The, 903

Lighting Plants, Losses in Small, 193
Lightning, 74
Lightning Conductors at St. Paul's, 358
Light Railways, 17, 60, 100, 132, 161, 207, 244, 322, 394, 452, 492, 527, 564, 599, 629, 670, 706, 780, 794, 814, 855, 923
Light Railways from a County Surveyor's Point of View, H. F. Wakelam, 132
Liquid Fuel, 760
Liverpool Electricity Works, 546
Liverpool Tramways Contine, 277
Load Factor, Improving the, 866
Local Loans, Amount of, 17
Lock and Block Signalling, 379
London County Council Scholarships, 865
London County Council, Tramways Report to, 167
Losses in Small Lighting Plants, B. V. Swenson and A. W. Richter, 193
Lumb, T. G., The Blackpool and Fleetwood Tramroad, 199

M.

Maclean, M., On the Effects of Strain on the Thermo-Electric Qualities of Metals, 311, 349
Magnetic Force, Determination of, 434
Magnetisation and Electricity, 327
Magnetism, Atomic, 88
Magnetism, Terrestrial, 147, 365
Maintenance of Certain Portions of Distributing Systems at Earth Potential, C. H. Wordingham, 93
Manchester Electricity Committee, 617, 627, 630, 631, 666, 671, 706, 813
Manchester and Liverpool Express Railway, Sir W. H. Preece, 380
Manchester and Liverpool Railway Brakes and Signals, F. J. Behr, 382
Manchester Load Curve, A, 310
Mansion House Subways, The, 686
Manchester Post Office, Fire at, 417
Mason, F. C., Electrical Contacts, 771
Maxim Electrical Engineering Co. (Amalgamation), 681
Medhurst Mr., a Parliamentary Candidate, 452
Mercury Interrupter, A New, 77
Metallurgical Congress, The, 435
Metals, Effects of Strain on the Thermo-Electric Qualities of, 311, 349
Meteorological Observations, 577
Meter, A New Electrolytic, 652
Meter Testing, 2, 722
Military Hospitals in South Africa, 508
More Miracles!, 269
Motor-Starting Switches, New, 869
Municipalities and Income Tax, 774, 868
Municipal Trading, 112, 240, 255, 329, 378, 419, 898

N.

New Branches, 211
New Firms, 500, 924
New York Journalism, 89
Nickel Extraction, 652
Nobel Prizes, The, 580
Novel Drying Lines, 614
Novel Escape, A, 649

O.

Obituary:
Abdank-Abakanowicz, Mr., 899
Armstrong, Prof., 753
Armstrong, Lord, 924
Dent, M. C., 32
Hausmann, J., 685
Jefferies, J. R., 415
Short, B. C., 55
Vasquez, Senor, 55

Observatories, Insulating, 831
Ostrich, The (Note on Contemporary's Remarks), 401
Overhead Line to France, 425
Owens College New Laboratories, 19
Oxides, Conductivities of, 255

P.

Paris Congresses, 78, 258, 270, 289, 292
Paris Exhibition, 56, 118, 186, 198, 249, 257, 258, 270, 271, 284, 292, 299, 319, 320, 357, 392, 427, 442, 465, 505, 669, 685, 729, 772
Partnerships, 68, 176, 680, 716, 859
Pearson Wing Trolley and Traveller, The, 272
Perry, Prof., Presidential Address, 662, 666, 695
Personal, 31, 73, 105, 141, 212, 289, 321, 393, 397, 433, 577, 682, 685, 786, 793, 862, 896
Phillips, C. H. S., The Apparent Emission of Cathode Rays from an Electrode at Zero Potential, 380
Philosophy of Dynamo Design, 555, 582, 654, 734, 762, 836, 870
Photographic Exhibitions, 362, 501, 913
Phyxollera Electrocuted, 91
Piano Note Recorder, A, 325
Platinum Silicium Resistances, 614
Poetry, H_2O, 147
Polyphase Electric Traction, Prof. Carus-Wilson, 805, 843
Polyphase Work, 217
Pope, H. W., The Railway and the Telephone, 277

Portraits:
Balfour, D., 446
Barnsley Works Staff, 402
Bastow, S. E., 404
Holmes, A. B., 546
Medhurst, F. H., 618
Oliver, C., 618
Potter, Alderman, 396
Rathmines Electricity Works Group, 366
Roe, A. H., 618
Shillitoe, T., 618
Short, B. C., The Late, 55
Snell, J. F. C., 297

Digitized by Google

Portraits *(continued)*:
Taunton, Mayor of, 297
Taunton Works Staff, 331
Thornhill, E. P., 298

Power Factor, Increasing, 688, 866
Power Factor Indicator, 650
Power Generation, J. B. C. Kershaw, 564

Power Transmission:
in Australia, 541
Bills for, 25, 51, 74, 127, 140, 178, 214, 722, 752
in Canada, 219, 669, 760, 925
Derbyshire Scheme, The, 925
in India, 188
New Scheme, A, in the Tees-side District, 649, 789, 825, 926
at Paderno, 869
for Railways, 544
in Scotland, 218, 249
in Sweden, 469
in Switzerland, 38, 365, 436
in Telephonia, 158
in the Tyrol, 793
153-mile, 866

Practical Notes on Electric Mains, 736, 839, 872, 905
Preece, Sir W. H., The Manchester and Liverpool Express Railway, 331
Preece, Sir W. H., Wireless Telephony, 380
Presentations, 31, 233, 428, 571, 682, 861
Prevention of Scale in Boilers, E. D. Summerfield, 91
Priestman, A., Municipal Trading, 419
Prompt Delivery and Erection, 912
Provisional Patents, see each Issue
Pyrometry, The Progress of, 289

Q.

Questions and Answers, 25, 61, 98, 134, 165, 205, 241, 278, 315, 350, 383, 421, 457, 493, 527, 565, 602, 634, 673, 707, 743, 781, 814, 853, 889, 918
Quin, E. C., Combined Management of Tramway and Lighting Departments, 11
Quin, E. C., Protecting Telegraph and Telephone Wires in Connection with Overhead Traction, 97

R.

Rail Joints, Welding of, 218
Railway and the Telephone, 277
Range Finding, 362
Rapid Variations in the Current through the Direct-Current Arc, W. Duddell, 882, 886, 915
Rathmines Electricity Works, 366
Relative Advantages of Direct-Current and Three-Phase Distribution for Small Installations, H. A. Earle, 766
Reduction by Electrolytic Metals, 40
Reduction of Light-Load Losses in Alternating Supply Works, H. Boot, 13
Removals, 104, 140, 141, 177, 247, 393, 433, 464, 498, 536, 607, 924
Renewable Electric Lamp Company's Works, 140
Reno Inclined Elevator, 176, 196
Resistance Offered by Iron Conductors to Alternating Currents, 741
Resistance of Thin Films, 364

Reviews of Books, etc.:
A B C of Electricity, W. H. Meddowcroft, 523
Album of Electricians, 109
Boiler Record Book, 249
Books Received, etc., 145, 181, 212, 361, 571, 644
Bright, Sir C. T., Life Story of, 884
Chamber of Commerce Journal, 506
Electric Wiring Tables, 523
Elementary Questions in Electricity, etc., M. Maclean and E. W. Marchant, 523
English Illustrated Magazine, 249, 357, 465, 715, 789
Feilden's Magazine, 191
Fowler's Mechanical Engineers' Pocket Book, 861
Great Eastern Railway Booklets, 177
Injectors, W. W. F. Pullen, 524
Lead Storage Battery, D. G. Fitz-Gerald, 739
Manual of Electrical Undertakings, 608, 703
Masonic Illustrated, 433
Path of the Sun, The, etc., W. Sandeman, 448, 558, 595
Practical Engineer Pocket Book, 715
Science Abstracts, 433
Stone Trades Journal, 37
Street Railway Review, 613, 721
Technical, Industrial, and Commercial Vocabulary, 847
Tramway, etc., World, 41
Universal Directory of Railway Officials, 217

Richter, A. W., and B. V. Swenson, Losses in Small Lighting Plants, 193
Road Traction, Prof. Hele-Shaw, 882
Roosegool, A. B. Le, Impressions of American Tramway Practice, 96
Rothesay Electricity Works, 150
Rowland, A. J., Mistakes in the Rating of Incandescent Lamps, 561, 657
Royal Insurance Company's Rules, 291
Rucker, Prof., The Magnetic Field Produced by Electric Tramways, 899

S.

Sales, 536, 681, 751
Schuckert Contact System of Electric Traction, 690
Schuster, Prof. A., Electric Inertia and the Inertia of Electric Convection, 696
Schuster, Prof. A., Magnetic Precession, 898
Seager, J. A., Some Notes on Enquiries for Engines, 127
Searchlights at Paris Exhibition, 669
Self-Driving Weight Motor, A, (Mr. Gilbert's Machine), 688
Service Cables, Connecting, 536, 572
Shah, The, in Paris, 146
Share Market, 824, 896, 924
Shettle, Dr., Some Remarks upon the Cause and Nature of the Electric Force, 265
Shettle, Dr., Some Remarks upon a Hitherto Unrecognised Planetary Law, 590, 634
Ships, Electrolytic Action on, 650
Simplified Calculation, 737
Slough Report, The, 699
Smoke Nuisance, The, 508, 650, 824, 830, 856

Societies and Institutions:
Academie des Sciences de France, 37, 75, 291, 826, 614
Amalgamated Association of Postal Telegraph Engineering Department, 182
American Association for the Advancement of Science, 74, 289, 327
American Electrotherapeutic Association, 758
American Institute of Civil Engineers, 3
American Institute of Electrical Engineers, 289
American Society of Mechanical Engineers, 182, 256
American Street Railway Association, 397, 686
Armour Technical College, 469
Associated Chambers of Commerce, 289
Association of Municipal and County Engineers, 37, 74, 132, 453
Association Suisse des Electriciens, etc., 398
Automobile Clubs, 1, 247, 507, 608, 685, 688, 703, 704, 725, 757, 904
Birkbeck Institution, 397
Birmingham Municipal Technical School, 394
British Association, 37, 220, 169, 292, 335, 337, 339, 343, 370, 375, 378, 380, 381, 382, 385, 401, 434, 436 437, 451, 452, 564
B. M. T. Athletic Club, 897
British Institution of Draughtsmen, 832
Camera Club, 613, 680
Canadian Electrical Association, 509
Chemical Society, 184
City and Guilds of London Institute, 2, 238, 251, 397, 433, 506, 689
Civil and Mechanical Engineers' Society, 397
Crystal Palace School of Engineering, 109, 865
Electrical Engineers (E.E.) Volunteers), 38, 110, 145, 237, 527, 596, 637, 757, 793, 876
Electro-Harmonic Society, 469, 650, 752
Faraday House, 140
Faradian Club, 613, 686
Forthcoming Events (Notices of Meetings), 199, 233, 307, 377, 449, 487, 527, 564, 593, 630, 672, 707, 737, 780, 809, 847, 881, 915
Franklin Institute, 109, 561, 657, 758, 901
Glasgow Technical College Scientific Society, 477, 524, 541, 553, 577, 596, 912
Gloucestershire Engineering Society, 833
Institution of Civil Engineers, 3, 74, 469, 545, 832, 902
Institution of Electrical Engineers, 75, 87, 127, 129, 145, 182, 255, 258, 505, 544, 558, 613, 662, 669 685, 686, 694, 721, 758, 766, 772, 776, 795, 800, 810, 811, 812, 830, 831, 851, 865, 875, 878, 886, 915
Institution of Engineers and Shipbuilders in Scotland, 608, 753
Institution of Junior Engineers, 1, 73, 149, 181, 249, 258, 541, 615, 649
Institution of Mechanical Engineers, 505, 578, 805, 843, 908
Institution of Mining Engineers, 397
International Association of Municipal Electricians, 346, 544, 771
Ipswich Engineering Society, 273, 303
Iron and Steel Institute, 249, 393, 472
King's College, 651
Liverpool Self-Propelled Traffic Association, 685, 904
London University, 505
Midland Institution of Engineers, etc., 579
Motorcar Clubs, see Automobile Clubs
Municipal Electrical Association, 11, 45, 93, 651, 865
National Electric Light Association, 201
National Physical Laboratory, 41
New South Wales Electrical Association, 40, 146
Northampton Institute, 38, 68, 336
North-East Coast Institution of Engineers, 73, 253, 687, 761
Northern Polytechnic, etc., 899
North-West Electrical Association, 77, 193, 217
Ohio Electric Light Association, 362
Physical Society, 217, 633, 746, 794, 898
Rontgen Society, 218, 649, 901
Royal Institution, 1, 649, 794, 847
Royal Meteorological Society, 721, 902
Royal Photographic Society, 501
Royal Society, 797
Societe Internationale des Electriciens, etc., 218
Society of Arts, 76, 608, 759, 770, 832, 844, 884
Society of Chemical Industry, 73
Society for Extension of University Teaching, 1
Society of Model Engineers, 73, 541, 577, 721, 865
South-Western Polytechnic, 289
Tramways and Light Railways Association, 4
University College, Liverpool, 211
Verband Deutscher Elektrotechniker, 42, 86, 117, 192, 229, 267, 551

Soda and Chlorine, Electrolytic Production of, 687
Some Notes on Dr. E. C. Shettle's Views of the Ultimate Nature of Electricity, 232, 271
Some Remarks upon the Cause and Nature of the Electric Force, Dr. Shettle, 265
Some Remarks upon a Hitherto Unrecognised Planetary Law, Dr. Shettle, 590, 634
Southport Tramways, 85, 114
Sparking Experiments, 221
Spark Length, 328, 361
Speed on the London Undergrounds, 482
Speed Regulation, 163
Standard-Gauge Electric Locomotive Exhibited by the A. E. G. at the Paris Exhibition, 442, 492
Standard Time, 880
Starting Torque, 867
Steam, A New Form of Calorimeter for Measuring the Wetness of, 337
Steam Trials, Extended, 110
Steel Rail, Loss of Strength of Committee on, 89
Stevens, J. F., Electrical Measuring Instruments, 513
Stockton Electricity Works, 681
Street Subways, 904
Summerfield, E. D., Prevention of Scale in Boilers, 91
Sunderland Tramways, 294
Supersession of the Steam by the Electric Locomotive, W. Langdon, 776, 800, 846, 851, 879
Swansea Tramways, Opening of, 6
Swenson, B. V., and A. W. Richter, Losses in Small Lighting Plants, 193
Switch, A High-Tension, 521
Symons Memorial, 721

T

Tariffs Remitted, 420
Taunton Electricity Works, 297, 330
Technical Education, 3, 183, 399, 650, 689, 865, 912
Telautograph, The, 125, 696
Telegraphone, The, 724
Telegraphs and Telephones at the Paris Exhibition, J. Gavey, 729, 773

Telegraphy:
in and to Africa, 23, 145, 325, 499, 714, 751, 793, 924
to Alaska, 541
in and to America, 253, 536
at Arbroath, 714
in Argentina, 253
Atlantic Cables, 145, 146, 176, 217
to Belle Isle, 109
Cable Ship "Orizaba," The, 614
in and to China, 73, 233, 292, 319, 397, 427, 536, 787
Committee on, 141
Companies' Meetings, see COMPANIES' MEETINGS, ETC.
Conductivity of Cables, 470
Damage to Wires, 361
in and to France, 361, 506, 729, 773, 901
in and to Germany, 146, 176, 217, 325, 788
at Ilford, 233, 573
in and to India, 361, 397, 649
between Lighthouses and the Shore, 80
between London and Vienna, 217
at Mafeking, 23
Mason, Mr. (New Appointment), 685
Pacific Cables, 74, 102, 145, 184, 644, 667, 721, 757, 812, 829, 867
Pollak-Virag System, 925
at Porto Rico, 759
Postal Finance, 450
Preece, Sir W. H., Lecture on, 758
in Russia, 613
at Sproatley, 428
Submarine Telegraph Jubilee, 307
and Street Subways, 904
Typewriting Telegraph, A, 185
Umpiring by, 397
to West Indies, 329
Wireless, 37, 73, 90, 75, 145, 147, 149, 181, 290, 325, 353, 363, 487, 535, 649, 680, 797, 811, 829, 856, 892, 924
Wires, Protection of, in connection with Electric Traction, E. C. Quin, 97

Telephony:
at Aberdeen, 1
Actions, 135, 500, 605, 717
at Alnwick, 607
in America, 2, 219, 363, 723
and Association of Municipal Corporations, 578
Automatic, 680
at Aylesbury, 607
at Belfast, 680
at Bournemouth, 536
at Bradford, 176
at Brighton, 607, 714
at Bristol, 1
Brussels-London Line, 469
Cablegrams by, 253
Calls, New System of, 1
at Cardiff, 31, 176, 643
in Churches, 1
Companies' Meetings, see COMPANIES' MEETINGS, ETC.
Correspondence on, 212
at Croydon, 925
at Daventry, 211
at Dover, 177
at Eastbourne, 499, 571, 824
at Ellesmere, 571
at Fife, 824
at Folkestone, 680
in France, 218, 865
in Germany, 145, 218, 289
at Glasgow, 290, 501, 901
at Gosport, 714
and the Government, 832
at Grantham, 213, 356, 427
at Grimsby, 752, 788, 823
at Handsworth, 924
at Hartlepool, 681
Hasty Spaniard A (Wrecking Instrument), 469
at Huddersfield, 104, 248, 896
at Hull, 325, 681
in Hungary, 469
in Italy, 572, 865
at Keighley, 824
at Keswick, 714
at Kingsbridge, 861
at Liverpool, 253
in London, 256, 465, 500, 542, 631, 717, 723, 825, 898
at Longton, 645
Loud-Speaking, 182
at Manchester, 896, 925
in Mid-Wales, 429
at Much Wooiton, 537
Municipal, 104, 248, 578, 896; also see under names of towns
at Newark, 31
News Distribution by, 577
at Northampton, 577
at Northfleet, 714
at Norwich, 53
Novelties in, 319
between Paris and Berlin, 211

Digitized by Google

Telephony (*continued*):
Penny-in-the-Slot Telephones, 319, 433
at Perth, 68
at Peterhead, 67
in the Philippines, 471, 759
at Portsmouth, 291, 393, 428, 572, 680
Radio, 437
and the Railroad, H. W. Pope, 277
and Royalty, 146
in Russia, 499, 825, 829
at Salford, 283
at Salisbury, 212
between Ships and the Shore, 577
Sounder, Use of, Preferred, 219
and Street Subways, 904
and Stroud Chamber of Commerce, 896
Strowger Patents, 289
at Sunderland, 926
at Sutton Coldfield, 500
at Tunbridge Wells, 177, 356, 860
at Walsall, 714
at Waterloo, etc., 248
Wireless, 325, 330, 280
Wires, Protection of, in connection with Electric Traction, R. C. Quin, 97

Telpherage, 3
Temperature, Production of High, 477

Tenders Wanted and Accepted:
at Aberdeen, 174, 209, 245, 318, 354, 390, 424, 425, 533, 606, 641, 713, 748, 785, 786, 821
at Accrington, 174, 354
for Acme Wood Flooring Company, 532
in Africa, 28, 681
at Aldershot, 922
at Ashington, 319
at Aston Manor, 65
in Australia, 354
in Austria, 245
at Ayr, 496, 499, 532, 568, 569, 786, 820, 858
at Bangor, 533
at Barnes, 138, 209, 281
at Barnsley, 606, 748
at Barrow-in-Furness, 499
at Barton, 210
at Battersea, 785
at Beckenham, 139, 174, 210
at Bedford, 533, 713, 748
at Belfast, 138, 568, 677, 893
at Bermondsey, 27, 28, 65, 210, 462, 713, 894
at Bexhill, 748
at Birkenhead, 27, 210, 424, 425, 641, 748
at Blackburn, 138
at Blackpool, 28, 246, 354, 748, 785
at Bolton, 893
at Bootle, 174, 462, 678, 821
at Bradford, 138, 281, 318, 354, 390, 424, 425, 532, 641, 748, 786, 858
at Bray, 424
at Bridgwater, 138
at Brighton, 389, 390, 425, 498, 606, 641, 713, 748, 786, 821, 858, 894, 923
at Bristol, 677, 713, 785, 786, 893
for Brookwood Asylum, 246
in Brussels, 499
in Bulgaria, 174, 318, 462
at Burton, 893
at Cardiff, 65, 175, 245, 281, 354, 390, 498, 677, 678, 713, 821, 859
for Central Electric Supply Company, 138
at Chelmsford, 174
at Cheltenham, 65
for City of London Corporation, 641
for City of London Union, 390
at Colchester, 821
for Commissioners of H.M. Works, 319
for Cotswold Sanatorium, 499
at Croydon, 27, 194, 354, 499, 923
in Cuba, 532
at Cupar Fife, 209, 318
at Darlington, 65, 390
at Dartford, 498, 894
at Darwen, 859
at Devonport, 389, 606, 786
at Doncaster, 318
at Dover, 28
at Dublin, 175, 281, 319, 389, 748
at Dundalk, 319
at Dundee, 389, 498, 606
at Eastbourne, 354, 641
at Edinburgh, 174, 354, 893
in Egypt, 138
at Farnworth, 640, 893, 923
at Fenton (Staffs.), 209
in France, 65, 498
at Fulham, 209, 354, 389
in Germany, 174, 605
at Glasgow, 102, 174, 245, 463, 498, 532, 568, 785, 923
at Grantown-on-Spey, 532

Tenders Wanted and Accepted (*continued*):
at Grays, 533, 569
at Greenock, 281, 463
at Greenwich, 677, 786, 923
at Grimsby, 65, 102, 174, 463, 748, 749
at Hackney, 174, 245, 389, 463, 606, 641
at Halifax, 138, 174, 713
at Hammersmith, 175, 281
at Hampstead, 174, 281, 923
at Hanley, 174, 390
at Hapton, 65, 138, 210
at Harrogate, 785
for Hart Accumulator Company, 425
at Harwich, 641
at Hendon, 713
at Heywood, 425, 893
at Hornsey, 748
at Hoylake, 424
at Huddersfield, 27, 240
at Hull, 65, 102, 174, 281
in Hungary, 748
at Ilford, 245, 424, 425, 713, 785, 893
for India Office, 463
at Islington, 28, 65
in Italy, 65, 923
at Keighley, 28, 821
at Kendal, 533, 640, 680
at Killarney, 606
for Lancaster Infirmary, 280
at Larne, 174
at Leeds, 65, 174, 209, 281, 354, 425, 499, 568, 641, 821, 858, 893
at Leigh, 785, 786, 821
at Lewes, 748
at Limerick, 389, 569, 677
at Lincoln, 174
at Liverpool, 65, 210
for London City Corporation, 499
for London County Council, 65, 102, 245, 319, 354, 532, 569, 641, 677, 678, 786, 821, 893
for London School Board, 786
at Long Eaton, 425
at Longton, 65, 641
at Louth, 641
at Lowestoft, 27, 281, 568, 859
at Luton, 65, 209
at Maidstone, 462, 859, 893
at Manchester, 27, 28, 65, 102, 210, 245, 354, 424, 641, 748, 858
at Medomsley, 425, 499
for Metropolitan Asylums Board, 786
at Mexborough, 319, 821
at Middlesbrough, 281, 390
at Middleton, 354, 463, 533, 606, 677, 821
for Midland Railway, 640
at Nelson, 245, 246
at Newcastle-on-Tyne, 174, 245, 354, 425, 533, 640, 677, 748
at Newington, 65, 859
at Newport, 27, 209
in Norway, 353, 499
at Nottingham, 353, 463, 641
at Nuneaton, 390
at Oldham, 281, 713, 748
for Pacific Cables, 102, 821
in Paraguay, 858
at Partick, 858
at Pemberton, 568
at Perth, 318, 678
at Plumstead, 209
at Poplar, 318, 923
at Portsmouth, 174, 209, 281, 390, 748, 893, 894
at Preston, 318
at Radcliffe, 319
at Rathmines, 785
at Rhyl, 821
at Rochdale, 27, 245, 354, 390, 424, 533
at Rotherham, 923
in Roumania, 318, 858
at Rugby, 65
in Russia, 65, 174, 893
at St. Pancras, 65, 786, 821, 923
at Salford, 65, 209, 319, 354, 678, 748, 858, 923
for Sculcoates Guardians, 319
at Sheffield, 65, 246, 424, 678, 713
at Shipley, 245, 463
at Shoreditch, 605, 677
at Southampton, 245, 281, 318, 463, 499, 606, 893, 894, 922
at Southend, 27, 102
for South London Supply Corporation, 174
at South Shields, 210
at Southwark, 748
in Spain, 27, 28, 65, 174, 424, 462, 463, 499, 532, 713, 858
at Stafford, 102, 569
at Stockport, 102, 533, 641, 677, 713, 893
at Stoke-upon-Trent, 65
for Strand Board of Works, 568, 677
for Suffolk Asylum, 389, 607

Tenders Wanted and Accepted (*continued*):
at Sunderland, 65, 354, 462, 785, 786, 821, 923
at Swansea, 462, 568, 821, 858, 923
at Swindon, 786
at Thetford, 858
at Thorp Perrow, 102
at Torquay, 102
at Tunbridge Wells, 28, 318, 424, 425, 533, 749
for Tussaud's Exhibition, 28
at Walker, 641, 677
at Walsall, 569, 713
at Walthamstow, 319
for War Office, 533
at Warrington, 174, 354, 462, 678
at Watford, 677
at West Bromwich, 677, 858
at West Ham, 28, 748
at Whitby, 209, 569, 677, 923
at Whitechapel, 498, 786
at Wigan, 424, 499, 569
at Wimbledon, 28, 319
for Winwick Asylum, 821
at Witney, 463
at Wolverhampton, 498, 568, 748, 858
at Worksop, 245, 463, 533
at Worthing, 245, 281, 499, 533, 713, 858
at Wrexham, 318

Tesla, N., Some Novel Inventions of, J. Wright, 190
Thefts, 284, 680, 819
Thompson, Prof S. P., Construction of Large Dynamos as Exemplified at the Paris Exhibition, 374
Thompson, Prof. S. P., Electricity in the Industries, 451
Tivoli Theatre Improvements, 357
Tramways Exhibition, 20, 50
Tramway Shares, Purchase of, 721
Transformer, The Helios, 363
Transvaal, The, 525
Turbo-Alternator, A Large, 93
Turnbull, C., Development of the Density Factor, 875
Turner, Sir W., Address to British Association, 943

U.

Unexplained Phenomena, 111
Uranium Radiations, 87

V.

Vacuum Electroscope, A, 2
Viagraph, The, 436
Victorian Coal, 753
Vienna Exhibition, 37, 261
Voltage, Standard, 109, 217
Vote Recorder, A, 284

W.

Wakelam, H. T., Light Railways from a County Surveyor's Point of View, 132
Wall Ping, A High-Voltage, 424
War Fund, The, at Leicester, 476
Warrilow, W. E., The Evolution of Switch Gears for High-Pressure Alternating Currents, 139, 224, 274, 307, 371, 417, 488, 510, 608, 669
Warships, Speed of, 254
Waterfalls, Capital Value of, 686
Water Power Plants, 38, 299, 541, 686, 822
Water-Softening Plant, A, 824
Water, Specific Heat of, 290
Waves, Utilisation of, 218
Weddings, 31, 145
Wiedmann, H., Paris Exhibit, 320
Wilkinson, G., The Distribution of Electricity, 47
Wind Power and Electricity, 615, 788
Wireless Telephony, Sir W. H. Preece, 330
Wiring, 4, 291, 526, 542, 572
Wood Paving Blocks, 789
Wordingham, C. H., Maintenance of Certain Portions of Distributing Systems at Earth Potential, 93
Workmen's Compensation Act, 393
Wright, J., Some Novel Inventions of Nikola Tesla, 190

X.

X Rays, 39, 330, 472, 649

Z.

eppelin Airship, 577

Digitized by Google

THE

ELECTRICAL ENGINEER.

No. 1, Vol. XXVI. LONDON, JULY 6, 1900. PRICE 3D.

NOTES.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, Sir James Crichton-Browne, treasurer and vice-president, in the chair, when the special thanks of the members were returned to Dr. Ludwig Mond for his donation of £150 to the fund for the promotion of experimental research at low temperatures.

German Electrical Exports.—From trade returns published in Germany recently we gather that the exports of electrical machinery from that country during February greatly exceeded those of the preceding month, the weight in machinery being some 630 tons, as against about 350 tons in January. Of this total the United Kingdom took 44 tons, as against 28 tons in January.

University Extension Lectures.—The Society for the Extension of University Teaching do not appear to be neglecting their work during the summer months, as arrangements are now being made for the autumn courses of lectures. Thus we notice that the society intend to give another course of free pioneer lectures in St. Pancras, and have asked for the use of the vestry hall for one night a week for 10 weeks for this purpose.

Telephone Calls.—The great success of the new installation at the exchange of the National Telephone Company at Bristol of what is known as the common or central battery system, has decided the company to add it to other exchanges throughout the country. This system does away with the call bell, its place being taken by an incandescent electric lamp instead of a number, as now in use on most telephone switchboards. By the new method of signalling, the mere act of the subscriber lifting his receiver off the hook indicates to the operator that he wishes to communicate with the exchange. The system is, we learn, to be at once introduced, so far as London is concerned, into the new exchanges at Kensington and London-wall.

Ecclesiastical Telephones.—The first introduction of the telephone into church in the Aberdeen district, in order that the deaf may hear what is being said, has just been made by the Rev. J. Ure, of the Woodside U.P. Church. The telephone, we learn, is fitted up so that it can communicate from the pulpit to any pew in the church. The apparatus was tried last Sunday for the first time, and proved very satisfactory. We certainly think that the small telephone receiver would be much preferable to persons hard of hearing than the old ear-trumpet, but we question if persons in such a condition would hear what was said in the telephone, or if this were loud enough to let them hear, if it would not distract the attention of those round who could hear well.

The Pan-American Exhibition.—Our friends across the water do not mean to suffer from want of electrical power at the Pan-American Exposition next year. They have, we learn, already made arrangements for the supply of some 4,000 h.p., in addition to the 5,000 already contracted for from the Niagara Falls. An auxiliary power-house is to be built outside the exhibition grounds, where electricity is to be generated with steam and gas, and this plant will supply energy in case of any failure in the Niagara supply. It is to be hoped that that portion of the Exhibition Committee who are to look after the electrical work will attend to the matter of the safety of the buildings if fuses burn out, and not arrange everything in favour of a fire, as is done in the great French Exhibition.

Lead-Poisoning.—On Thursday afternoon last week the question of the prevention of lead-poisoning in the Potteries occupied the attention of a drawing-room meeting at the house of Mrs. Asquith, in Cavendish-square. Amongst those who spoke on the matter was Dr. Lewis Jones, who is well known in connection with electrical treatment at St. Bartholomew's Hospital. He expressed the opinion that electrical treatment would do more, and do it more quickly, than drugs and medicine in cases of lead-poisoning. It must, however, be done systematically, and in an establishment properly equipped for the purpose. Amongst other speakers at the meeting were the Duchess of Sutherland, Lord Hugh Cecil, and Canon Gore, who all agreed that something must be done to combat the evil of lead-poisoning in connection with pottery-making.

Institution of Junior Engineers.—On Friday last the members of this institution visited the works of Messrs. Caird and Rayner, 777, Commercial-road, Limehouse, at which are manufactured evaporators, condensers, feed heaters, and pumps. Under the guidance of the manager and staff the members had fully explained to them the system of manufacture, erection, and testing employed. The motive power in the works is electricity, current being generated on the premises from a dynamo driven by a gas-engine, and a number of electric motors work sections of the shafting. The lighting is also carried out by electric incandescent lamps. We also note that on July 14 this institution is to pay a visit to Lord Rothschild's estate at Tring, to inspect electrical machinery and the Hon. Walter Rothschild's zoological museum, etc. The members will leave Euston by the 1.45 p.m. train.

The Recent Motor Tour.—The official report of the recent 1,000 miles' trial of motor vehicles promoted by the Automobile Club has just been issued by the committee of 15 experts connected with the mechanical engineering world, including Sir William Preece, Major H. C. L. Holden, Prof. C. Vernon Boys, and Mr. W. Worby Beaumont. Sixty-three vehicles started for the journey to Edinburgh and back—a distance of about 1,100 miles—49 of them covering the distance in 11 days. The report refers to the carriage owned by the Hon. C. S. Rolls, which ascended the first 8¼ miles of Snap Fell, a hill 10 miles long, and rising from 150ft. to 1,400ft. above the sea-level, at the rate of 27½ miles an hour. The remaining 1½ miles was composed of gradients varying from 1 in 10 to 1 in 17, and was covered at the rate of

Digitized by Google

17¾ miles an hour. Vehicles of considerably less power, the report further points out, ascended the hill with ease at speeds far in excess of the pace at which it could be ascended by a horse-drawn vehicle. Some 60,000 miles of motor travel, concludes the report, were accomplished without an accident caused by a motor vehicle occurring to other users of the road.

City and Guilds of London Institute.—The report of the Governors of the City and Guilds of London Institute for the year 1899, which was recently issued, contains some interesting information on the contentious question of the distinction between universities and technical schools. It gives a list of 11 students past and present who volunteered and were accepted for active service, while most of the men working the Marconi apparatus at the front are stated to be from the Finsbury and Central Colleges. Details are then given of the various classes number of students, etc., in the Central Technical College,' there being 211 students in the electrical engineering branch. The South London Technical Art School is next dealt with, after which comes King's College, of which particulars of grants and medals, etc., are given. The latter part of the volume is taken up with appendices giving a short history of the City and Guilds Institute; a report of the Central Technical College for the previous year; a report on the Technical College, Finsbury, for 1898-9; reports for the same period on the South London Art School and the Technological Examinations Department, and also on the Leather Trades School; and the address by Sir Douglas Fox on presenting the certificates and prizes of the institute on Feb. 15, 1900.

Meter Inspection.—The question of the official supervision and guarantee of electricity meters is, we learn, claiming considerable attention in Germany. It is sought to determine the permissible error corresponding to different loads in connection with such meters, and also to what extent they should be officially guaranteed or subjected to periodical inspection. In this connection an appeal has been made to manufacturers to obtain their opinions as to when it would be advisable to introduce compulsory standardisation of meters. The *Elektrotechnische Zeitschrift*, in a leading article, gives some interesting data with reference to the extent to which meters are employed in Germany. The figures are the result of careful enquiries; nine manufacturing firms, besides 950 central stations and private installations, having been appealed to for information. From the information so obtained it was estimated that on July 1, 1899, there were in Germany some 126,000 electricity meters, though 60,000 only of these were in actual use. The returns given by the manufacturers further proved that the increase in the number of meters employed amounted in 1898 alone to 20,000. With regard to compulsory standardisation, it would appear from the answers received that the manufacturers concerned would like this delayed as long as possible.

Vacuum Electroscope.—In a recent number of the *Elektrotechnische Zeitschrift* there appears a description of a vacuum electroscope which has been constructed for experimental purposes. The apparatus has the form of a pear about 4½in. in length, its top consisting of a hollow aluminium ball, which rests upon an aluminium wire welded into the glass. This wire projects into the interior of the electroscope, where it takes the form of a flat ribbon, to which the broad pendulum leaves are attached, these latter being of aluminium foil about ⅔in. long and ⅓in. broad. In the lower portion of the glass bulb are two platinum wires welded into the sides of the bulb very close together. Experiments with the instrument proved the vacuum to be a perfect insulator, and that delicate electrostatic effects might be obtained with it. The ordinary electroscope experiments succeeded when applied to the apparatus, though the heavy charges on the glass walls which occurred during these experiments had a disturbing influence. When the apparatus was observed in a dark room, no trace of luminosity was apparent in it during the occurrence of strong electrostatic effects. Discharges of electricity into a vacuum are therefore dark, from which it may be concluded that the phenomena of light are dependent upon the presence of material such as would be found in air.

The American Telephone Convention.—The subject which occupies considerable space in the issues of our American contemporaries just to hand is the Independent Telephone Convention, which was held in Cleveland, Ohio, on June 12, 13, and 14. The meeting took place in the Electric Building, the offices of the Cuyahoga Telephone Company. The president, Mr. J. M. Thomas, delivered his presidential address on the Wednesday, in which he stated that since the previous congress the American Bell Telephone Company had passed into the hands of the American Telephone and Telegraph Company. There were now about 2½ million telephones in operation in the United States, including the Bell and independent companies. He believed that at reasonable prices seven million would be used. The Bell Company were a long time creating a demand for telephones, but since the independent movement the demand had grown enormously. If the Bell Company had not been hampered by a short-sighted policy, they might have advanced to an impregnable position before the patents running out allowed the other companies to take the field. In a paper on "Toll-Line Traffic," Mr. J. B. Ware, of the Citizens' Telephone Company, said toll-line business was always larger than was anticipated, and always proved a good investment. He thought that air line distances should control toll rates between points more than 50 miles apart, inside which limit local rates should obtain. The length of conversation should be three minutes, and a clearing house should be established to settle toll fees. The Hon. Hugh Dougherty, on the subject of "Telephone Investments," stated that he thought the telephone completed the trinity of business necessities—namely, the mail, the telegraph, and telephone. Many other papers of an interesting nature were also read.

The Dublin Bill.—By the narrow majority of six the Dublin Electrical Bill has been thrown out on the third reading in the House of Commons. Our readers will remember that this Bill would have authorised an electric lighting company to compete in Dublin with the Corporation electric supply. The Bill was passed through committee chiefly on the grounds that the Dublin Corporation had been most negligent in providing electric light for would-be consumers in Dublin, and that the Corporation had shown itself incapable of efficiently managing its undertaking. We, therefore, agreed with the passage of the Bill, which was brought forward at a time when the Corporation had again shown evidences that it would amend its ways. The present decision in the House of Commons is practically a verdict that while the Corporation of Dublin has shown itself a serious defaulter in the past, it is to be given one other chance before being branded as the owner of the first municipal electric lighting undertaking against which competition had to be granted. Personally, we think that even now the competition would be beneficial both for the electric lighting consumers of Dublin and for the Corporation itself. The speeches made at the third reading of this Bill in the House of Commons are worthy of careful perusal. Thus Mr. Ritchie, who usually inclines to favour municipal authorities, stated that he could not believe that the Corporation of Dublin was so feeble as to

Digitized by Google

be unable to obtain money to carry out the obligations as regards electric lighting, while at the same time it was conducting its ordinary duties as a corporation. Looking at the matter from the standpoint of the interests of the consumers, he thought it advisable that the now defunct Bill should be carried. Those speakers who supported the Corporation did so largely from sentiment. We trust that the narrow shave which the Dublin Corporation has had will be a good lesson to those other municipal authorities who, owning provisional orders, are not working them, or are working them in a perfunctory way.

Telpherage.—We have received some leaflets from the Consolidated Telpherage Company, of New York. The object of the company is to provide automatic methods, by the use of electricity, for the quick and economical transportation of mails and other light material. Telpherage, we are informed, is divided into four classes—viz., electric overhead transportation by means of aerial cableways, electric tube dispatch, electric overhead tramrail, and automatic narrow-gauge railway. As to aerial telpherage, this means consists of an electrically-driven car running on wires erected on high poles. One of the chief characteristics of the aerial system of the company is what is called the unit system. After many trials this was selected as the most flexible, and the one which most successfully fulfilled the greatest number of conditions. The unit consists of the combination with a suspended car of a shaft rigidly fixed to the supporting wheels, and electric motors on each side of the wheels having their revolving armatures fixed rigidly on the shaft. These motors are combined with a frame which connects them together. A unit combined with the yoke, including a trailing wheel, constitutes a telpher truck, and is termed a single-unit telpher. Two units combined by the yoke are termed a double-unit telpher. There is no gearing machinery on these motors, any speed variations being made by changing the size of the driving wheel of the unit. The motors are iron-clad and waterproof. The electric tubular dispatch is another branch of telpherage, and consists of tubes, of various materials, in which are steel rails. On these run cars propelled by small motors, and a speed of 50 miles per hour is said to be obtainable. A complete block system is provided in the tubes, the cars being switched on to their proper rails automatically. It is also arranged that the aerial cars can be transferred from the overhead arrangement to the underground without disturbing the cargo. It is a pity that the term "telpherage" should be used to cover underground systems. The past experience of English engineers in the overhead work should serve the company well.

Science and Technics.—In the June number of the *Wisconsin Engineer* we notice an address, delivered by Mr. B. A. Berend, of the engineering school of the University of Wisconsin, on the above subject. Mr. Berend's experience in electrical matters was gained in Germany, and he has proved himself by his technical writings to have profited by the education afforded him by his own country. Now he is located in the States, and his views as to the shortcomings of the educational system of Germany and on the general relations between science and technical engineering are of great interest. In his address the author deplored the contempt for facts and observation which was rampant in all German universities in the beginning of the present century. We presume that, in order to be correct when speaking of Germany, we should say at the beginning of the last century. For instance, Liebig, the great chemist, deplored that he had been cheated out of two precious years of his life by listening to the aimless and purposeless teaching of Schelling. The outcome of this highly speculative school of teachers was that Germany did not play the part it should have done in the early days of electrical engineering, but the author shows that his country, recognising its deficiencies, has since made strenuous efforts to overcome the same, and has been most successful in these. He proceeds to refer to a number of German physicists who have done much to give real scientific instruction, and at the same to keep this instruction in touch with practical engineering. Naturally, Prof. Hertz is mentioned. Discussing the examination question, Mr. Berend favours the German practice of making the universities places at which students have the right to hear any lectures they choose, without any restrictions as to which they should attend, and without any competitive examinations. There are a certain number of students who might be made to do average work under a more severe discipline, but the students wishing to acquire information in any particular subject are not hampered by restrictions such as obtain in some English colleges. In the author's opinion, the great drawback of the German polytechnic institutes is the onesidedness of their various departments. While he believes in specialisation, he thinks that a more general view of other branches of science should be given. In this he holds that the combination of scientific, technical, and literary education as is done in the States is to be highly recommended.

Institution of Civil Engineers. — The visit of the American Society of Civil Engineers to accept the hospitality of the London institution duly commenced on Monday last, when Sir Douglas Fox, the president of the English institution, received the representatives of engineering from the States and Canada. In his speech Sir Douglas sympathised with the visitors on the sad occurrence at New York. During the last year or two this country had experienced much to make them serious, but there had been one bright rift in the cloud—namely, the sympathy and the hearty fellowship which had been shown them by the United States. If both stood together for what was right and true nothing could prevent that progress which all desired, and it was a great advantage that men of science could approach such questions with a calmer mind and more resolute determination to pull together than was generally displayed in the political world. Indeed, even on the Continent during the last few years there had existed a friendly feeling. He was addressing strong competitors, but competition was looked for, and he thought that they in this country would be able to learn something from their visitors, for the engineers of the United States and Great Britain would have a great deal to do with the future of the world. When the Queen had heard that the American engineers were coming over, her Majesty was kind enough to order that the palace and grounds of Windsor Castle should be thrown open to them on Tuesday afternoon. On Thursday they would be received at the Guildhall, and on Friday at Warwick Castle by the Countess of Warwick. Mr. J. F. Wallace (the president of the American Society of Engineers), Mr. Jesse M. Smith, and Colonel Haynes having acknowledged the welcome, the visitors partook of refreshment, and later listened to the presidential address at their thirty-second annual convention. At night the subject of the height of buildings was discussed. During the afternoon much interest was displayed in the telautograph, which was exhibited at work in the hall, the circuit being 200 miles. By means of this apparatus handwriting can be telegraphed, the sender merely writing his communication in his ordinary handwriting, at any speed, on a roll of paper 5in. wide attached to the instrument. The communication thus sent is reproduced instantly on a similar roll of paper

Digitized by Google

attached to a similar instrument at the other end of the line, whether ordinary writing, cipher, shorthand, etc. The Queen gave a personal welcome to the engineers on Tuesday at Windsor.

Fuse Wire.—The material used for fuse wire on various electric lighting circuits is still varied according to the opinion of the engineer in charge of the undertaking. Of the various materials which are employed, tin and copper are most usually found. The use of tin is said to be bad by those engineers who prefer to use copper wire, because the fuse cannot be depended on after a certain length of time has elapsed. The opposite school, on the other hand, object to copper wire on the ground that it is necessary to run the same at a rather high temperature, unless a very large margin is allowed between the working load and the point at which the fuse blows. The real disadvantage of the tin fuse is, we believe, a mechanical one. The fuse wire is soft, and when screwed up it undergoes deformation. Unfortunately, this is not the only outcome of the softness of the material, and it seems from actual experience that with the slight expansions and contractions of the metallic parts of the fuse, due to the heat of the current in the fuse wire, the portion of the same under the terminal is gradually flattened still more until it is a loose fit. This causes more heating again, and in the end the fuse will blow at the terminal, and at a current often below the normal working current of the installation. The best way of overcoming this difficulty, and still retaining the advantages of the low melting point of the tin over that of the copper, is to provide heavy brass washers with a broad sawcut on one side of the same, into which the tin fuse wire can be soldered. These brass washers give a good connection with the terminal blocks, and also sufficient surface to prevent local heating The other method of avoiding the difficulty is to employ the copper fuse wire above referred to, and this is often done, but a molecular change seems to take place in these fuse wires in the course of time which renders it expedient for them to be inspected at intervals. We recently heard that one of the electrical officials of the Paris Exhibition was aghast at the fact that a copper wire could be used for a *plomb*. He argued that a *plomb* must be lead, and if a copper wire were used it would disorganise the whole system. We believe that this gentleman is still in charge of the Exhibition fuses, and we trust that he may not have to interview the fire insurance offices when the fuses under his charge set fire to the floors of the Exhibition.

Wiring Fireproof Buildings.—Mr. G. H. Jones gives in the *Wisconsin Engineer* some notes on electrical construction in fireproof buildings. He takes as his text the work carried out on the Merchants' Loan and Trust Building, Chicago. This building is a 12-storey one, occupying 18,000 square feet of ground space. The total floor area thus works out at about five acres. The electrical equipment of the building consists of some 5,000 16-c.p. lamps and 350 h.p. of motors, besides bells, telephones, watchmen's circuits, etc. The building is provided with two wire-shafts from the basement to the attic in the west portion, and one shaft from the third storey to the attic in the east portion. In these shafts the feeders and risers are run on porcelain insulators. At each floor-level the cables are fitted with split bushings, around which the flooring is to be laid. This transforms the cable-shafts into tiers of pockets, and overcomes the fire risk from open raceways. The wiring throughout, except the feeders and risers in the wire-shafts, is run in coricated iron conduits of standard gaspipe weights, there being over 12 miles of it used. The conduit is run as a complete iron-pipe job from cut-out cabinet to farthest light, each outlet being fitted with a cast-iron outlet box, into which the conduits are securely fastened by means of locknuts. The supply for the building is taken on the Edison three-wire system from the public mains, the voltage at the lamp terminals being 113. The motors are connected across the outside wires of the three-wire system at 230 volts. The electrical energy is distributed throughout the building by five lighting feeders and six power feeders, which emanate from a large distribution board at the basement. The lighting mains feed into sets of risers at central points, dividing the load equally. From these risers connections are taken off at each floor to supply current for main distributing centres located in the meter closets. All office floors are provided with two such closets, in which meters and cut-outs are placed, a meter loop being left for each office opening on a corridor. Each room has a separate circuit, even though there are only four or five lights on it. This gives great flexibility in case different offices are to be grouped together on one meter. The circuits terminate in cut-out cabinets made of sheet steel and having steel doors fitted with Yale locks. These cabinets are lined and faced with polished marble, which conceals wires and ends of conduits. All circuits are protected by Edison plug cut-outs, arranged so as to permit of their being grouped together as may be desired.

Tramway Profits.—In a paper read last Friday by Mr. C. H. Gadsby before the Tramways and Light Railways Association at the Agricultural Hall, the author stated that the problem of working tramways was to increase the gross receipts without unduly increasing working expenses. The first direction to which one would turn was naturally to increase gross receipts, and this increase might be effected by raising or reducing the fares according to circumstances, increasing the services, by better cars, better heating and lighting, better attention, and numerous other means; the increased service, however, being the one to which receipts responded most readily. To illustrate this the author gives a table showing the increase on a certain English steam tramway from this means, in this case the mileage being doubled in seven years, and the number of passengers and gross receipts being more than doubled, while working expenses had increased only about 70 per cent., giving a good net result. As to the receipts per car mile of tramway, these on British tramways varied from about 7d. to about 2s., but the author considered that for electric and cable lines any rise in receipts per car mile above 9d. should be at once checked by an increased mileage. In the case of horse tramways the limit should be 12d., and steam tramways 14d. or 15d. The author then gave a calculation to show that by increasing the mileage a larger clear profit could be made, while keeping down the receipts per car mile. Mr. Gadsby proceeds to give tables showing the average working expenses of horse, steam, and electric traction. With horse trams it appears the average total working expenses amount to 9½d. per car mile, those of steam 10¾d. per car mile, of which engine power costs 3½d. Taking the average working expenses of eight electric lines, the author works them out at between 5d. and 6d. per car mile, the cost of motive power being much lower. A table showing American experience with electric tramways agrees very closely with that of the English lines. The paper then contains remarks on the size of plant to be used, the wages and hours of tramway men, the time lost by both cars and men at the termini, etc. The author's conclusions are then given, these being: that it is generally possible by increased services to increase the gross receipts; that the operating expenses do not increase at the same rate as the mileage, and generally at a less rate than the receipts; that services

Digitized by Google

judiciously increased generally result in larger net profits; that electric traction constitutes the readiest means of increasing the receipts, and at the same time of reducing working expenses; and that on tramways already equipped in this country there is scope for reduction of operating expenses and increase of profits.

An Old Railway.—As will be gathered from our notice of the Swansea electric tramways, the British Electric Traction Company propose to commence at once to equip the Swansea and Mumbles Railway for electric driving. The history of this railway is unique, dating from 1804, when a Bill was brought before Parliament for the construction of a canal from Swansea to the Mumbles. We believe that at the last stage of this Bill it was deemed advisable by the promoters to include other means of transit than by water. The line was first equipped with stone rails, and was used principally for carrying limestone from the Mumbles to Swansea. Some idea of the value of the traffic on this line can be obtained from the following figures. In 1864 the line was sold for £20,000 to its present owners. In 1877 it was leased to the present tramway company for an annual rental of £1,500. In 1890 the Mumbles Railway Company agreed to pay the tramway company £1,000 per annum to forego this lease. Now we believe the tramway company has agreed to lease the line in perpetuity at a rental of £10,000. We need hardly say, after our personal examination of the line, that this rental is not justified by the present traffic. The line is now worked by steam engines drawing a train of from four to six coaches, according to the time of day and season of year. On bank holidays the rush is so great that the present plant is quite inadequate for the handling of the crowd which wishes to get to the fresh air of the Mumbles. For instance, on Whit Monday last over 25,000 people were carried, and we are informed (not by the tramway officials) that another 5,000 walked, because there was no chance of their hanging on to any unoccupied portion of the cars. With the present steam plant only 15 trains per day are run in each direction, which is equivalent to about one train per hour. As the district served is a residential one, private houses lying round the whole of the bay, it is obvious that this infrequent service is a great drawback, both for the line and the inhabitants of the district. It is this regular traffic which enables the line to earn dividends. If the line when equipped were to use the same large bogie cars as are now employed, and the train of six carriages were divided up into six trains of one carriage, a much more useful service would be obtained. We are confident, however, that the very fact of increasing the frequency of the service will multiply at least threefold the number of people travelling, particularly on the journeys to the stopping places in the middle of the line. In fact, we know of no line in which the conversion from steam to electricity offers greater advantages. As a physical connection will be made also between the line and the tramway system, a still further advantage will accrue. We trust that when we next visit Swansea it will be to see the inauguration of the electrical equipment of this Mumbles railway.

Modern Tramways.—At the Agricultural Hall last week, Mr. J. Young, manager of the Glasgow tramways, read a paper on "The Functions of Modern Tramways," specially referring to Glasgow. In this paper he stated that electric tramways have come as a godsend to those municipal bodies having to solve the housing problem. In the ordinary way electric cars were quite as safe as horse cars, and the Glasgow cars running on 60ft. well-jointed rails were as comfortable to travel in as could be desired. A car service must be regular, and at as short intervals as possible. As to the speed of the tramway car, that should depend on the power to control and stop it, and also on the nature of the traffic in the street. The maximum speed of eight miles per hour allowed by the Board of Trade was, he thought, too low for suburban traffic, although quite high enough on a crowded street. One great benefit of electric tramways was their economy of space, the horse space not being required. Coming to the work of the Glasgow Corporation, he stated that the tramways in that town dated from 1871, at which date the Corporation leased them for 23 years. In 1894 they proceeded to operate them as a municipal department, and when the extensions under the Glasgow Act of 1899 were completed he estimated that the system would extend to 121 miles of single track. The actual mileage would be a little over half of this, however, as the lines were almost all double. Of this 121 miles, 34 were outside the city boundary; and the population served by the Glasgow system was put down at 850,000. In 1896 a deputation was sent to Europe and America to report on electrical systems of tramways, and in 1898 a temporary power station for about 50 cars on the overhead trolley system was equipped. The success of the experimental line was so great, that after two months the Corporation decided to adopt the overhead system on the whole length of line. The scheme now being carried out makes provision for one central generating station and five sub-stations, and for eventually working 1,000 cars. The scheme was far advanced, and the Corporation expected to operate the bulk of the system at the time when the Glasgow International Exhibition was opened in May, 1901. The cars in Glasgow were only stopped at fixed stopping places, and a great traffic was created by means of halfpenny fares, the average distance for which fare was about half a mile. The lowering of the fares seemed to increase the net revenue. The number of passengers carried in 1894 5 was 57,000,000, and the receipts £222,000. In 1899 1900 these had increased to 127,600,000 and £465,000 respectively. Their experience with the small installation was that the total working expenses with electric traction were 6¼d. per car mile, as compared with 9d. with horse traction. There was, of course, interest on the greatly increased capital to provide for, but the saving in expenditure of 2d. per car mile was assured, and there was also a substantial gain in additional receipts. In fact, after deducting working expenses from gross receipts, the net revenue for the year ended May 31 last was 2·63d. per car mile with horse traction and 7·63d. with electric traction, a difference of 5d. per car mile in favour of electric traction. Next year, he thought, with the adoption of electric traction generally, the fares would be further reduced. In fact, the Tramway Committee had had before them for some time a proposal for next year to extend the ½d. stage, which would make the 1d. stage about three miles. The policy of the Glasgow Corporation was to carry the people at as low fares as possible, always keeping a safe margin for a reserve. They could not fall back on the ratepayers for any deficit. On the other hand, there was no attempt at relieving ordinary city rates with tramway profits The rates were imposed to pay for necessary work of various specific kinds performed for the community, and the work of each department was accounted for separately. Glasgow Corporation made its own gas, but did not, however, ask the consumers of gas to pay more than the cost of production in order to lessen the police, or sanitary, or any other rates. The same with the tramways; the benefits went to the users in cheaper fares and a better service.

Digitized by Google

THE SWANSEA TRAMWAYS.

The electrical tramways at Swansea, which were opened on Saturday last by the British Electric Traction Company, have had a very stormy history. The tramlines which are now converted to electric traction were originally laid down by the Swansea Improvement and Tramway Company. When the period of this company's Act was almost expired, the Swansea Corporation attempted to get the tramways into their own hands. For this purpose they brought a Bill before Parliament for the famous triple scheme, by which tramways, electric lighting, and refuse destruction were to be combined under one management. Numerous experts were called in on the question to confirm each other's reports, but, owing to some parliamentary formalities having been broken, the Bill was rejected. At the same time there was a Bill before Parliament for the conversion of the tramways to electrical driving promoted by the British Electric Traction Company, which had obtained a controlling interest in the Swansea tramways. As the Corporation Bill had failed, the company's Bill was allowed to pass, which gave a new life to the tramway undertaking in Swansea. In consequence of this, a complete reorganisation of the undertaking was commenced.

The next step taken by the tramway company was to apply for parliamentary powers to extend their tramways to the various outlying districts round Swansea. These extensions would, of course, be of great value to the inhabitants of these outlying districts, provided that the extension lines were equipped and run under one ownership with the old tramways. Here, however, the company was not successful, the opposition of the Corporation being so strong that the Bill was thrown out. Now the Corporation are themselves applying to the Light Railway Commissioners for powers to carry out practically the programme initiated by the company. What the success of this scheme will be it is difficult to say; but it seems to us that, even should the Corporation obtain the necessary powers, it would best serve the convenience of the public if the powers were afterwards leased to the company. If, then, an annual rental is asked for the right to construct these extensions, this rental becomes a direct tax on the users of the tramways, which is not to the advantage of the town and trade of Swansea.

The track now being used is entirely new, and it speaks volumes for the energy and organisation of the engineer responsible under the company for this work, Mr. Howard Smith, that this change was made without interrupting the horse tram service. The trams are now running over five miles three furlongs of route, connecting up Swansea, and of this some $2\frac{3}{4}$ miles is of single track. The equivalent length of single track is just over eight miles. The new rails are of the steel girder type, weighing 87lb. per yard. They were supplied by the Lorain Company, of America. The space in between the rails has been filled in with granite setts. Some parts of the routes were exceedingly hard on the horses, as on one section there is a half-mile of tramway with an average grade of 1 in 24. In this length a grade of 1 in 22 lasts for over a furlong. The curves, too, were severe, and these have been, where possible, improved by the company in reconstructing.

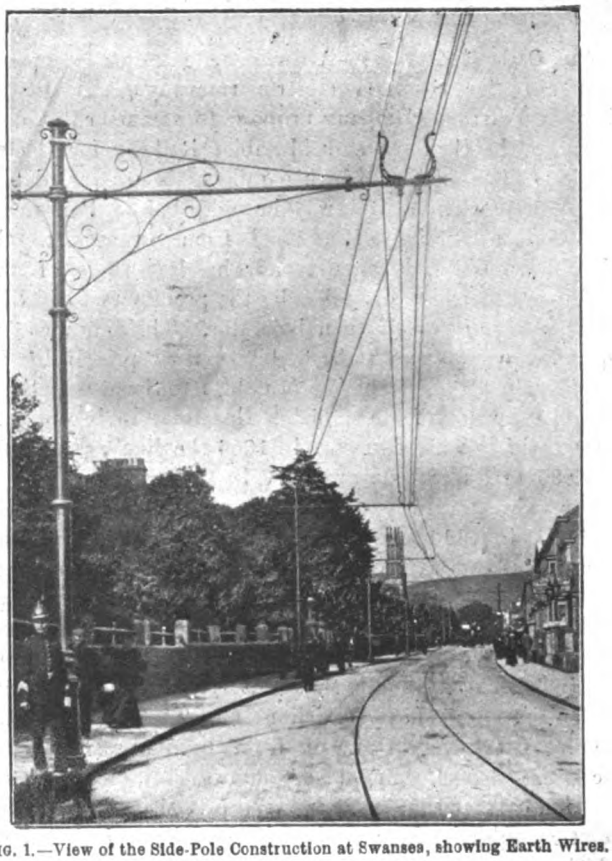


FIG. 1.—View of the Side-Pole Construction at Swansea, showing Earth Wires.

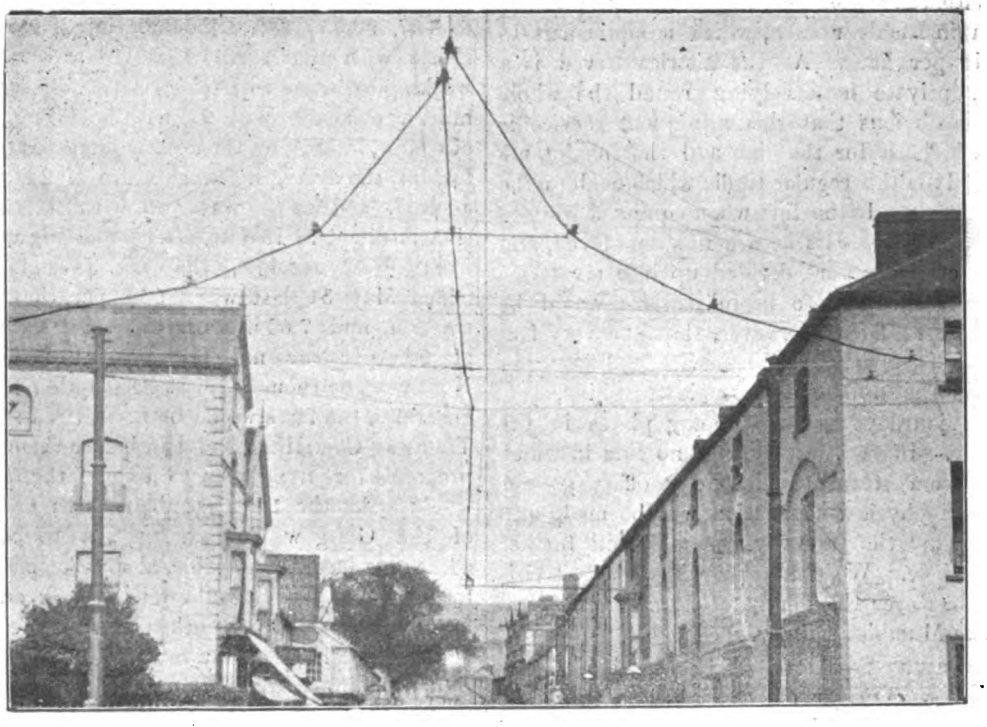


FIG. 2.—View of a Three-Way Switch in the Trolley Wire.

The whole of the overhead work was also carried out by the engineer to the British Traction Company, the materials being purchased from various well-known suppliers. In this

Digitized by Google

equipment both the side-pole and central-pole constructions are adopted, and the work, as inspected by us, shows evidence of great care in laying-out the positions of the poles for supporting the trolley wires. In our illustrations (Figs. 1 and 2) the reader will see examples of the overhead work, and also the means of supporting the guard wires. When passing under the railway bridges, a somewhat novel arrangement has been adopted to get over the need for asking leave of the railway company to attach the insulators to the trolley wires to the bridges. It is, of course, of the utmost importance that the insulation between the bridge and the trolley wire should be ample, and that the pressure of the trolley should not lift the wire against the iron bridge, causing a short-circuit to earth. To prevent this, long wooden troughs are supported under the bridges (as shown in Fig. 3) from the poles placed at each side of the bridge. In this way a good insulation is obtained, as well as a mechanical protection against any faults which may arise. In Fig. 2 is seen a three-way switch on the trolley wire, which is somewhat unique, as it is not often that three routes join at the one point.

The rolling-stock used on the line is not confined to one make either of car or motor equipment, and this enables the British Electric Company to conduct interesting trials as to the relative efficiency of the different equipments. Thus, on the Swansea tramways, no less than three different contractors have supplied motors. These contractors are the Brush Electrical Engineering Company, the British Thomson-Houston Company, and the British Westinghouse Company. The cars employed on the line just after the opening ceremony were of the single-truck type, and had only a single deck. The Brush Company have, however, supplied some large bogie cars, also single-deckers, which will be put in use shortly. These were being delivered at the time of our visit. Fig. 4 is a view of one of the smaller cars.

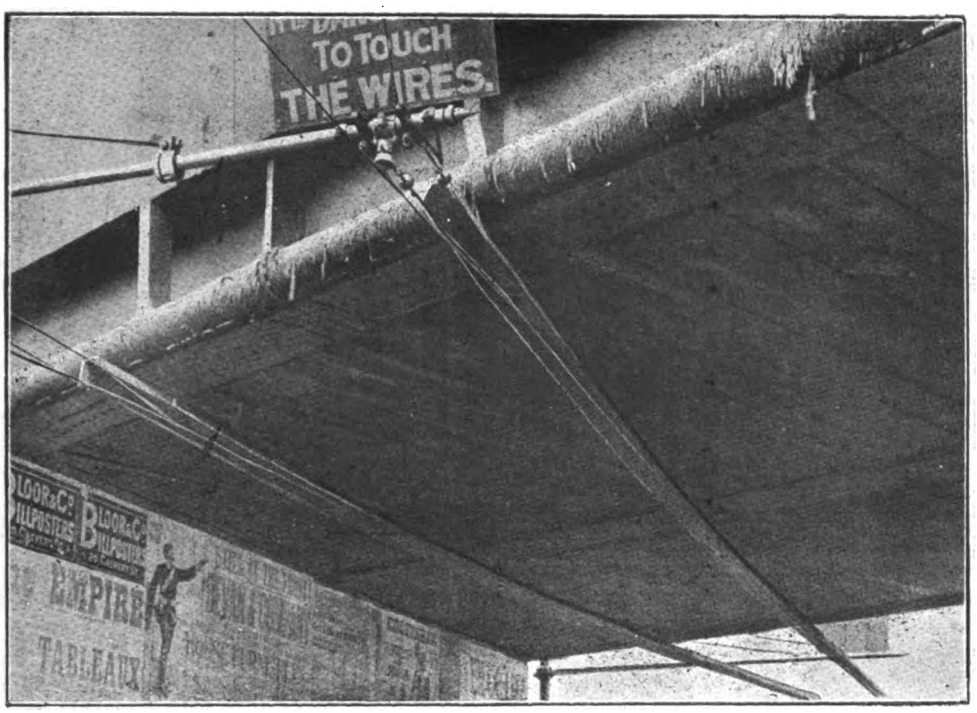


FIG. 3.—Method of Carrying the Trolley Wires under Railway Bridges adopted at Swansea.

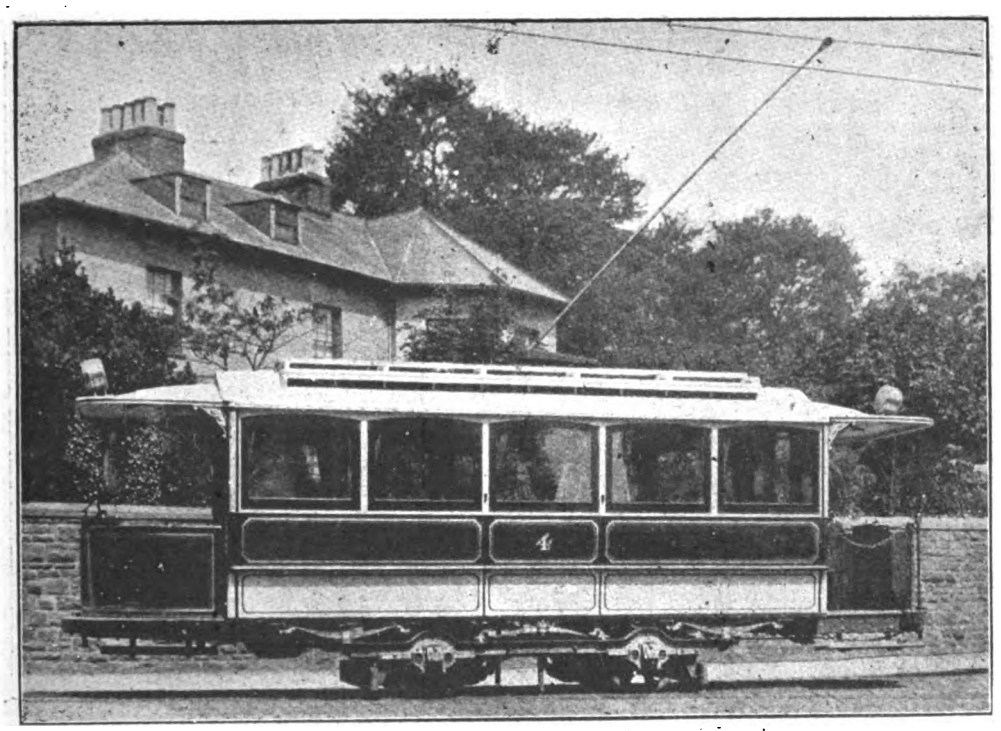


FIG. 4.—Swansea Electric Tramcar.

Generating Station.—The electrical machinery for supplying the overhead line is placed at the tramway company's

Digitized by Google

depôt, which is near the shore of the bay. In these works there are at present installed two Ball and Wood engines, direct-coupled to two Westinghouse railway generators. The engine is capable of driving the dynamo when giving 200 kw. to the line, and running at 200 revolutions per minute, with a steam pressure of 150lb. The dynamos

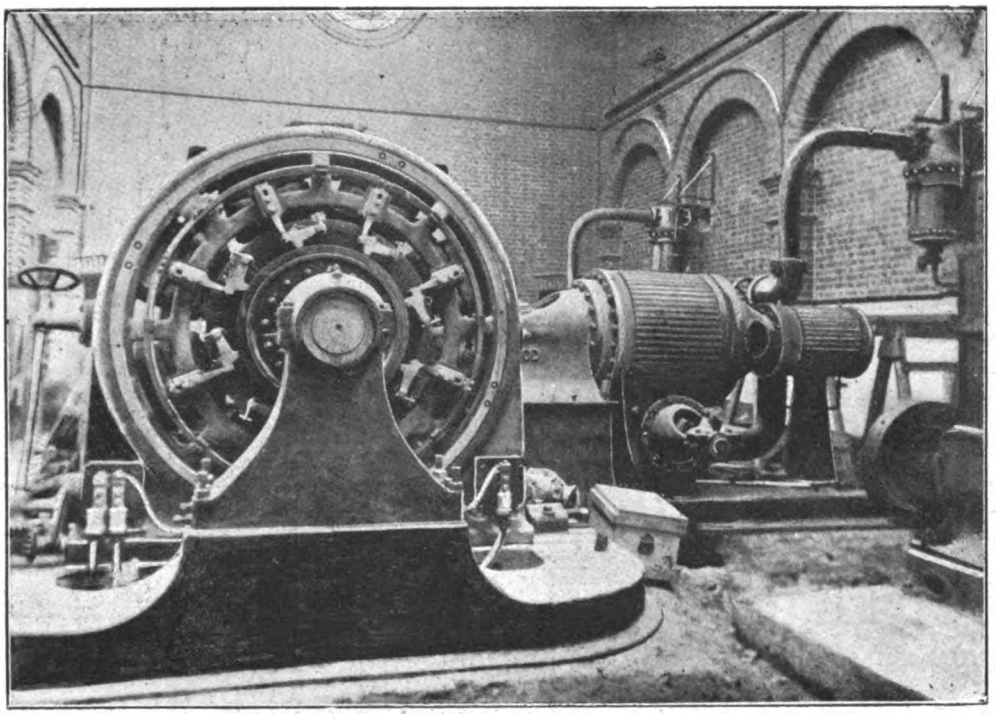


FIG. 5.—View of the Engine-Room, showing Westinghouse Generator and Ball and Wood Engine.

are 10-pole machines, as can be seen from Fig. 5, which gives a general view of the station. The arrangements of the machinery can be better seen from the plan and elevation of the station (Figs. 6 and 7). In addition to these two large dynamos, a smaller motor-

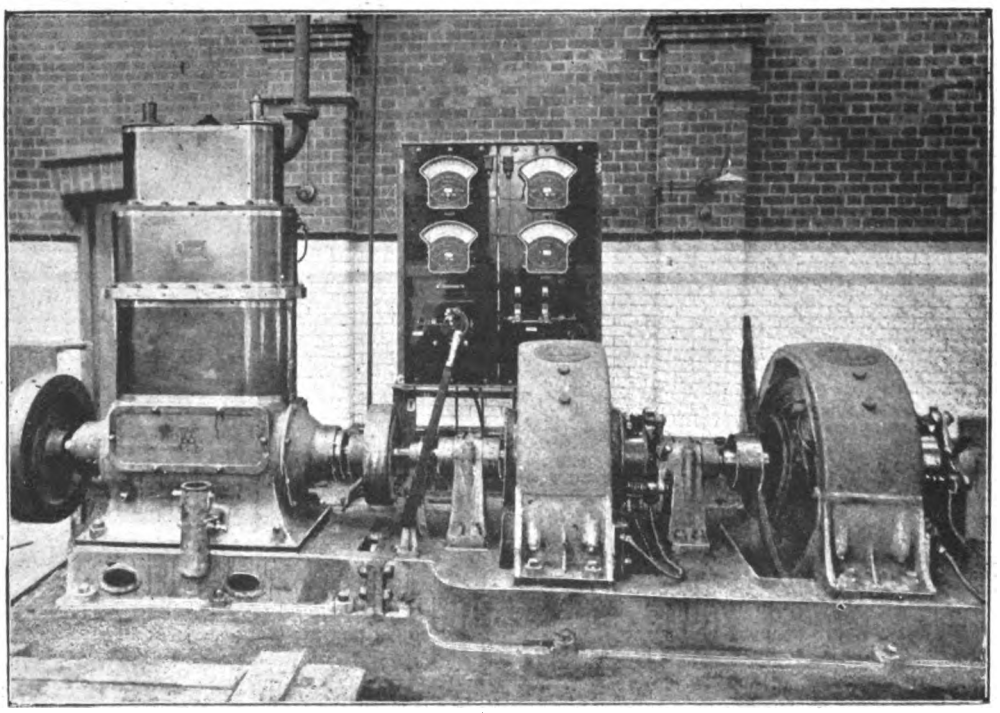


FIG. 8.—View of the Motor-Generator and Alley-Maclellan Engine.

generator (Fig. 8) is provided, together with an engine of the Alley-Maclellan type. The coupling between the engine and the spindle of the motor-generator is of the friction type, so that the engine can be uncoupled when it is required to run simply as a motor-generator. The speed of this set, which was supplied by the General Electric Company, of London and Manchester, is 450 revolutions per minute. In the ordinary way the motor in the combination is the 500-volt machine, which takes current from the 'bus bars. The other machine acts as a generator, and gives an output of 200 amperes at 100 volts. This 100-volt supply is used to drive the electric motors for the feed pump, air pump, circulating pump, and the other electric motors about the station. The station lights are also supplied at 100 volts. At night, when the large engines are shut down, by coupling the Alley-Maclellan engine to the motor-generator sufficient current can be obtained from the 500-volt machine running as a dynamo to bring home individual cars, while the 100-volt dynamo drives the accessories and lights the station. The next machine of which we have to make mention is the negative booster, which was also supplied by the General Electric Company, of London. This consists of an ordinary motor wound for 500 volts driving a booster which has a series field excited by the current passing through it to the positive

Digitized by Google

feeder. The return feeder goes through the armature circuit. In order to regulate the boosting voltage, a carbon shunt is provided across the series coils of this machine. Until the line is working fully it is difficult to say exactly what voltage will be required on this negative feeder, but the machine gives 28 volts when 165 amperes passes through the series coil. The switchboard is worthy of special notice, and although certain of the instruments are American, the rest of the board is thoroughly English, being supplied by the above-mentioned General Electric Company. The instruments on it are those usually used in traction work, and special care has been taken over the equipment of the instruments on the earth side which are required by the Board of Trade.

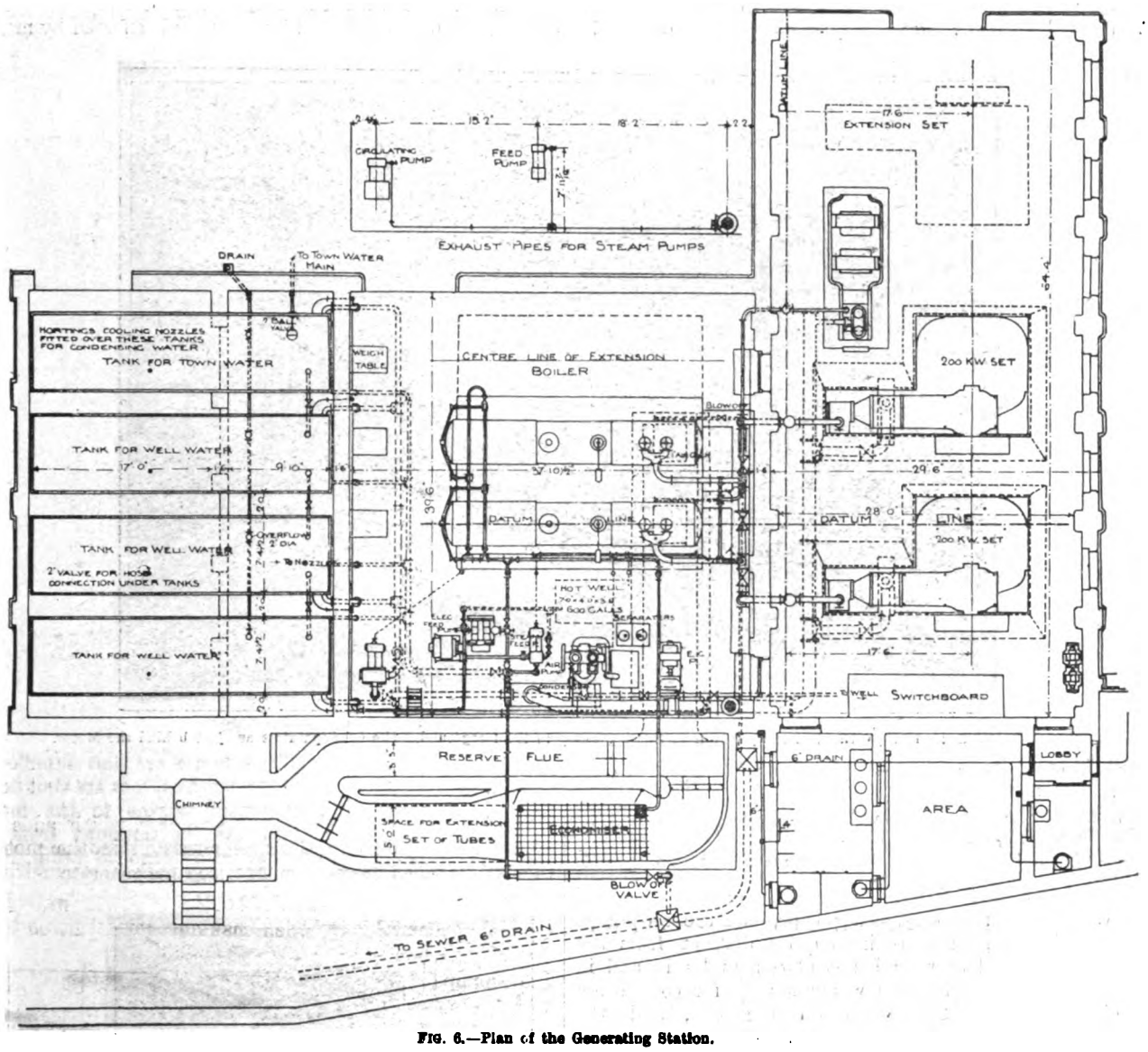


FIG. 6.—Plan of the Generating Station.

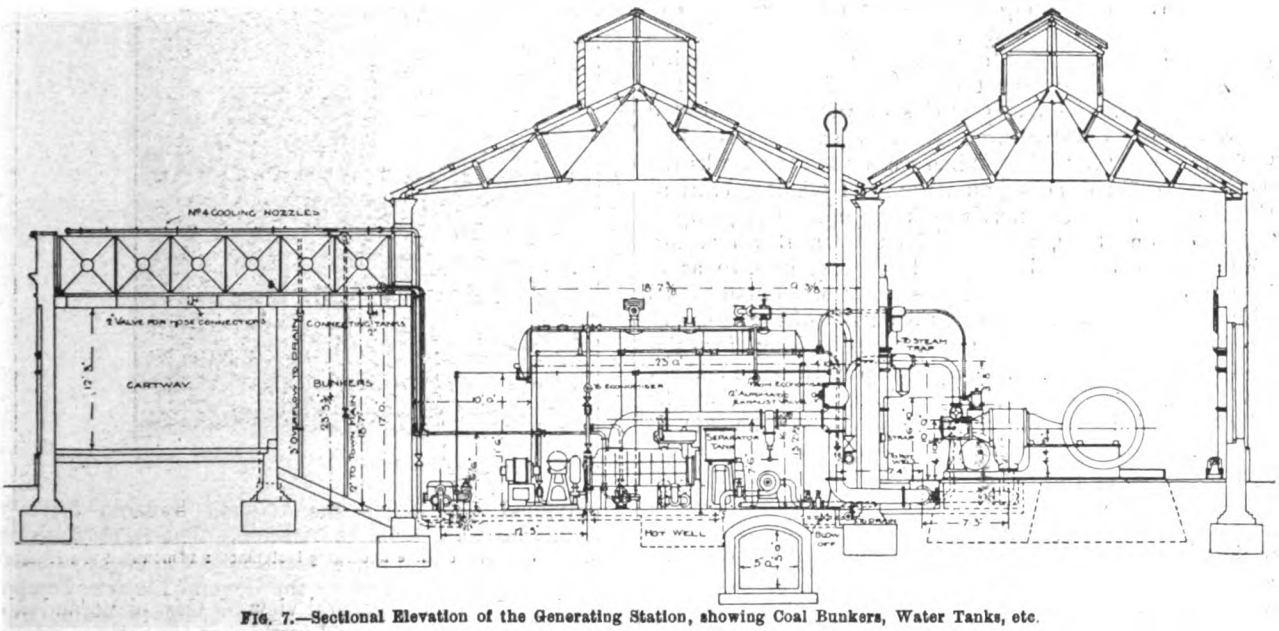


FIG. 7.—Sectional Elevation of the Generating Station, showing Coal Bunkers, Water Tanks, etc.

Three feeders are provided for on the switchboard—one going to the central part of the town, one to Morriston, and the other to the Cwm Bwrla route.

Digitized by Google

Boiler-Room.—The machinery in the boiler-room, and the arrangement of the boilers and tanks, are far in advance of those in other stations built by the British Electric Traction Company which it has been our privilege to inspect. As it will be seen from the drawing (Figs. 6 and 7), of the worm gearing driving the pump, is arranged on the principle of the well-known Hooke's universal joint.

When the station is in full work, it will be of great value to experiment with these electrical driving feed and circulating pumps to see if any saving is effected by means

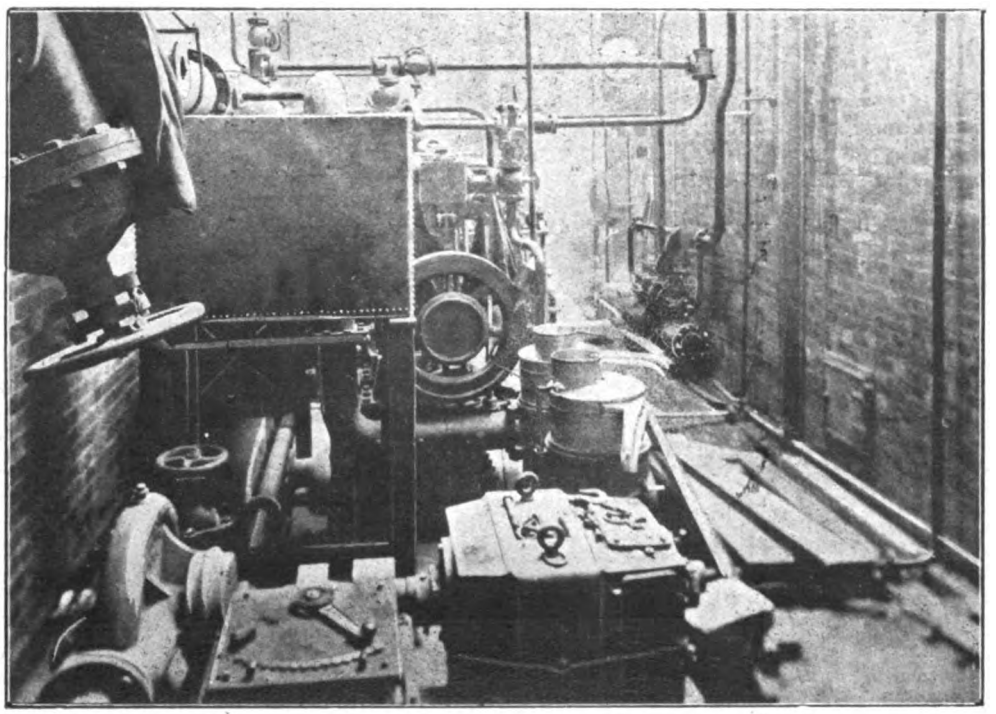


FIG. 9.—Condensing Plant, with Electrically-Driven Circulating Pump in the foreground. The Oil Separators are just behind the Motor.

Babcock-Wilcox boilers are used, and of these two at present are fixed. The coal is shot direct from the cart into the coal bunkers, the inclined floors of which bring it always within reach of the stoker. It is, however, to the condensing and boiler feeding arrangements that special attention has been paid. For instance, the condenser used is of the Wheeler surface condensing type, but the air-pumps and circulating pumps are kept quite distinct from the body of the condenser, and not placed under in and in combination as usual. The water supply for condensing is obtained from two wells on the site, and the town supply can also be taken in case of need. A large tank constructed over the bunkers serves as a reservoir for condensing the water, while a smaller tank at the other side contains the water reserved for feeding the boilers. The water is pumped out of the wells by means of a Blake-Knowles pump discharging into the overhead tank. The circulating water, after passing through the condenser, is sprayed up into the atmosphere from a number of nozzles distributed over the surface of the tank. The evaporation from the fine particles of water so projected upwards cools the water down to normal temperature before the drops reach the tank. When we visited the works the condenser was not going, on account of slight alterations being required to these nozzles. The circulating pump is of the Gwynne type, and is driven by a Brush motor. This motor is enclosed completely in cast iron, so as to render it quite dust and water proof; but we were surprised to see that the terminals were on the outside of the case, and that they were only insulated by a slight bushing of insulation from the cast-iron. It is a great pity that the makers do not design their enclosed motors in such a way that the cables can be led to terminals completely inside the case, so that no live metal is exposed. In fact, with this motor, as in the case of certain other English types of enclosed motors, sufficient care has not been paid to detail. The motor reminds one of an open-type machine with an irregular iron box round it. The water condensed in the Wheeler condenser is led to two separators of the dairy type, which, revolving at a high speed, completely separate out the oil from the water. Coming now to the feed pumps, we find that there is one steam feed pump and one three-throw Warren pump, which is driven by a Crompton enclosed motor. The connection between this motor and the axle of electricity. It must be remembered, however, in this case all the current which is passed into the motors is first transformed down in the motor-generator, which adds an appreciable amount to the power wasted in the motors themselves when making comparison with a steam-driven

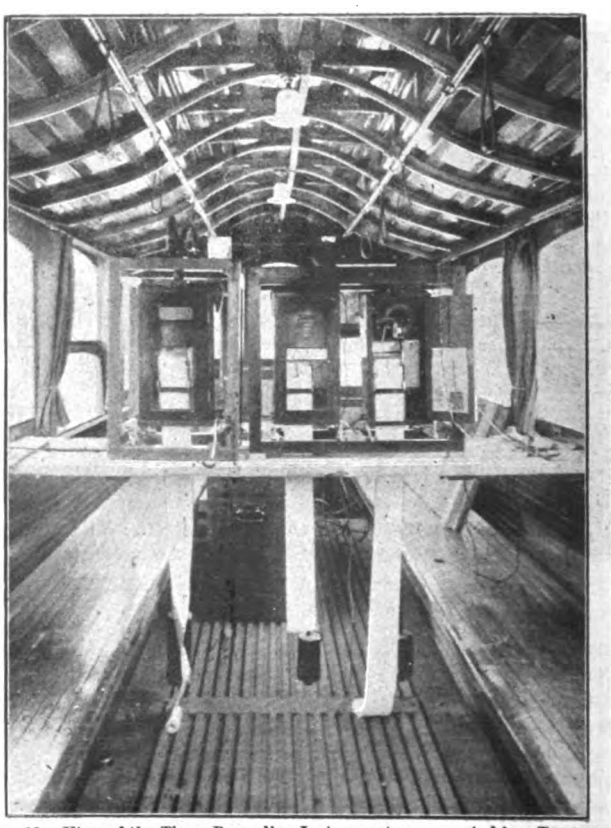


FIG. 10.—View of the Three Recording Instruments as mounted in a Tramcar.

set. Fig. 9 gives a general view of this plant and also of the cream separators used in this case for the extraction of the oil from the condensed water. The other general arrangements of the boiler-house plant can be well seen from Fig. 6. A weighbridge is placed near each boiler, so

Digitized by Google

that the quantity of coal taken for each can be found and recorded. A Green's economiser is placed in the main flue, so that hot feed water can be obtained. It will be noticed that this supply of current to the motors in the boiler-room is dependent on the motor-generator. A complete breakdown, however, is avoided by the provision of a steam feed pump, and, should an accident occur, the station could be worked non-condensing. This steam feed pump then could supply the boilers.

The car sheds are arranged in two distinct blocks in a straight line with each other, and between the two buildings a traverser will run, so that cars can be taken out of either shed without having always to traverse the full length of the sidings, or to take the first one that comes in the car-sheds. We may mention in this respect that there are two distinct entrances to the depôt from the lines in the street.

Referring, now, to the trials which the company are making on the various car equipments, these are being conducted for Mr. Sayers by Mr. S. Sudworth. For this purpose Mr. Sudworth has arranged three recording instruments, which can be conveniently mounted in any tramway. The way he supports these instruments is seen in Fig. 10. They are respectively a voltmeter, ammeter, and wattmeter. In order to prevent the vibration of the car from affecting the recording pen, an anti-vibration suspension has been obtained by means of indiarubber bands. Even these were found to be not sufficient to guard against the sudden jerks caused by rail joints and curves affecting the readings. Mr. Sudworth got over this by providing an iron tube at the base of each instrument, and attaching to the end of each tube a heavy lead weight. This weight gives the instrument a relief from vibration which could not be obtained in any other way. Our next illustration (Fig. 11) shows the curve traced by the ammeter for one portion of the Swansea tracks. These instruments, or rather the curves obtained by them, enables the engineers of the British Electric Traction Company to decide whether one type of car equipment has great advantages over another.

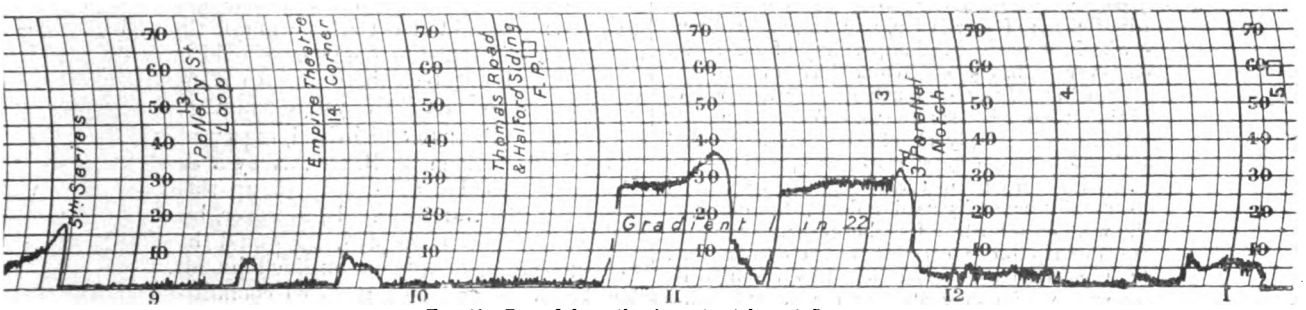


FIG. 11.—Record from the Ammeter taken at Swansea.

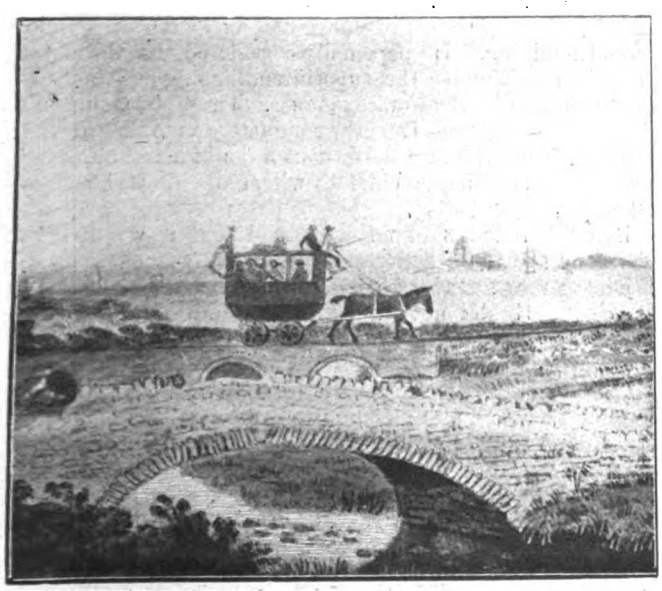


FIG. 12.—Historic View of the Mumbles Railway previous to the introduction of Steam-Engines.

Opening Ceremony.—The opening ceremony on Saturday last was commenced by the Mayor switching the current to the line at noon. A trip in the cars was then made by the guests invited over the longest section of the line, the cars returning near to the Hotel Métropole, where a luncheon was provided. After the menu had been thoroughly discussed and practically approved, Mr. GARCKE, as chairman, proposed "The Queen." The next toast was "The Town and Trade of Swansea." In the speech proposing success to the town and trade of Swansea, Mr. Garcke gave a most able exposition of the rights and wrongs of municipal trading, with local morals. He argued, quoting a socialistic society's views on the subject as his authority, that if for any reason a municipal authority decided to put tramways in the hands of a company, they should then treat that company as their agent doing a good work for them. In the license so granted all rents and remuneration should be kept low, but special provision should be made to secure the comfort of the public and a good and efficient service. A further quotation from the publication of the Fabian Society was to the effect that profits earned on the municipal tramways should be used for the reduction of general rates. This meant the taxing of the tramway riders for the benefit of the ratepayers generally. As regards Swansea itself, Mr. Garcke pointed out that they would have to carry four times the present number of passengers per annum in order to make a good dividend on the money expended in acquiring and converting the lines.

The MAYOR briefly responded to the toast. He did not agree with Mr. Garcke's remarks as to the application of profits from municipal tramways. He thought that if the profits were devoted to street improvements and general purposes, it was quite all right.

Mr. THOMAS replied for the trade of Swansea.

The next toast was "The Tramway Company," which was proposed by Mr. THORNTON ANDREWS, and replied to by Mr. D. F. SUGRUE

Reference was made to the Mumbles Railway as being the oldest in the kingdom, or the next to the oldest, as far as parliamentary powers were concerned, and through the kind offices of Mr. Sugrue and Mr. Fischer (the manager of this line) we are able to give our readers an illustration (Fig. 12) of one of the first passenger coaches on this railway. We have Mr. Garcke's authority for saying that the rails of this railway were of stone. The guests were conveyed by this railway to the Mumbles, and left to return at their own pleasure, after inspecting the pier, etc.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

HUDDERSFIELD CONVENTION.

(*Continued from page 914, Vol. XXV.*)

The following paper on the combined management of tramways and lighting departments was then read by Mr. Quin:

Combined Management of Tramway and Lighting Departments.

BY R. C. QUIN, BOROUGH ELECTRICAL AND TRAMWAY ENGINEER, BLACKPOOL.

It will be admitted, by all members of the association, at least, that the municipal authority should be the lighting and tramway authority also. So far, the author begs the question,

Digitized by Google

and in dealing with it purposes to treat it solely from the municipal point of view. It does not follow that because both undertakings are owned by the municipality that it is necessarily the best policy to combine generating stations. In the majority of cases this question can readily be settled, but in some—the tramway area and lighting area, or, perhaps, the author might more correctly say their "centres of gravity"—are far from coinciding, and it may then be advisable to have separate generating stations.

Assuming, then, that in our hypothetical town separate generating stations are established for lighting and tramway purposes, is it advisable to combine the two undertakings? In order to find a satisfactory answer to this problem we must first consider whether the undertakings are, to any great extent, of a similar nature. In both cases we must have an engineer fully conversant with the problems of economical generation and distribution of electricity, and lastly, but by no means least, one who fully realises the importance of continuity of supply. Whatever tramway engineers may say to the contrary, continuity of supply is of much greater importance with electric lighting than with tramways. Who, then, best realises that continuity of supply should be the first aim? There can, I think, be but one answer to this question—the lighting engineer. I have used the term "lighting engineer" because it is the term most generally used to denote the engineer responsible for the works established for the general supply of electricity, but the description is certainly not a correct one. A general supply of electricity is not established for lighting only, but for the supply of power also, and what "lighting engineer" is not familiar with motors? What new problems does traction supply call into existence? The question of load factor certainly arises in the calculation of sizes of cables, also the various stresses in connection with overhead line and posts will have to be provided for, and the starting, uniform running, and stopping of the tramcars be ensured by suitable arrangements. But everyone of these problems is simple, and any engineer worthy of the name could readily solve them. From this it will be seen that, in the author's opinion, the man best qualified to design and work a traction system is the qualified central-station engineer. But having two stations, is it now necessary that we should have two engineers? Certainly not. In many towns multiple stations even for general supply are established, yet they are invariably under one chief engineer.

The next phase of the question to be considered is how far the engineering side of the question is dominant in a tramway supply. In the maintenance of the traction system there are several points to be considered, and I will enumerate them as follows: (1) the maintenance of generating machinery; (2) the maintenance of cables; (3) the maintenance of overhead line and posts; (4) the maintenance of track; (5) the maintenance of cars and motors: (6) the cleaning of cars; (7) the regulation of traffic; (8) the collection of fares.

The first five are entirely engineering, and without due regard to them the tramway system must cease to exist. The remaining three, though important, do not require that technical skill and training, nor the exercise of such resource, as do the former. Suppose, then, that we appoint, as chief of our tramway department, one who has previously been manager of a horse or other tramway system. How far is he fit and capable of efficiently controlling and maintaining the system? He is certainly competent to give due regard to the last three points (6 to 8); he might also have had sufficient experience to enable him to maintain the track. But his electrical knowledge would probably be extremely slight, and it would then be necessary to have an electrical engineer, who would become the servant of the tramway manager. We shall find ourselves in this dilemma, that we have placed the maintenance and responsibility for good working of the most important part of our system upon a servant, and placed over him a man incapable, by reason of his want of knowledge, of properly controlling him. The engineering side is without doubt the most important in a mechanical, and especially electrical, system of traction.

But it may be said that the collection of fares and regulation of traffic requires experience which the electrical engineer may not have. Granted that it may be so, it does not necessarily follow that the engineer would control this. These duties could be placed upon a traffic manager. As to whether this traffic manager would be the servant of the engineer is largely a matter of the personality of the two men; and to the author there appears no difficulty whatever—and he speaks from experience—in thus separating a tramway system, though there are advantages obtainable by placing the whole system under one responsible head. The question of collecting fares has some analogy to the collection of electricity or gas rents. In most towns, the author believes, this is not done by the electrical engineer, but by a separate department of the municipality.

What the author would most wish to impress upon his readers is the fact that the design and working of an electric traction system is almost entirely an engineering problem, and that the man best qualified to carry out this work is the competent central-station engineer.

Mr. J. F. C SNELL, of Sunderland, said that the author's paper raised a most important question. In Sunderland they had solved this question by making one engineer responsible for both departments instead of having two independent engineers, and this engineer (the speaker) was also general manager of the tramways. It was deemed that the engineering side of the management preponderated. When the trams are started the following subordinates to the engineer will be appointed: an assistant engineer, who will have charge of the car sheds, of repairing the roads, and of maintaining the cars; a traffic manager, who will have complete charge of the staffs on the cars, and who will look after the running of the same to schedule times. The financial department will also come under this manager's care. He thought that the solution of the difficulty was a good one, and that the engineer should have the complete control, and not be subordinate to a non-technical man. They hoped to start their system running next month.

Alderman PEARSON, of Bristol, regretted that the problem did not affect them at Bristol, as by a small majority the Corporation had decided to give up their opportunity of acquiring the tramways. If, however, his proposal in this respect had been adopted, he would have arranged the management generally as outlined by Mr. Quin. He did not think it well to have two committees on the same corporation both concerned with works for generating electricity. He believed in getting the tramway and lighting load supplied from the one station. He quite agreed with Mr. Snell's division of the labour and responsibilities of the tramway department.

Mr. PHILIP DAWSON agreed, from a contractor's point of view, with the author's proposals, as he found in his capacity that the more authorities one had to deal with the more difficult it was to get any single point decided. With two committees to please, and a tramway engineer, the contractor was continually having to stop work for some reason or another. Without a doubt the man most qualified to design an undertaking should also have the working of the same, and for this purpose an engineer was required.

Mr. S. E. FEDDEN, of Sheffield, said it was of vital importance to the tramway undertaking that only one flag should be flying. He personally considered that the motormen should be under the superintending engineer, and the conductors under the traffic manager. The motormen would then take instructions from the conductors as to the stopping and starting of the cars. Without a doubt a technical man should be the ultimate chief to whom all things should be referred.

Bailie WILLOCKS, of Glasgow, said that it was a great pity they had not a congress of tramway managers in an adjoining room, so that their views on the question might be heard. He did not suppose they would agree with the author of the paper. With regard to the situation in Glasgow, it was rather a question of whether Jonah would not swallow the whale instead of the whale swallowing Jonah. They had an exceedingly strong tramway manager, Mr. John Young, and while their electrical engineer was at the time an exceedingly capable man, he had not the personal influence and character to get charge of the two undertakings. Still, they had managed to keep their electric light undertaking in their own hands. They were doing good work in this, and found their present engineer, Mr. Chamen, a very good spender of money. As regards their tramways, which they hoped to have completed for the exhibition next year, the tramway equipments were in the hands of Mr. Parshall. There was no doubt that to make a good tramway manager a strong personality was wanted.

Alderman BRUCE, of Sunderland, said it was absurd to have two committees and two electric power stations in one town, both belonging to the same corporation. He thought that the electrical engineer who laid down the plant should have full charge in working the same.

Alderman WOODHEAD, of Halifax, said that by having one combined station for traction and lighting, there would be a great saving in staff and working expenses. He agreed with the author as to the division of labour in connection with the undertaking after it was started, but they ought not to expect the electrical engineer to take over the detailed duties of a traffic manager. In Halifax they had

Digitized by Google

two committees, and the Tramway Committee bought its current from the Lighting Committee. The Electric Lighting Committee last year made a net profit of £5,400 from the following scale of charges: 4d. per unit for lighting, with discounts; 2½d. per unit for current used on motors; 1½d. per unit for current sold to Tramway Committee.

Mr. H. C. BISHOP, of Wigan, also agreed in the advisability of having one committee to maintain both tramways and lighting. In Wigan they started with a clear field—*i.e.*, no tramways or lighting—and hence were able to choose a system of supply which was suitable to both purposes.

Mr. C. S. VESEY BROWN, of Lincoln, advocated having one committee split up into three or four sub-committees: one of these to look into generating plant, one for the distributing plant and mains, one would have charge of the financial arrangement and returns, while the fourth committee would have charge of the tramways. With very large stations he was not quite certain that when the size exceeded 30,000 h.p. there was any further advantage in adding plant in one station instead of building two; 30,000 h.p. was larger than any engine contained in one steamship.

Mr. QUIN, in reply, said that so little contentious matter had been raised that he agreed practically with all that had been said.

The discussion then closed with a vote of thanks to the author.

The last paper for discussion on Thursday was the following:

The Reduction of Light-Load Losses in Alternating Supply Works

BY HORACE BOOT, CONSULTING AND RESIDENT ENGINEER TO THE TUNBRIDGE WELLS CORPORATION.

The question of light-load losses in electricity works, be they continuous or alternating, deserves more attention from engineers than it has hitherto received. These losses might be divided under two heads—viz.:

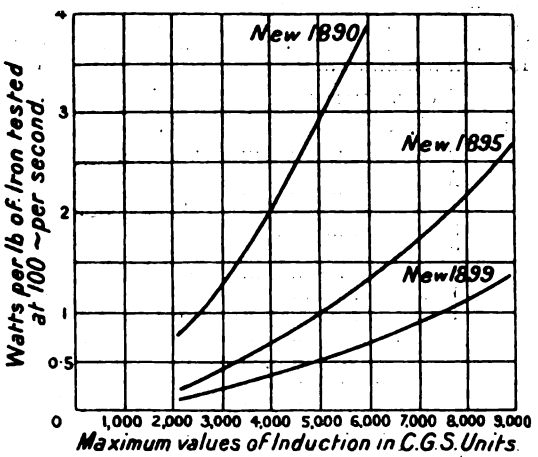
Works Losses.—(1) Fuel used in keeping up steam ready to supply; (2) radiation losses in boilers, separators, brickwork, steam and drain pipes; (3) in running larger generators at light loads to enable the voltage to be kept constant, should motors or other apparatus requiring heavy starting currents be in circuit; (4) wages paid to the men during the hours of light load; (5) interest and sinking fund on the buildings and machinery during light-load hours.

Distribution Losses.—(1) Losses in transformers (magnetising watts); (2) losses in the shunts of meters; (3) interest and sinking fund on capital, outlay on cables, and distribution appliances. (Nos. 2 and 3 apply equally to alternating and continuous systems, but No. 1 only applies to the alternating, except where continuous-current transformer systems are in use.)

The author does not purpose in this short paper dealing with the losses under the works heading, as there are many ways in which these can be reduced to a minimum, but he has not yet come across a system, be it direct or alternating, in which these in the course of a year do not total up to a very large amount, which would make an appreciable difference in the cost of supply if they could be overcome. In distribution, the most important losses requiring consideration, and which are more or less complicated, are the transformer losses during light loads, and since it is increasingly evident that in the near future transformers dealing with alternating currents of mono-, di-, or polyphase will be used by both what are known as "continuous current" and "alternating" engineers, it is important to both sections to endeavour to meet these losses, and to ascertain the manner in which they can be best reduced to a minimum. Low-tension engineers of a few years ago are all of them propounding schemes involving high pressures, and it is notable that all these schemes propose using alternating currents and transformers, or motor-generators. There is a consensus of expert opinion that the most economical way to supply electricity over large areas, and on a large scale, is by a form of high-tension transmission, and therefore the author does not feel called up to apologise to his continuous-current friends for wasting their time over problems which they now see they will have to tackle in the future.

The transformer losses may be divided into "iron" losses and "copper" losses; the iron losses being dependent upon the eddy-current loss, varying, of course, with the temperature and periodicity, and the contact between the adjacent plates and hysteresis loss depending upon the quality of the iron and the temperature to which it is heated, the E.M.F. curve, and the maximum induction; also, a not unimportant item, the mechanical strains and stresses to which it is exposed. The copper losses may be summed up as the $C^2 R$ loss due to the magnetising current and resistance of primary winding. These, of course, again vary as the square of the current, the resistance of the copper, the temperature to which the winding attains, sectional area of same, and the length. The author has found, however, that the $C^2 R$ loss due to magnetising current is about ·20 per cent. of the maximum output. It is important to note that the limit of work which a transformer can undertake is governed by the overheating permissible, as this exercises a very important function when short-circuits on the distributing networks take place, as the transformer only requires to be fused to its burning-up limit, which is usually very much higher than its output. It will be seen that it is important to design a transformer in such a manner that it has sufficient means of radiating its heat, as only in that manner can a transformer be kept within decent limits in weight and size.

With regard to improvements in transformers, it is interesting to reproduce a curve having for ordinates the watts per pound of iron tested at 100 frequency, and for abscissæ the maximum volts of induction in C.G.S. units, for which the author is indebted to Mr. Berry. From this it will be seen that the efficiency of transformers has advanced enormously since 1890.



CURVE A.—Showing Advance in Transformer Efficiency.

This increase of efficiency plays a very important part in the light-load losses, as by comparing efficiency curves it is now possible to obtain an all-round efficiency, including light-load hours, of something like 94 per cent.—that is, taking 20 hours at no load, two hours at full load. Many works, however, are fortunate in obtaining a longer period of load. Comparing the efficiencies for the last 10 years, there has been an improvement of something like 16 per cent. It therefore will be seen that one of the ways to reduce light-load losses is to instal transformers of high quality. It is, of course, apparent to anyone that the copper losses from the all-day efficiency point of view are of less importance than the iron ones, because the iron, like the poor, "is always with us," whereas the copper losses do not play such an important part until the transformer becomes loaded. The ageing of the iron is a very important matter, and the author has found from tests carried out that in the case of old transformers the effect of age has been to increase the magnetising watts by as much as 45 per cent. This should not be the case with our present knowledge, as in the case referred to it was due to the number of lines forced through the iron to a very large extent, whereas if the iron density had not been pushed so far, also the temperature limit, both in the iron and in the copper, there is no reason why the watts taken to magnetise should have increased so enormously. In other instances tried by the author, they have increased 10 per cent. after nine months' use. He thinks it is here that in all probability our systems put down with English plant will eventually show their superiority over American-made machinery, as it is well known that Americans load their machinery up to the limit. In his transformer specifications the author finds it necessary to insert a clause, that the tests on the core losses shall be taken after the transformer has been six months at work on its full load, and he is even of the opinion that this six months would be better if it were 12 months, because a transformer appears to get better as its gets older, until it reaches a certain point, and then the increase in iron loss runs up. The ageing which increases the iron loss can be governed by temperature rise, the quality of the iron, and the strains of a mechanical nature to which it is exposed when in use. In a table below are given the actual tests obtained from different sizes of transformers in sub-stations in Tunbridge Wells, showing the increase in magnetising watts with age, also the number of watts used on large transformers (calculated) during the period of light load. This is important, as from these figures can be calculated the saving that can be effected by switching the transformers in or out, according to the conditions of load, making, of course, provision for the labour, interest, and sinking fund required for doing this.

Digitized by Google

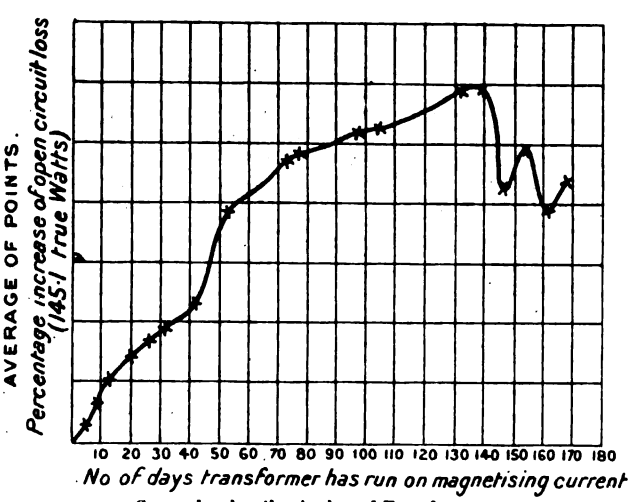
SUB-STATIONS OR TRANSFORMER PITS.

Size of transformer in kilowatts.	Core loss in watts when first installed.	Core loss in watts now.
50	490	490
25	385	410
50	491	590
25	390	390
25	420	770
25	391	390
25	468	470
5	120	121
5	150	170
15	320	350
25	426	430
5	102	180
5	71	80
25	462	460
25	540	550
5	—	230
5	—	180
5	—	—
5	—	150
3	120	150
25	390	450
15	340	400

HOUSE TRANSFORMERS.—Core Losses.

Size, kilowatts.	Watts.
2	110
1	45
2	110
1	45
3	150
2	110
1	45
1	45
1	45
3	150
2	110
2	110
3	150
2	110
1	45
2	110
3	150
2	110
1	45
2	110
1	45
2	110
1	45
1	45
1	45
1	45
1	45
3	150
3	150
5	180
Total kw. 56	Total watts lost = 2,765 = 2 765 units per hour.

With regard to ageing of transformers, there is an interesting curve published by the London Electric Supply Corporation in 1895, and which, with their kind permission, is reproduced here.



Curve showing the Ageing of Transformers.

The author has calculated that at Tunbridge Wells the units generated during the period of no load in 1899 amounted to 32,920. The units supplied to the transformers in circuit, calculated taking the same number of hours, equals 10·75 × 3,000 hours = 32,250, and the total number of units generated in 1899 equals 466,901, showing that the number of units due to core loss amounts to 6 09 per cent. of the whole. The cost of supplying these "core loss" units (1·5d. per unit) amounts to £201. 11s. 3d., and it is this figure which the author is hoping at some future time to save entirely, and then he will be in the same position as his "continuous-current friends," so far as efficiency of distribution goes. By adopting the network interconnection system and running a sufficiently large low-tension main into the works, or, if the works are situated some distance from the distributing area, supplying the whole of the distributing networks from either the works or one sub-station, the whole of the loss, with the exception of that occasioned by the use of one transformer, can be saved, against which, however, must be balanced the labour involved in visiting these sub-stations twice a day for the purpose of switching on and off the primary and secondary. The switch gear in these sub-stations should be as simple as possible, so that it does not require a particularly skilled man to operate same, nor should it be possible for him to kill himself.

A few years back Mr. Walton (then chief engineer to the Metropolitan Electric Supply Company) brought out and patented an automatic transformer switch, to switch in the transformers on both the primary and secondary as soon as the load became sufficiently heavy to require a supply from that transformer. These have been in use since March, 1897, at the sub-stations in Marylebone-passage, Brook-mews, Rathbone-place, and I believe the London Electric Supply Corporation and the Brush Provincial Company are also using them. This automatic switch is most useful in towns subjected to sudden demand, as the engineer can rest assured that a sufficient number of transformers will be switched in to cope with the load, and will not have to depend upon the vagaries of human intelligence. It is, of course, easy for any station engineer to calculate the saving effected in switching off these transformers, which becomes more marked in towns with a poor load factor, and in the provinces, where sudden heavy demands are almost unknown, from the following formula :

$$\frac{\left\{\begin{matrix}\text{the number of hours}\\ \text{per annum the trans-}\\ \text{former is not loaded}\end{matrix}\right\} \times \left\{\begin{matrix}\text{the cost per Board}\\ \text{of Trade unit to}\\ \text{generate}\end{matrix}\right\} \times \left\{\begin{matrix}\text{core loss}\\ \text{in units}\end{matrix}\right\}}{1{,}000}$$

Another advantage to be obtained by being able to cut out all transformers during the hours of light load is that it places all the feeders, with the exception of one perhaps, at the disposal of the mains superintendent for testing purposes, or working thereon, and then there can be no excuse for not keeping them in perfect condition, as they can be tested daily.

The question of the best position for fuses in the high-tension feeders is a very troublesome one, and the author has found that the safest place to have fuses is at the works, and at the works only, especially when we get to the condition of things where transformers never go wrong ; as, unless fuses are constantly watched in the sub-stations and frequently changed, no reliance whatever can be placed upon them. I venture to think, in the analysis of the number of extinctions and the cause, 75 per cent. could be put down to the erratic behaviour of fuses, both on the high-tension and the low-tension side, and for that reason fuses should only be inserted where it is dangerous to do without them. In the distributing networks I have not found it necessary to insert fuses, except at the point of interconnection as above stated. This method of reducing the light-load losses to the minimum, unless precautions are taken, may introduce serious results, and be the cause of cables and transformers breaking down.

Some time ago there was an article in the *Electrical Review*, by Mr. Hay, proving that when breaking a current, at the instant of breaking the current it had a higher value than its normal maximum, the core being left more strongly magnetised than when under working conditions. In some experiments carried out with transformers it has been proved that transformers do not, as a rule, break down at the instant of connection, but the core settles down to the ordinary cycles of magnetism gradually, and there is no rise in potential difference across the terminals ; but if they break down the damage was done when switching off. It would be interesting to hear from other members if they have found the life of the cables and the transformers, when intermittently used, to be shorter than when they are in constant use. Beyond the strain of switching on and off, the author does not see that there should be any difference, unless the transformers get unduly heated, in which case the continual heating and cooling may do mechanical damage.

There is another danger which may be introduced at the time of switching in and out—viz., the capacity effect—but, provided care be taken to switch in the outer conductor first, and switch out the inner conductor first, it is unlikely that the conditions will be such as to break down the cable. Experiments were performed by Prof. Fleming and Mr. Alexander Siemens on the Deptford mains, which will be within the memory of the members, and the able articles written at the time with respect to the same are worth studying. One of the points to be borne in mind, however, is to avoid any discontinuity in the outer conductor of a concentric cable, and this can best be secured by earthing the outer without any fuse

Digitized by Google

in circuit. In the *Review*, in March, this subject was ably treated by Mr. Gisbert Kapp, the article being the translation from the *Elektrotechnische Zeitschrift*, Dec. 28, 1899, in which he depicts some conditions into which we unhappy alternate-current engineers may get and break down our cables. However, it is rarely that these conditions are present, but it is always advisable to take precautions such as the adoption of Neufeld's rule for switching in and out: "The earthing of the outer conductor, and omission of all fuses in the outer."

It is important that transformers should be constructed to withstand a considerable load for a short period, as when such is the case it is possible to use a transformer that will be fairly well loaded at normal times of heavy demand, and occasionally withstand a great deal more. In some of the transformers the author has tested there appears to be very little limit to their overloading capacity—one in particular, a 5-kw. transformer, easily withstood a load of 12 kw. without burning up; but he finds that when the larger sizes are dealt with, the manufacturers are not so generous in giving more than you pay for. From calculations and tests made, it appears that about 140 watts are wasted in core losses for every thousand watts supplied to the lamps. Considerable economy may be gained in distribution by keeping the number of sub-stations to a minimum—in fact, the Board of Trade alteration in the permissible pressure of supply has been an immense boon to alternate-current as well as to continuous-current engineers. The insulation of the distributing mains is better maintained in the case of alternating than appears to be the case in continuous-current distribution systems, in which, by increasing the pressure, "shorts" and other troubles have been experienced.

Taking the cost of coal, which in Tunbridge Wells is very heavy, at 1d. per unit, the cost of energising the transformers on circuit amounted to £137. 3s. 4d. in 1899. In order to overcome this loss it is necessary that the low-tension networks supplied from the various sub-stations be interconnected, as it is then possible to switch off all the transformers, except one, on both primary and secondary. For this purpose the author has arranged the networks so that they can be fed in the daytime from a transformer situated at the works, and the whole of the transformers in the sub-station can be switched out of circuit. This at once reduces the light-load losses from 10,750 watts to 590, against which, however, has to be put the cost of the extra switch gear and men's wages, unless an automatic switch is used; but it will be seen that this arrangement enables the feeders to be tested every day, worked upon, and kept in perfect order, without in any way discontinuing the supply, which, as prescribed in the Act, is continuous during the 24 hours. In towns where it is possible and economical to build a large sub-station and make it a centre of distribution, transformers can be banked, and it is usually arranged for one man to attend to these, but in Tunbridge Wells the area is very extensive, and no particular sub-station can be looked upon as the feeding centre, so that the most economical way is to place one large transformer in each instead of providing several small ones, and switching them in as the load comes on. The author has found, from experience, that the most satisfactory arrangement for fuses on the outer networks is to make them comply with the following conditions: Each transformer sub-station should be allotted a certain small area, which should not exceed the maximum load of the transformer at the time of full demand, even if it were isolated from the other sub-stations. A fuse box on the distributors should be inserted before connecting that particular transformer area with the other network area. This is what he has carried out throughout, and found to work admirably. It is advisable to test the transformers at least once a year, to obtain the magnetising watts on open circuit, and the full load voltage drop, and compare them with the previous tests, and in most instances it will be found advisable to scrap the old transformers, and buy others more up to date, having more permanent efficiencies. With a reduction of frequency to a standard of 50 periods, many alternating troubles would disappear, such as impedance. With regard to skin effects, Lord Kelvin showed that the current only penetrated to ·0393 of an inch after increasing the frequency above 150, but the loss occasioned by this may be more or less neglected with low periodicities.

A very important point to bear in mind in alternate-current distribution is to keep the power factor as near unity as possible. This problem is not easy, and is often the cause of great loss in efficiency. The effective volts and amperes rarely exceed ·75 of those apparent; it may be much less than this when motors, arc lamps, and various inductive apparatus are in circuit. This wattless circuit loads up the armatures and the cables, producing considerable phase difference. However, provided the frequency is kept low, the difficulties can be overcome, as the current lagging in phase depends upon the inductance in circuit and the periodicity. Various suggestions have been made for introducing capacity in order to give lead, and thus nullify the lag in an alternate-current circuit caused by induction, but the author is not aware of any system being in operation in this country. When it is necessary to calculate actual resistance these effects present difficulties, as it is apparent that the resistance must change according to the kind of load.

Another source of waste, although of not very large moment, is the energising watts supplied to maintain the shunts of the meters when no energy is being consumed. It will be seen that

APPENDIX.—Information Obtained from 17 Towns.

Town.	Do you interconnect networks with fuses?	Do you bank your transformers?	Are any arrangements made for reducing the idle magnetising watts in time of light load?	Magnetising watts and amperes given to mains.	Do you use any automatic switch for cutting-out transformers?	Magnetising watts more after using transformers some time, percentage?	Does your low-tension network come into the works?
Bath	No.	Yes.	No.	—	No.	—	One circuit
Bedford	Only occasionally.	In some cases	No.	5 kw. and 6 amps.	No.	—	No.
Bolton	No.	No.	—	—	—	—	Yes.
Bristol	Yes.	Yes.	Nothing daily.	About 30,000.	Not now.	—	One does.
Cardiff	Yes.	Yes.	In the summer.	—	No.	—	No.
Croydon	Not generally.	Yes.	Yes.	About 10 kw.	All switching off is done by hand.	No increase noticed hitherto.	No.
Derby	No.	Wherever possible.	In the summer.	7 primary amperes full load current at present about 300 amps. Mag. watts estimated about 10 kw.	No.	—	One of four
Hanley	Yes.	Yes.	No.	7 amps. at 2,050 volts.	—	—	No.
Halifax	No.	As little as possible.	No.	About 16 amps. at least at 2,000 volts.	No.	Cannot say definitely.	No.
Harrogate	Yes.	Yes.	No.	About 13 apparent amps.	No.	—	No.
Huddersfield	No.	Yes.	No.	About 15 kw.	No.	Depends very much upon make of transformer.	No.
Kingston-upon Thames	Yes.	Yes.	Can be switched out in sub-stations.	7 amps. at 2,100 volts.	No.	Yes.	Not at present.
Newport	No.	Yes, in sub-stations.	No.	20 kw.—15 amps.	No.	—	No.
Portsmouth	Occasionally	No.	No.	Average 15 watts per kilo of rated output of transformers.	No.	Not ascertained.	No.
Southport	Will do so this year.	Yes.	No.	Mag. power amounts to 16 kw. and the current 8 9 amps.	No.	Not appreciable.	No.
Wolverhampton	Yes.	—	—	—	—	—	No.
Worcester	No.	Yes.	No.	8 amps. at 2,000 volts.	No.	Have never determined.	No.

Digitized by Google

there are 1,000 meters on circuit, all of them taking a small amount, and most of them taking that amount for 20 hours out of the 24 for no purpose, that a saving would be effected if this shunt were cut out when no current was flowing through the series coil. The author has introduced into Tunbridge Wells a small relay, which is governed by the current in the series coil, and is made to close the shunt circuit of the meter immediately ·1 of an ampere flows through it. The arrangement is simple and works admirably, the three points in its favour being: (1) it prevents consumers complaining of the noises their meters are making all day long when there are no lights burning; (2) it prevents consumers thinking that the meter is registering when they are not using any energy; (3) it saves the wasted watts during the time when the meter is not registering.

In conclusion, in order to reduce the light-load losses—(1) the low-tension distributing network must be interconnected, each sub-station interconnection being by a fuse on both poles; (2) the supply can be given by one transformer, preferably situated at the works, and so arranged as to feed the whole networks; (3) in each sub-station switch gear must be arranged to disconnect the primary from the source or sources of supply, and the secondary winding from feeding or being fed by the low-tension network; (4) unless automatic switches are used, it is the mains superintendent's duty to arrange with certain men on their way to work to open the switches and switch in the transformers at sunset; (5) the feeders should be so arranged that during the hours of daylight they can be tested and all pressure removed. In some instances, of course, this would necessitate cutting off the supply to a few isolated houses which may have separate transformers, but no doubt this could be arranged in the price charged to these consumers, as they would be situated outside the "compulsory" area.

Mr. L. ANDREWS, of Hastings, opening the discussion, remarked that he had a paper on somewhat the same subject coming on the next day. He thought that every engineer should calculate the results of switching off his transformers. He had not found any great advantage at Hastings. For instance, on one feeder using 2,000 volts the condenser current was 0·9 of an ampere. When two 18-kw. transformers were switched on to the end of this feeder the current actually fell to 0·85 ampere. At times of light load current was quite as important as energy, as on the current depended the size of the plant which had to be kept running. He did not agree with the author as to the use of fuses in transformers, which he thought should only be put in so as to protect the feeders if a transformer burnt out.

Mr. H. FARADAY PROCTOR, of Bristol, referred to that part of the paper in which the noise of meters is complained of. He thought there was no difficulty in selecting meters which do not make a noise, and also that the watts consumed in the shunts of the meters were so small that it was not worth while switching them off. Taking the whole year through, these watts only worked out to 18 units per meter, which at 1d. per unit would hardly repay for the automatic gear and the risk of failure. As regards the switching off of transformers in the sub-stations, here again he considered that the cost of switching off by hand labour did not bring any commensurate advantage. At 1d. per unit, 4d. per hour would pay for all the energising current for the transformers referred to in the author's paper, and he did not think it worth while to send a man round to the sub-stations in order to save eight hours' supply at this rate. As regards the switching on and off of feeders, he found that there was no trouble from a rise of voltage if one always switched on the low pressure before the high, and reversed the sequence of events when switching off.

Mr. H. S. RUSSELL agreed with the author that it paid to scrap old transformers if their core losses were high. As regards the increase of these core losses, with time it would be seen that it was not such a simple phenomenon as was hoped, as there were irregularities in the curves which could not be predicted.

Mr. PRUSSMAN, of Doncaster, raised the question as to whether the relays for the switching in and out of the meters could be relied on to work at the current mentioned—0·1 ampere. If the relay did not switch on when 0·15 ampere was going through, it would mean that an 8-c.p. lamp could be burnt continuously without registration, as the meter would be out of circuit.

Mr. J. F. C. SNELL, of Sunderland, raised some questions as to the figures in the paper, which he thought were rather too favourable to the alternating-current system of supply.

Mr. EDGCOME, of Kingston, said he had also had complaints of the noise made by meters on the alternating-current system.

Mr. W. B. ESSON asked the author if he could give the length of time that each of the transformers referred to in the paper had been in use, in order that one could see how long it took for the core losses to increase to the extent shown. He pointed out that if the whole of these losses were saved, it would only amount to £150 per annum, and it was a question as to how much one could spend, and how much complication it was worth while to introduce in order to save a certain proportion of this amount.

Mr. H. L. P. BOOT, in reply, explained that the figures to which Mr. Snell referred were for the core losses only. He would try to give the information which Mr. Esson asked for in the *Journal*. He explained that the noise in the streets in Bristol was very likely sufficient to prevent the noise from the meters being heard. Tunbridge Wells was a health resort, and the noise of the meters was objectionable to invalids. Mr. Boot caused much amusement by explaining that the meters and the visitors were both placed in the cellars.

The meeting adjourned at 1 p.m., which gave the members time for lunch before attending the Mayor's garden party, which was held in the Beaumont Park from 3 to 6 p.m. This park, which is a great credit to the town of Huddersfield, was originally a quarry, and the irregularities in the ground caused by the quarrying operations have given every facility for making the ornamental park which is now enjoyed so much by the inhabitants of Huddersfield. Two bands were engaged for the occasion, one of which played in the band pavilion and the other in the terrace opposite the castle. From this park a most extensive view of the country round Huddersfield can be obtained, and the rising smoke from Huddersfield was also exceedingly apparent at the time of the garden party. It is wonderful, however, that the country should keep so exceedingly fresh within such a short distance of a large manufacturing town.

The annual dinner of the Municipal Electrical Association was held in the town hall at night, when Mr. Mountain, the president, again took the chair. The toast list included the following: "The Queen and Members of the Royal Family," "The Corporation of Huddersfield and the Electricity Committee," proposed by Alderman Bruce, M.P., and replied to by the Mayor of Huddersfield; "The Guests," proposed by Alderman G. Pearson and replied to at length by Sir Thomas T. Woodhouse. The toast of the evening, "The Municipal Electrical Association," was placed in the hands of Councillor G. Thompson, and was, of course, replied to by the President.

Mr. W. A. CHAMEN, in proposing "The Electrical Industry," gave some interesting reminiscences of the pioneer work in electric lighting. He referred, for instance, to the arc lighting carried out in those days when one dynamo was provided for each light, and when the sparking at the commutator was the recognised method of telling if the lamp had lighted up. In the case in point this test failed because the commutator had distributed itself about the engine-room.

The toast was replied to by Mr. S. Z. DE FERRANTI, who made some interesting points on the developments of electrical industry, and the way it was hindered and helped by municipal corporations.

Mr. MACLAREN also replied.

The proceedings closed with the toast of "The Press," proposed by Mr. EDGCOME.

The Johnson-Lundell Company.—We understand that this company is now getting in working order, having appointed Mr. A. Tilley as secretary, and Mr. A. F. Hall as engineer, the latter of whom has had extensive experience in the States under Mr. Parshall. The financial state of the company leaves nothing to be desired, and we wish Mr. Hall every success in working its manufacturing business.

Digitized by Google

LOCAL LOANS.

A glance at the annual reports of the Local Government Board, although these reports are somewhat belated, gives some interesting information. Just at the present juncture we may refer to the 1898-9 report, that for 1899-1900 not being yet available. Herewith we give certain figures which may be of use for reference in discussing municipal matters. These show the receipts and expenditure, also the loan on capital accounts in certain more or less debatable directions. The figures are instructive reading, and when those of the forthcoming report are issued and added will prove a little startling. We now simply give the figures, reserving comment.

TABLE I.—EXPENDITURE (not out of loans) AND RECEIPTS FROM OPERATIONS CONNECTED WITH WATER, GAS, AND ELECTRICITY.

Items.	1892-3.	1893 4.	1894-5.	1895 6.	1896-7.	1897-8.
Expenditure on waterworks	£1,010,008	£1,093,622	£1,112,589	£1,218 484	£1,192,130	—
Revenue from waterworks	2,723,303	2,825,652	2,875,984	3,039,413	3,166,824	—
Expenditure on gasworks	£3,480,925	£3,698,514	£3,566,318	£3,624,533	£3,753,205	—
Revenue from gasworks	4,333,589	4,510,784	4,750,738	4,718,528	4,864,381	—
Expenditure on electric lighting	£2,237	£24,464	£33,605	£44,554	£61,149	—
Expenditure on electric lighting and supply (other than public lighting)	18,740	37,514	92,540	126,988	177,842	—
Revenue from electric lighting and supply	21,081	44,123	123,580	195,472	329,819	—
Expenditure on tramways	£51,818	£61,063	£109,981	£134,737	£160,736	—

TABLE II.—LOANS TO LOCAL AUTHORITIES.

	1892-3.	1893-4.	1894-5.	1895-6.	1896-7.	1897-8.
Gasworks	£401,985	£727,550	£749,964	£399,879	£539,396	—
Electric lighting and supply	115,248	572,645	559,299	596,549	1,186,739	—
Public lighting not included under other headings	1,996	2,857	4,464	1,383	9,109	—
Tramways	58,996	186,645	173,458	66,859	12,684	—

TABLE III.—EXPENDITURE OUT OF LOANS.

	1892-3.	1893 4.	1894 5.	1895 6.	1896-7.	1897-8.
Gasworks	£547,473	£796,826	£598,360	£455,839	£641,515	—
Electric lighting and supply	165,465	445,645	704,278	590,423	1,087,231	—
Public lighting not included under other headings	2,398	5,732	1,546	11,561	9,780	—
Tramways	57,427	211,190	54,263	172,680	144,074	—

TABLE IV.—OUTSTANDING LOANS.

	1892-3.	1893 4.	1894 5.	1895 6.	1896-7.	1897 8.
Gasworks	£15,533,605	£16,128,586	£16 931,943	£17,162,143	£17,433 760	—
Electric lighting and supply	273,548	835,263	1,378 818	1,942,773	3,112,097	—
Public lighting not included under other headings	31.923	32,809	32,860	30 778	37,474	—
Tramways	1,295,702	1,433,744	1,466,610	1,604,412	1,585,295	—

LIGHT RAILWAYS.

The Light Railway Commissioners have submitted to the Board of Trade an order for the construction of light railways in the county of Worcester between Bromsgrove railway station, Bromsgrove Town, and Lickey End.

At a recent meeting of the Bowness District Council the proposed electric tramway to connect Bowness, Windermere, and Ambleside was discussed, and the Council resolved to continue their opposition to the scheme.

The Cinque Ports Light Railway, Limited, is the title of a company which has been formed, with a capital of £25,000 in £1 shares, to take over and continue the application under the Light Railways Act for a provisional order for the construction of the Cinque Ports light railway, and to carry on the business of railway and general engineers, railway and tramway proprietors, etc.

The complete scheme for the Mansfield and district light railway has now received official approval, and the substance of the two applications will be drafted in one order The extensions to Pleasley-hill and the cemetery at Mansfield, and from Sutton to Hucknall Huthwaite are estimated to cost £36,487.

The President of the Board of Trade in a return in regard to the operation of the Light Railways Act, 1896, states that no loans have yet been approved under Section 4 of the Act. The following are the free grants which have been approved conditionally by the Treasury under Section 5: (1) The Mound, Embo, and Dornoch, company incorporated by the order, £14,000; (2) Forsurard, Melvich, and Port Skerra, company incorporated by the order, £20,000; (3) Fraserburg and St. Combo, Great North of Scotland Railway Company, £5,000; (4) Kelvedon, Tiptree, and Tollesbury, Great Eastern Railway Company, £16,000; (5) Elsenham, Thaxted, and Bardfield, company proposed to be incorporated by the order, £16,000; (6) Tanat Valley, company incorporated by the order, £18,000; (7) Leek, Caldon Low, and Hartington, company incorporated by the order, £10,000; (8) Welshpool and Llanfair, company incorporated by the order, £7,000; (9) Wick and Lybster, company incorporated by the order, £20,000. Order authorising the light railway not yet confirmed for Nos. 4 and 5.

The Staines and Egham Light Railway Company, Limited, intend to apply for an order authorising the construction and working of light railways in the Egham district.

Sir Courtenay Boyle held an enquiry on the 28th ult. into the Barnsley and district light railway order. The promoters—the British Electric Traction Company—were represented by Mr. Sydney Morse. The objectors were the Barnsley Corporation, represented by Mr. Soutter (Durnford and Co.), and the Worsborough Urban Council, for whom Mr. Oddie (Torr and Co.) appeared. Mr. Soutter said the Corporation of Barnsley objected to Sub-Clause 1 of Clause 6 as to the supply of electrical energy. It proposed certain conditions for the supply of electricity by the Corporation to the company, but the Corporation had the power already, and they considered this sub-clause unnecessary. They did not know how it got into the order at all. This and various other clauses objected to were passed, and Sir C. Boyle said, with regard to the company selling the undertaking, that it was not conceivable that the Board of Trade would assent to the sale to a company or person without consulting the local authority. They had set their face against transfers and concessions.

It has been decided to commence forthwith the construction of a light railway from Ludgershall, over the War Office property, to Tidworth and Clarendon Hill, the site for the barracks on Salisbury Plain.

At a recent meeting of the Parish Council of Llannor, near Pwllheli, Mr. Evan R. Davies, Pwllheli, and Mr. Bennett, Manchester, explained the proposed scheme for a railway to be worked by electricity between Nevin and Pwllheli. The following resolution was passed: "That we approve and give our support to the construction of the railway, as we are convinced that it would benefit the various districts interested, both commercially and agriculturally, but that we record our opinion as to the following points (1) that the gauge ought to be the ordinary one of 4ft. 8½in.; (2) that it would be desirable for the rails to be laid from Pwllheli as far at least as Efail Newydd, outside the public road; (3) that the road for the distance mentioned should be widened to 30ft.; (4) that the Council should have the right hereafter, if necessary, to have the railway fenced, and that Mr. J. Evans and Captain John Roberts be appointed to appear before the Light Railway Commissioners' enquiry at Pwllheli."

The Board of Trade have confirmed an order for the construc- of a light railway, promoted by the Railway Developments, Limited, from Highbridge to Cheddar.

A conference is to be held in a fortnight, with regard to the Driffield-Hornsea light railway proposal, between the promoters and the Hornsea Council.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	1	The English Electric Manufacturing Company's Works	21
The Swansea Tramways	6	Field Telegraphy at Mafeking	23
The Municipal Electrical Association: Combined Management of Tramway and Lighting Departments	11	The Power Bills	25
		Questions and Answers	25
The Reduction of Light-Load Losses in Alternating Supply Works	13	Contracts for Electrical Supplies	27
		Traction Notes	29
Local Loans	17	Lighting Notes	30
Light Railways	17	Companies' Meetings and Reports	33
Olla Podrida	18	Provisional Patents	35
The New Owens College Physical Laboratories	19	Traffic Returns	36
The Tramways and Light Railways Exhibition	20	Companies' Stock and Share List	36

TO CORRESPONDENTS.

All Rights Reserved. *Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.*

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

OLLA PODRIDA.

After the rejection of the Dublin Electric Bill on the third reading on Monday, the House of Commons could hardly stultify itself, hence the St. Marylebone Bill was rejected on the second reading on Tuesday last. The hearty sympathies of the profession must be given to the promoters of these Bills, and to Mr. Campbell Swinton, who has had to see his Tyneside Bill consigned to the limbo of the "not passed." It is perfectly evident that the House has not condemned the St. Marylebone Bill upon its merits. It had little in common with the Dublin Bill. In the latter case the authority is actually in being as an undertaker, and is moving in the matter of extension; in the former—that is, the St. Marylebone case—the authority which it is promised shall act is not yet in existence, and will probably have so many things to consider in the early years of its life that actual work will not be commenced for two or three years more. As a matter of fact, both these Bills have been thrown out by lobbying tactics. In each case strong efforts have been made, not to discuss upon merits, but to throw them out in any case. Events are moving quickly, and while the House acts in favour of municipalities, the committee on the Power Bills is taking a far more sensible course and trying to put the matter upon a satisfactory footing. Coleridge said, "In politics, what begins with fear usually ends in folly," and this is borne out by the past twenty years of legislation. Any fool's scheme can be passed through Parliament provided that it is heralded by enough sounding brass and seconded by "votes." Leaders fear the latter, and notoriety seekers provide the former. We have been amongst the most fervent advocates of municipalisation, but only to a certain point; we have never advocated the giving of powers to authorities by means of which they shall be able to put back or to stay the hand of time for years, if not for ever. The Board of Trade is not of much account. It is a species of red-tape hydra—once getting an idea, sticks to it till long after the work carried out on the lines conservant with that idea is obsolete. A local authority has infinite trouble in getting a provisional order when a company occupies the ground unless it buys out the company, and *vice versâ*, but usually buying out means the purchase of obsolete plant and a costly fight as to price. When bought, the plant is consigned to the scrap heap as soon as possible, and something up to date installed in its place. Thus the absurdity of a hard-and-fast rule. Authorities who would act are prevented, and companies who see existing failures are unable to obtain powers to improve matters. A point that will tend to clear matters with regard to tramway work and assist the deliberations of the Joint Committee on Municipal Trading, is that the London County Council seem to accept the statement that "their tramway undertaking must distinctly be considered a trading institution." Such was Mr. Beachcroft's admission at the Council meeting on Tuesday, when the question was raised as to the giving of evidence before the Joint Committee. Once get such admission generally received, the ground is cleared for a

Digitized by Google

definition of what comes within the scope of municipal action, and what constitutes trading. It is no reply to say certain authorities make a good profit on their trading. We have long since advocated the view that authorities ought not to carry on undertakings for the purpose of making profits, and gladly see this view being adopted by some of the witnesses before the Joint Committee. In trading, a possible profit includes a possible loss, and it is certain the keenest advocates of work for profit-making will be less keen if the probability of loss is equally great. Of course, it is always best to prophesy on a certainty.

THE NEW OWENS COLLEGE PHYSICAL LABORATORIES.

[BY OUR OWN CORRESPONDENT.]

There is a well-known political maxim that "What Manchester says to-day, England will say to-morrow." Manchester has just spoken, with no uncertain voice, on the subject of the improved scientific education of her residents, and has proved, both by practical example as well as by precept, by the readiness with which its wealthier magnates have disbursed themselves on behalf of the science schools and colleges in their midst, and by the keenness of the interest they have shown in providing the best possible education for their sons, in the best possible surroundings, and with the best possible appliances and teachers. This has been splendidly illustrated by the circumstances which have attended the building and equipment of the new Owens College physical laboratories, and which were opened on Friday last by Lord Rayleigh with all the pomp and ceremony and formalities which are the common adjunct of these occasions, and in the presence of a large and distinguished assemblage of scientific gentlemen from all parts of the world.

The occasion marks an epoch in the history of physics in this country, for now for the first time can we point with proper pride to an institution at all comparable in size and efficiency as an educational instrument to the best and largest laboratories of the Continent and of America. In point of size, the new laboratories are the largest in the United Kingdom, and stand fourth in the world's list, of which the Johns Hopkins, Stuttgart, and Darmstadt laboratories are respectively first, second, and third; while in the means for carrying out extensive research, and in the possession of apparatus and appliances of the highest and most perfect kind, its position will be even nearer the top of the list. A walk round the various rooms cannot fail to raise in the minds of everyone who is able to recall the facilities, or, rather, the want of facilities, of 20 years ago for carrying out elaborate experiments in physics an unholy feeling of envy, to be immediately followed, however, by one of congratulation and contentment at the superior advantages which the next generation will receive.

We hope to describe at full length in an early issue these laboratories and their equipment. Some conception of their nature may be gathered from the following brief description. The buildings, which are of red brick outside, with fire and glazed brick inside, are situated in Coupland-street, on a plot of ground opposite to the main college buildings, with which it is connected by a subway. It contains four floors, including the ground floor, and a basement. Broadly speaking, the ground floor contains all the research rooms. It will also be provided with means for the testing of commercial instruments, as current meters, wattmeters, etc. Leading off from a door on this floor is the John Hopkinson memorial laboratory, a handsome, well-lighted, and splendidly ventilated brick building, built and presented by the relatives of the late Dr. John Hopkinson, to be devoted to the study of electro-technics in all its branches. The equipment of this Hopkinson wing was presented by the friends of John Hopkinson, and will include, by the beginning of next session, a 20-h.p. to 25-h.p. continuous-current motor, for driving half the shafting; two six-pole shunt-wound 18-kw. E.C.C. generators combined on the same base-plate, and fitted with collector rings for multiphase currents; one 18-kw. Hopkinson alternator; one 3·5-kw. alternator, supplying either single, two, or three-phase current as required. In addition to these, the laboratories have been presented with 30 Chloride cells and 30 Tudor cells, the total capacity at normal discharge rate being about 300 ampere-hours. In the electro-chemical laboratory are installed a large electric furnace of the Moissan type, taking about 500 amperes, and suitable benches and tanks for electro-chemical research. The first floor of the main building is to be devoted to the elementary and advanced laboratories for elementary students, and those taking the ordinary and honours course in physics. The second floor contains the lecture-rooms, the largest of which is capable of comfortably accommodating 210 students. Leading from the second floor is a staircase to the observatory, which contains a large 10in. refracting equatorial telescope, presented by Sir Thos. Bazley. This is mounted on a stone pillar running down into the ground and entirely separate from the main floor of the observatory. Another important feature of the buildings is the large Rowland grating ruled on a 6in. surface to above 100,000 lines. The mounting for this grating was specially designed by Sir Howard Grubb, F.R.S.

There was a large and brilliant attendance on the occasion of the opening of the new Owens College physical laboratories on Friday last by Lord Rayleigh, F.R.S. Mr. Alderman Thompson (treasurer of the college) presided, and amongst those present were Sir W. Abney, Sir W. Roberts-Austen, Sir Thos. Bazley, Sir H. Roscoe, Profs. J. J. Thomson, S. P. Thompson, Perry, Armstrong, Jack, Rücker, Lodge, Ludwig Mond, and Pickering (Harvard), and Mr. Wm. Mather.

Mr. Alderman THOMPSON, in opening the proceedings, said that the study of the physical sciences had become so interesting and so engrossing that the college had been compelled to erect this new building, and to fit it with the best possible appliances.

Principal HOPKINSON said that the erection of the laboratories was first rendered possible by the two magnificent donations of £10,000 and £5,000 respectively, given by friends of the college who desired to remain anonymous, the one towards the cost of building and the other to the endowment. Donations had been also received from others, and numerous gifts had been made by many engineering firms of the district. A grant of £500 had also been made by the Lancashire County Council, and a sum of £5,000 had been given by the executors of the late Mr. Harling for the founding of a research fellowship in physics or electro-technology in memory of that gentlemen.

Lord RAYLEIGH, in declaring the laboratories open, said that, as an old friend of Prof. Schuster, he was pleased to be able to participate in the ceremonies of the day. Twenty years ago they were associated in some work on electrical units, which they then brought to a satisfactory conclusion. It was hardly credible to many of those who studied electricity at the present time, that 20 years ago the ohm was uncertain to as much as 2 per cent. Speaking as a middle-aged or an elderly man, he could not help at first an unholy feeling of envy and jealousy on looking at the buildings which had been erected mainly through Prof. Schuster's labours, whose career he had watched with admiration, and with a sincere appreciation of his width of knowledge and soundness of judgment. He himself had attended with the utmost enthusiasm the lectures of Sir George Stokes at Cambridge, but there there were no facilities for personal experiment. Apart from the work which might contribute to actual scientific advance, there was also the humbler and more useful practical work by which the students acquired some knowledge of the realities described in their text-books. Phrases were liable to be repeated in an unintelligent manner when there was nothing to illustrate the meaning. A child is said to have defined the equator as a "menagerie lion running round between two poles." That might be an extreme case; but all were slaves to phrases which were only partly understood, and it was undoubtedly true that a student who went through a course of practical physics acquired an idea of what he was doing

Digitized by Google

and talking about that could never be satisfactorily got from books, or even from attending experimental lectures. They had been told that these laboratories owed much to the munificence of Manchester men. He had no doubt that in the future the benefactions of Manchester men would be called upon again. Besides providing a laboratory, there were constant demands for extensions and for increased staff and appliances. He could not help thinking that in America the rich men entered more fully into their duties than had often been the custom in England. A story was told of the president of an American university who had frequently received help from a certain wealthy magnate in the city where the university was situated, and who paid another call with a similar intention. The wealthy magnate said, "I have no time to talk to you; I know what you want. Here's my cheque-book; fill it up." He looked forward to the future of the laboratory with great hope. They had a professor who had already done much, and from whom much might be still reasonably expected. He thought that anyone occupying Prof. Schuster's position should be relieved of as much routine work as possible. He concluded by declaring the laboratory open—an assertion which would not be disputed—and by wishing it all the prosperity and the success which it deserved.

Prof. SCHUSTER, in moving a vote of thanks to Lord Rayleigh, said that the whole history of the college showed that one of the main objects of Owens College was, on the science side, to provide that high type of technical work which meant the training up of men who should not only supervise the work done in our workshops and factories, but who should also go on to fresh discoveries and the advancement of knowledge. No doubt it would be necessary ultimately to separate the subject of technical electricity and pure electricity, with separate professors, but he thought there was a certain charm in a place where the theoretical and practical parts were so closely united. He abhorred the remark which one heard so frequently, that a thing may be all right in theory but it was wrong in practice. It was altogether wrong to say this. A thing might be wrong in theory, or the practice may be imperfect, but what was right in theory could not possibly be wrong in practice. Alluding to the new John Hopkinson building, Prof. Schuster announced that an anonymous friend had given £500 towards completing the equipment of this wing.

Sir HENRY ROSCOE seconded the motion. He said that when he first came to Owens, in 1857, he found not only no means of practising physics in the laboratories, but neither was there any means of lecturing in physics. Looking round the buildings, he could not help repeating a remark of the late Lord Derby's, that "England is always late, but she's never too late."

The resolution was carried with acclamation, and this terminated the proceedings.

A pathetically sad, but highly interesting, ceremony next took place in the new John Hopkinson laboratory, to which most of those present at the principal ceremonies adjourned. Alderman John Hopkinson, on behalf of the relatives of the late Dr. John, presented formally the new buildings to the college, to be known as the John Hopkinson Department of Electrical Engineering. In a speech that was full of pathetic references, Alderman Hopkinson said that the relatives hoped that the facilities now given for the study of applied science might help Prof. Schuster in his important work, and that under his supervision a "Manchester school" of electrical engineering should be established second to no other. Manchester was proud of her distinguished son, and rejoiced with his family in his successes, and mourned with them in the early termination of a life so full of beneficent energy and of promise of yet larger results. They hoped that his example and career might enter with living power into the work of the students within those walls, and fulfilling the old motto of the Institution of Civil Engineers, "To use the forces of nature for the benefit of mankind." Mr. Alderman Thompson gratefully accepted the gift on behalf of the college. Mr. W. Mather, M.P., then formally presented the equipment of the Hopkinson laboratory on behalf of a few friends and admirers of the deceased. Prof. Rücker and Prof. Jack bore independent testimony of Dr. John's greatness, the one as a man of science, the other as a mathematician, and the proceedings then closed.

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(Continued from page 916, Vol. XXV.)

Passing from the exceedingly interesting exhibit of the British Westinghouse Company, one naturally turned to the combined exhibit of Messrs. Dick, Kerr, and Co., the English Electric Manufacturing Company, and the Electric Railway and Tramway Carriage Works. This combined exhibit consisted, in the first place, of track work of various kinds, the rails being of different weights, and suited for all kinds of roads. Poles and brackets for overhead trolley work were also exhibited. Naturally, the portion of the exhibit which one noticed most were the electric cars. The first of these was a large car for heavy service, and built to seat 64 passengers. Like others of the cars exhibited, this one was fitted with the Bellamy reversed staircase. This staircase, instead of starting from the side of the platform from which the passenger alights or gets on the car, is taken across to the other side. The improvement is, no doubt, very good when one gets used to it, but a moderately tall man is rather apt to spoil his hat on the apparatus which informs people in the street of the car's next stopping place. This last-named apparatus is certainly an improvement to the extent that at a fair distance one can see by the lamps placed behind opal glass the name of the car's destination. The tramcars are mounted on maximum traction trucks, and the motor equipments of the cars shown are of Messrs. Dick, Kerr, and Co.'s standard type, and are fitted with a special solenoid blow-out controller. The bogie cross-bench car for summer service which was shown is similar to that used on the Blackpool and Fleetwood tramway. These tramcars are mounted on equal wheel bogie trucks, and have an overall length of 40ft. 3in. and a seating capacity of 65. The seats on the car shown were very comfortable, and had a good type of reversible back. The improved Preston single-deck car shown was of a similar type to a number which the English Electric Manufacturing Company have built for Messrs. Dick, Kerr, and Co. It is very nicely fitted, and has a very neat and graceful appearance. The motor work is similar to that on all the cars which were in this exhibit. The brakes used are pneumatic, and are worked with an axle-driven air-compressor. Apart from the car exhibits was shown a standard type of truck fitted with motors and air brakes, and also various motors and controllers made on the Short system, and of the kind usually used in the construction of the tramcars. A motor-driven compressor for working the air-brakes was also shown.

The British Thomson-Houston Company, Limited, exhibited quite a quantity of apparatus of the type used in the latest pattern for electrical tramway construction. In the first place, two large tramcars, properly fitted up, were exhibited. The one which would be of particular interest to those who have lately seen the progress made with the construction of the overhead line in the western suburbs served by the London United Tramways Company, Limited, would be the car made for use upon those lines. The car was very roomy and comfortable, and was built to the designs of Mr. J. Clifton Robinson, the managing director of the above-named company. These cars are built to accommodate 69 passengers—30 inside and 39 out. Communication is made with the driver by means of small bell-pushes. The lighting is carried out by means of electrical incandescent lamps, which are rendered more effective by being placed behind cut-glass globes. The trucks are of the Peckham bogie type, and the electrical equipment consists of two of the exhibiting company's B. & L. motors of 28 b.h.p., mounted one on each truck on the axle of the larger wheels. Electric brake controllers, lightning arresters, circuit breakers, etc., are fitted. The trolley arm is of the upward pressure type, mounted on internal springs in the trolley standard. It is placed on one side of the car, a seat for one passenger only being used in order to make room for it. The other car, a standard Hurst-Nelson reversed stairway car, was very

Digitized by Google

similar to the London United car, except that, probably intended to be used only for show purposes, it was fitted up in a very handsome, though extravagant fashion. The trucks on this car, however, were of the Brill maximum traction type, and the electrical equipment was of the standard British Thomson-Houston double G.E. 58 motor electric brake equipment. In order to freely show the electric equipment, a Hurst-Nelson truck with extension springs was exhibited, on the axles being mounted two G.E. 58 motors with enclosed gear cases. The truck was placed so that the wheels could revolve and actual working conditions be shown. The motors used were especially suitable for heavy service, and could be used on both standard and narrow gauge tracks. The armature could be wound with either a four or six turn winding, the horse-power given being 37 b.h.p. and 27 b.h.p. respectively. The motors were connected to a series-parallel magnetic blow-out controller of the rheostatic brake type, so as to show the effectiveness of the rheostatic electric brake. These controllers are used for controlling the direction of rotation of the motors as well as the amount of current they take, there being less current consumed when the motors are connected in series than when they are connected in parallel, the latter being used where the cars are run at high speeds, while the former connection is used for starting, slow running, and frequent stopping. The operation of the rheostatic brake is secured by connecting the motors in such a manner as to convert them for the time being into generators, and thus transforming the kinetic energy stored up in the car by virtue of its rapid motion into electric energy, which is dissipated in suitable resistances in the motor circuit. This transformation of energy is so rapid that an exceedingly effective retardation of the car is obtained, the amount being entirely within the control of the motorman. The controller is further provided, like all British Thomson-Houston controllers, with a magnetic blow-out, in order to reduce the cost of maintenance and repair to minimum. In making the changes from series to parallel there is produced at the terminals of the controller fingers an arc, which if not instantly extinguished will soon roughen, and eventually volatilise the metal that the contact fingers are composed of, but which the magnetic blow-out "blows out" before it has an opportunity of doing the slightest damage. A number of automatic circuit breakers were shown, and also some standard resistance boxes. A trolley was arranged to show that the upward pressure was uniform throughout its whole range. Amongst the other exhibits by this company were electric car heaters, tramway recording meter, material for overhead construction, magnetic blow-out lightning arresters, and a specimen portion of track fitted with the centre slot type of underground conduit. A specimen of surface-contact system was also shown.

The principal exhibit which the Brush Electrical Engineering Company showed was a bogie vestibule car. This car is of an overall length of 39ft. 6in., and is divided into two compartments, the entrance being in the centre. In this way one half of the car can be used for smoking if desired. The car is naturally only a single-decked one, but it is very well fitted, and is arranged with sliding windows similar to those of railway carriage doors. The exhibit, however, which was newest was that of the controllers made by the Brush Company. The first, the H.G. 2, was a series-parallel controller fitted with an emergency electrical brake and return current position. By means of this controller the weight of the car descending a gradient is utilised to generate a current and return the energy to the line. The other controller shown was a series-parallel controller with a rheostatic brake, and by which the speed of the car can be easily reduced either gradually or, on emergency, suddenly. The motor which was shown was a 25-h.p. four-pole iron-clad motor with ventilated armature and laminated pole-pieces, and having the field coils wound on brass spools, which allow of easy renewal. The bottom half of this motor is made to hinge downwards, either with or without the armature bearings.

The J. G. Brill Company, of Philadelphia, U.S.A., had an exhibit which consisted of a tramcar, trucks, etc. The tramcar which was shown was a single-decker and entirely self-contained, in that it could be used for winter or summer use by either pushing up or pulling down the sides and windows. The sides and windows are carried in the roof, and are easily operated. The car shown, which was similar to those built by the Brill Company for the Leeds Corporation, was very well fitted inside, the benches being seated with cane in imitation of the old style of rush-bottom used in chairs. The backs of the seats are reversible. There were also three type of trucks exhibited, amongst the distinctive features of which were the absence of bolts and the use of solid forged side-bars, separate specimens of the latter being shown. Models of trucks in bronze were shown, and a gong worked by the motorman's foot.

The Electric Construction Company exhibited a 70-kw. variable-ratio transformer, as used in the Oxford system, and an alternating-current transformer of the E.C.C. standard pattern, in which the iron circuit is composed of circular discs, by which means the loss is reduced to a minimum. Magnetic leakage is also reduced by splitting up the winding into a number of sections. A 30-h.p. tram motor and a stationary Bushbury enclosed motor were also shown, this latter being constructed to stand an overload of 100 per cent. for short periods. A standard generator was shown, and also a specimen of the company's trolley for side suspension, in which the trolley head is fitted with a cushion spring to absorb shock. Switches and a generator panel were also included in the exhibits, and also a generator panel with an automatic cut-out and field regulator.

Messrs. W. T. Glover and Co., Limited, naturally exhibited cables; a case of samples of various kinds and sizes, lead covered, steel armoured, etc., was shown, and also various joint-boxes. In this portion were straight, tee, and four-way junction boxes for single, concentric, triple-concentric, twin, and three-core cable of all sizes. Rail bonds also formed part of the exhibit of this company, these having both round and compressed strands.

The British Insulated Wire Company showed specimens of their cables as in use in the various towns of Great Britain, and also the system of laying the same. The St. Helen's Cable Company were also amongst those exhibitors who showed specimens of cables.

(To be continued.)

THE ENGLISH ELECTRIC MANUFACTURING COMPANY'S WORKS.

AN OBJECT LESSON.

(Concluded from page 922, Vol. XXV.)

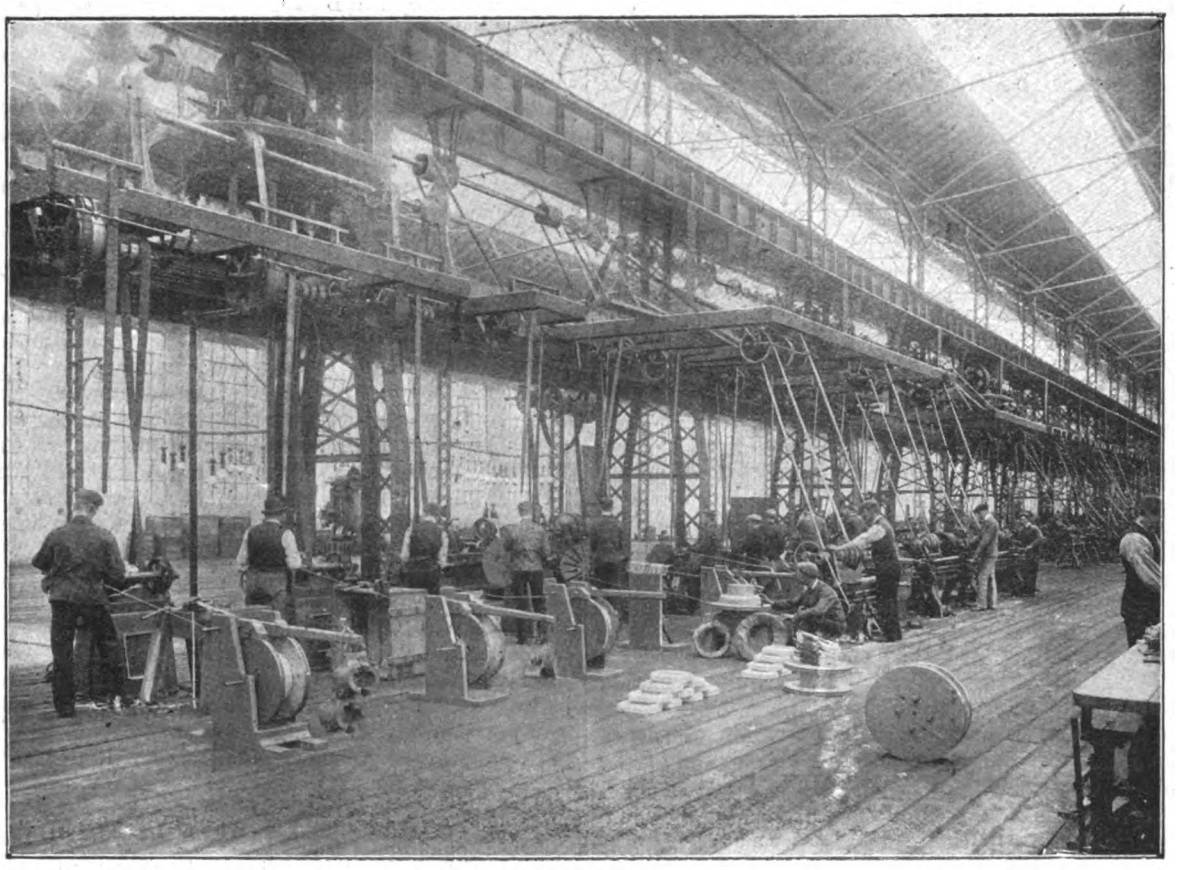
Offices.—In the south-east corner of the machine shop are placed the offices on the ground floor, the engineering department occupying the first floor with a thoroughly equipped laboratory for testing all materials entering into the finished product. The drawing offices and a very complete photographic department are on this floor. Both the offices on the ground floor and the engineering department are provided with large fireproof strong rooms for books and drawings. On the second floor the company has provided clubrooms, consisting of reading-rooms and library, dining-room, and kitchens for the use of the works' staff.

Foundry.—The foundry building is parallel with the machine shop, with a space of 60ft. between the two. It is 465ft. in length and 120ft. wide. It is equipped with two 30-ton and one 15-ton electric crane. In this building are contained the ironfoundry, the brassfoundry, the pattern shops, and the pattern storage shops. Two cupolas are provided for moulding iron and five brass furnaces for making the brass parts for motors, generators, and switchboards. The ironfoundry will be used for making the frames of the very large generators and alternators for the manufacture of which these works are specially equipped. In both the brass and iron foundries the machine tools provided are driven by an independent motor. These special tools are used for sifting sand, for cutting gates from castings, for cleaning and finishing castings after they come from the sand, and for magnetically separating brass and iron filings which may be returned from the machine shop. The pig iron and coke

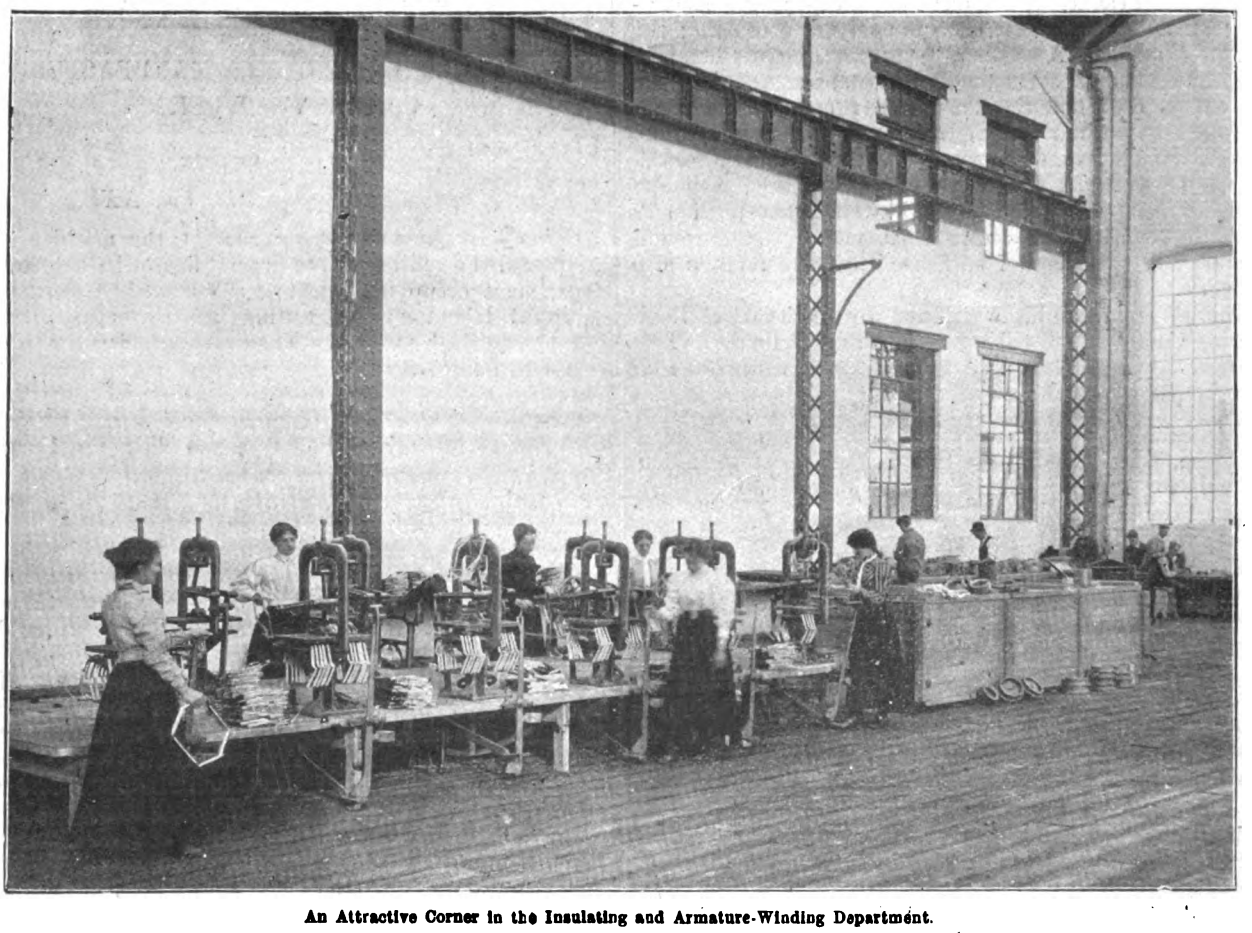
Digitized by Google

for charging the cupolas is delivered directly from the railway tracks upon the left cupola staging on the same level with the cupola charging doors. Here 600 tons of iron can be stored, with coke enough to melt it, and the cupolas charged without lifting or handling of material. The pattern shop is provided with its own motor and a complete equipment of the best wood-working tools.

Power-House.—The power-house is at the south end of the foundry, with a clear space of 30ft. between the two. It is 144ft. long, 120ft. wide, divided into a cold-storage room, boiler-room, engine-room, battery-room, and reservoir.



Winding Department.



An Attractive Corner in the Insulating and Armature-Winding Department.

The boiler-room contains at present three 500-h.p. Lancashire boilers, with ample space to receive an additional three boilers of the same capacity. A Green's economiser

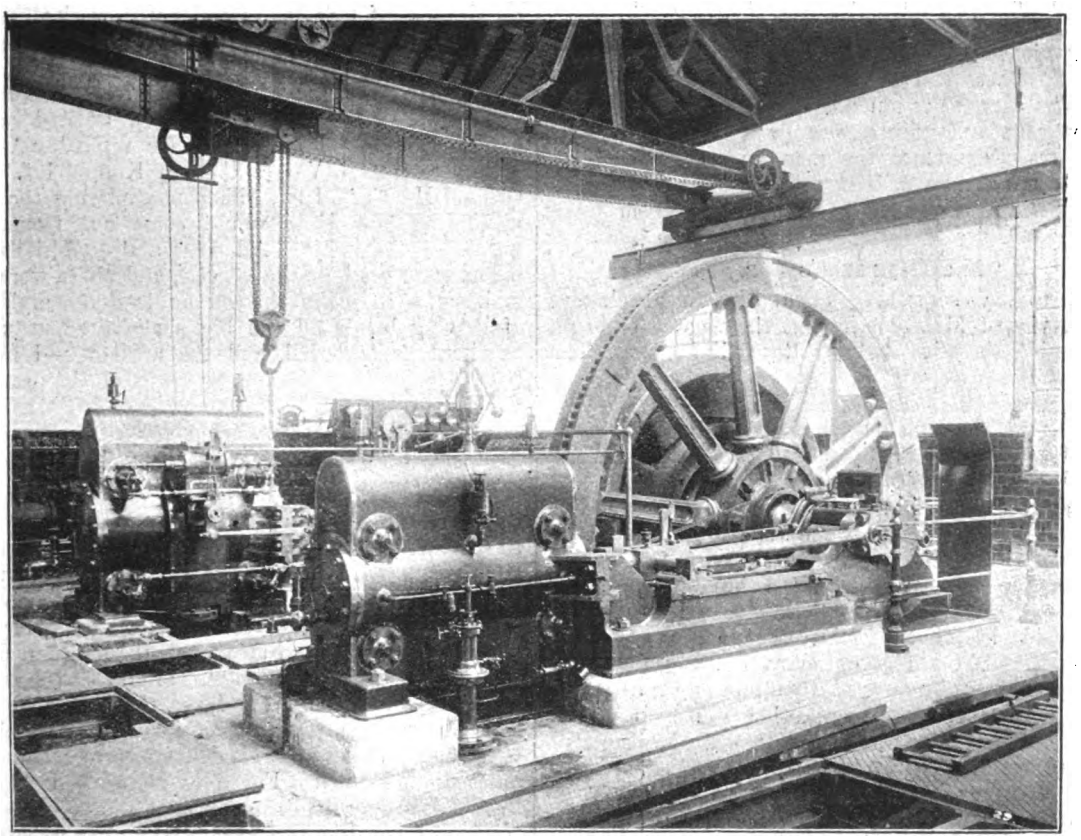
Digitized by Google

is provided, together with the necessary boiler feed pumps. The engine-room at present contains two cross compound Corliss engines, each direct connected to a generator of 400 h.p. capacity. There is therefore available at the present time 800 h.p., with a possible overload capacity of 25 per cent. Space is left to receive a 1,000-h.p. unit which will shortly be installed, and the generator for which will be made at these works. The battery-room contains a 500-volt Chloride accumulator set, which is used for supplying light and power throughout the works at night when the power plant is shut down. The reservoir, with a capacity of 60,000 gallons of water, receives its supply from an elaborate system of roof drains. A cooling tower erected over one portion of the reservoir cools the water coming from the condensers of the engines.

Lighting and Heating.—All the buildings and grounds are lighted most thoroughly, for the general lighting arc lamps being used with incandescent lighting suitably arranged for the individual tools. The heating and ventilation of the buildings is amply provided for, so that the temperature can be kept uniform at any point from 60deg. to 70deg. F. throughout the year. In the offices the direct radiating method is used, while for the shops the hot-air system is employed, accomplishing the double purpose of providing not only for heating, but for an adequate supply of pure air at all times.

General.—Within the grounds there has been erected what will be known as the directors' clubhouse, provided with a dining-room, kitchens, bedrooms, etc., for the accommodation of the directors and their friends while remaining overnight at the works. Special attention has been paid not only in the laying-out of the plant itself, but in other directions for the comfort and means of entertainment of the workmen in the shops. Alongside the foundry it is arranged that extensive bathrooms will be erected, provided with hot and cold plunges, etc., and in which each of the men employed in the foundry will have his own special locker reserved for his private use. A portion of the company's funds is being devoted to the erection of a large group of comfortable workmen's dwelling-houses upon an excellent site close at hand to the works. It is also intended to erect a large clubhouse with gymnasium and reading-rooms, etc., for the men. In this connection it may also be added that the directors of the company, recognising the important part which the young engineer with a fair technical education and a sound practical training has played in the building up of the industry in connection with the great German and American companies, have in view, for the benefit of such young engineers employed at the works, the delivery of a regular course of lectures on electrical engineering subjects throughout the year, this being a matter to which Mr. Short himself attaches the greatest possible importance as a factor in the continued future success of the undertaking.

Is it not Bain who says that when two pleasures concur, the result is a greater pleasure? and we presume the summation goes on correspondingly with more than two. Hence the pleasure of those interested in these works ought to be great. They have taken a leaf out of the book of their competitors; in fact, they have gone one better—they have remembered the mutual dependencies between labour and capital, and they have started successfully with orders. If pleasure is not derivable from every-one of these sources, it ought to be. Our thanks are tendered to the directors and officers who so fully and freely opened their works for inspection, and who were indefatigable in giving information, and we trust a successful opening may be followed by a long and successful existence.



View of Engine-Room and Overhead Travelling Crane.

FIELD TELEGRAPHY AT MAFEKING.

The following article, written by the war correspondent of the *Pall Mall Gazette*, appeared in that journal on the 28th ult. By the kind permission of the editor we are allowed to reproduce the same in full, and we concur heartily in the writer's appreciation of the good work done by the electrical engineers of Mafeking. It will be seen from the article that these gentleman had to "make bricks without straw," and that they did not despise the methods of the Dutch in the way of commandeering. No English Postmaster would dare to do what Messrs. Howat, Campbell, and Simpson did, and we are pleased to see a record in the Press of the appreciation of these gentlemen's services. The article in question reads as follows:

"Some departmental workers in the field are seldom heard of by the general public, and, therefore, do not come in for the share of praise for work done that should be theirs. Yet these departmental corps form the principal springs that work the war machine. Without a com-

Digitized by Google

missariat department an army could not take the field. It could not bring its necessaries with it, and would find itself in a corner for want of food. The Royal Engineers are seldom sung about, and few know how hard the scientific corps work to make everything possible for the conduct of operations. Is there a mountain to be removed? They do it. Does the general want to have a system of telegraphs constructed, or a railway built, or an engine driven, or a bridge thrown across a river, or a sea of timber cut down? The Royal Engineers are the men upon whom falls the work, and nobody can say that the corps does not perform it in the highest state of efficiency. Those corps that do the heaviest and most laborious duties are, as I have said, the bodies that are least heard of at home. They toil like galley slaves, but quietly; and when their toils are over little more is heard about them until they are required in some other part of the field. The public mind must be stimulated into interest by sound and dash. A blazing battery or mass of guns rattling and dashing over a plain to get into action comes first in public favour; the cavalry, with sabre in hand or lance-point dropped, scouring over the plain after a retreating enemy, come next; and patient, swearing Tommy of the infantry of the line, with his bayonet fixed and his helmet on his ear, poking his way into an enemy's trench, is generally a good third. These are the fellows of noise, glitter, and dash; but you cannot get much dash out of half a mile of transport wagons and mule teams or a system of useful telegraph wires. Therefore the men who work that part of the show must take a back seat, and be content to make up with the extra daily salary given them by a thoughtful War Office.

"MR. CAMPBELL'S JOB.

"I want to say something about the telegraph and telephone service of Mafeking during the siege. To begin with, we had little wire and no Royal Engineers. The postmaster of the place, Mr. J. B. Howat, had the planning of the arrangements in his hands, and Mr. Arthur Campbell, of the Belfast Telegraph Department, with Mr. J. B Simpson, of the Northern Relief, had the arranging and thinking and 'bossing up.' Miles of wire had to be laid to all the furthest forts and works, and the question was how to begin. As a start, all the telephones rented by the townspeople were taken down and the wires and instruments commandeered. With these a humble beginning was made, and an efficient field system was completed across the veldt in all directions. The wire was carried on small pegs raised a foot or so over the ground, and passing cattle and carts improved the lines and caused the staff to sing Watts's hymns and other items of sacred music. By-and-by, it was discovered that all the insulated wire that had been laid with much trouble under fire was wanted for the purpose of connecting mines to blow the enemy up with. Down came the lines again, and Campbell had to go around gathering all the scraps of wire that he could find in the town, tie them together, and endeavour to stretch 100 yards into 10 times that length. Metallic circuits were out of the question, as they would have necessitated the use of double the quantity of line. Earth circuits were formed, and the earth-plates consisted of iron buckets filled with mud, and rolls of zinc that had been shelled off the roofs in town. Occasionally a wire end was fixed to an iron rail on the top of a bomb-proof shelter, and that acted as well as anything else.

"DIFFICULTIES OF CONSTRUCTION.

"Everything was nicely settled as far as it went, and the telephone headquarters was established in the local post office, until it was found that it would be more convenient at the staff headquarters, a quarter of a mile away, and subsequently in the headquarters dug-out around the corner. Each of these shifts meant the taking down of the instruments, the elongation of the wires, and the fixing up of the instruments again. As new works were formed at the front, and our lines of defence were thrown out farther and farther, the demand for lines of communication became more frequent, and longer lines had to be established. The construction party went grey through thinking of their load of work and wondering where they would get the wire. At last somebody made a splendid find in the shape of thousands of yards of manganese wire, which the inmates of the gaol were told off to insulate by wrapping calico around it and tarring it over. Eureka! the difficulty was solved. At home a heavy storm or a big snow does damage to your lines, and causes the maintenance staff to use bad language. Here in Mafeking we had no snow, but the showers of iron were too much for the wires. Scarcely were we ever shelled but they were smashed, and the men had to go out under fire to set them right again. Times innumerable the cutting was done by Mauser bullets, and once during a heavy wind a tin roof sailed off a house in the market square, and of course, fate willed that it should fall right on the entire system of wires and fracture them. It was a warm moment when Mr. Campbell and his staff came out to count up the damage.

"MR. MACLEOD.

"Night and day that network of wires had to be watched and the instruments nursed like babies, and the work of repairing was never done. Many a time and oft in the darkness of the night the men were on the poles connecting up when the bullets began to whiz around them and make them shin their way to the ground again, and once MacLeod, the drawling fat Scotch ex-sailor who worked as linesman, was almost blown off the post by a shell. He seemed to work 20 hours out of the 24, but I only heard him growl once. He was sitting on a kerbstone, looking up with tired eyes at two wires that were twisted around each other, and when I hailed him he replied, 'A-a-h-h, mon, look y-o-o-nder. Y-o-n's Cannon Koppie lyin' d-o-o-n on Colonel H-o-r-e.' I left him contemplating the wreck, and wondering how Hore would come out from under the weight of the kopje. All sorts and conditions of instruments were used in the service, and there were numerous makeshifts to make the communication complete. Pieces of driving bands off the big shells fired at us made an excellent switchboard, and the ancient and modern contrivances found in the lumber-room of the post office were hauled out and fixed in the trenches to do duty for receivers, transmitters, and alarms.

"THE COMMUNICATION DEPARTMENT.

"This communication department was without exception the most severely worked body in Mafeking. In addition to erecting and maintaining under the most terribly trying circumstances, they had to work the instruments or train others to work them; they had to keep watch and watch and at the same time run the siege post office. Human nature could not stand that kind of thing indefinitely, and in course of time the postmaster and all the hands except Campbell went sick with fever, the result of exhaustion and other ailments, and then for weeks Campbell had to take the watches of all his colleagues and run the department single-handed. For days he worked 24-hour shifts, but he did not die, as many men would have done. On the top of his troubles came the siege surcharged stamps. Everybody wanted sets and new issues and particular stamps to make up their collections, and his bomb-proof post office was each morning beseiged by waiting crowds clamouring for mauve sixpennies, yellow sixpennies, sixpennies with the figure in a reclining position, and sixpennies with the 'elongated figure.' I often went over there to watch his labours and admire his patience. There is a law in nature by which a man finds rest while contemplating the toiling of another, and the sight of this brain-weary man leaving the dug-out to look after his duties elsewhere had a delicious, balmy effect. I admit the savagery of the idea!

"I wrote in a dispatch of the great rains that washed us out of our trenches. During those rains the telephone instruments suffered. They were submerged, and when the holes were baled out the receivers and transmitters were found to be full of mud. Even in this supreme trial the patience of the amazingly patient men did not desert them. They began to clean out the mud with no hope of ever being able to make sound go through the telephones again; and at the finish were surprised to find that they had once more got their machines into perfect going order.

"It will be well if telephone and telegraph people at home cut this out and read it twice each time that a snowstorm or a gale gets among their wires."

Digitized by Google

THE POWER BILLS.

On Tuesday last the Select Committee on the Electric Power Bills met to consider the clauses of the three Bills—*i.e.*, the Durham Bill, the Lancashire Bill, and the South Wales Bill—the preambles of which were declared proved on the 28th ult. Before commencing the consideration of these clauses, Sir JAMES KITSON made the following statement, which is an expansion of the declaration of the committee already given respecting the South Wales Bill: (1) The company to be authorised to supply electrical energy for power purposes anywhere within the area of supply subject to the consent of the local authority in certain cases as set out below. (2) The company to have no general lighting powers—*i.e.*, distribution to ordinary consumers—within the area except in pursuance of a provisional order obtained in the usual way. (3) where a local authority is now authorised to supply electricity within the area, their consent is to be required to the supply of electricity by the company. The Board of Trade to be empowered to override the refusal of the local authority to give consent if the authority are not prepared to provide the requisite supply on reasonable terms and within a reasonable time. (4) Any local authority who hereafter gets statutory powers for supplying electricity within the area to have in ordinary cases the option of taking over the company's supply in its local area on terms to be laid down by the provisional order or Act, by which the statutory powers are given. (5) A company having statutory powers to be in the same position as a local authority now having statutory powers, a company to whom powers are hereafter granted to be placed in the same position as a local authority to whom statutory powers are hereafter granted. Sir James Kitson also suggested that the Government draughtsman should meet the agents to go through the clauses before the next meeting of the committee.

Mr. E W. FRERE, respecting the Lancashire Bill, said that he did not see anything in the above statement which would apply to the Lancashire Bill. The insertion of the clauses suggested for limiting the South Wales Bill would be extending the powers the promoters of the Lancashire Bill asked for.

Mr. PRITT said the same applied to the Durham Bill.

The committee on Wednesday considered a clause prepared by the Board of Trade in reference to the South Wales Bill, which clause was finally adopted in the following form: "The powers of the company for the supply of electricity under this Act shall be subject to the following provisions: (1) Electricity shall be supplied under this Act only (*a*) for supply in bulk to authorised distributors and (*b*) for the purpose of providing power and for the lighting by any person to whom it is so supplied for power of any premises in any part of which the power is utilised. (2) Electricity shall not be supplied under this Act by the company in any area being at the passing of this Act the area of supply of any authorised distributors, except with the consent of those distributors, but that consent shall not be unreasonably withheld. If any question arises whether that consent is unreasonably withheld or not, that question shall be determined by the Board of Trade. The consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time, and, in considering what are reasonable terms and what is a reasonable time, the Board of Trade shall, amongst other things, have regard to the terms upon which, and the time within which, the company are willing and in a position to give the supply. (3) If at any time after the passing of this Act any local authority or company become authorised distributors in any area within the area of supply under this Act, the company shall be subject to any provisions which may be made by the Act or provisional order under which the distributors become authorised as to the taking over of any supply then given by the company for use exclusively within the area of supply of the distributors. (4) Nothing herein contained shall prevent a company from applying for provisional orders under the Electric Lighting Acts of 1882 and 1888. (5) Nothing in this section shall authorise a company to supply electricity for lighting other than the lighting specially mentioned in this section. In this section the expression 'authorised distributors' means any local authority, company, body, or person authorised by Act of Parliament or provisional order confirmed by Parliament to supply electricity within the area of supply."

The committee adjourned.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

285. In applying the pressure test to transformers, say with 6,000 volts between the primary winding and the secondary winding, core, and earth shield, and with 2,000 volts between the secondary winding and the core and earth shield, what reason is there for joining the primary winding to core and shield in the latter case?—C. W.

286. Should high-tension mains for, say, 6,000 volts be laid in cast-iron troughs in preference to wood? And if so, why?—J. R. W.

ANSWERS.

Question No. 280.—Describe and sketch a consumer's double-pole fuse-box to carry up to 50 amperes, which has the following qualifications: (1) the box or boxes to be of cast iron, with glass front, and cover which can be removed quickly; (2) fuses easy to renew; (3) no thimbles to sweat on to cables; (4) good insulation between poles and from earth; (5) arrangement for sealing; (6) cheap—not more than 10s.

Best Answer to No. 280 (*awarded* 10*s.*).—The house service fuse box as shown in the sketch, which is to scale, is a single-pole fuse, and therefore applicable to three and five services, as well as for two. The case is of cast iron, and the dimensions are for a fuse capable of taking 50 amperes at pressures up to 250 volts. It has some improvements over the ordinary type of service fuse, notably the horizontal position of the screws that secure the fuse, the locking arrangement of the same, and its very high insulation from earth, also the double-grip cable terminals. The advantage of having the fuse terminals horizontal will be obvious: it allows the fuse to be slipped in quite easily and screwed up with a wrench in an easy position, and if the meter board is fixed underneath a shop window or in a coal cellar, it will not necessitate the performance of an acrobatic feat to avoid coming in contact with some of the other apparatus with the other end of the wrench. The sketch shows plainly the locking arrangement of the fuse terminals, and is marked F and E (Fig. 3), and H (Fig. 1). By the way, the wrench should be provided with a screw-driver end for tightening up the screw F (Fig. 3). The cable terminals, as shown at A (Fig. 3), are as reliable as a sweating thimble. They have two nipping screws each, which will make doubly sure of having no loose connections. The burning of the rubber covering of the cable is utterly avoided, and therefore it is not necessary to rewind with tape. Where the cable enters at the top of the box, it should be wrapped with some kind of tape so as to exclude dirt; the bottom cable can be left loose, which will ventilate the box. The fixing screws, as shown at F (Fig. 1), should be well sunk into the porcelain division piece, marked E (Fig. 1). This division should reach nearly to the top of the fuse box—it will then baffle any arc formed by a fuse blowing; it should be divided, so as to allow the fuse wire to pass through. In some of the fuses now on the market

Digitized by Google

the fixing screws are placed very close to the current-carrying parts, and are therefore a constant source of surface leakage to earth. The door, which is shown by dotted lines in sketch, is furnished with a pair of hinges at D (Fig. 1); it is secured by means of a brass pin passing through the three ears at G (Fig. 1). This pin should have a small hole in one end for seal wire to be passed through. In the centre of this door is a small window, I (Fig. 1), for inspecting the fuse wire. The case is lined with a piece of vulcabeston sheet, which is secured in place by slipping it between the sides of the case and the porcelain base. The door is also lined with a piece of the same material. The fuse wire should be of copper, with end plates of copper sheet (see Fig. 2); this will keep the fuses well away from the door.

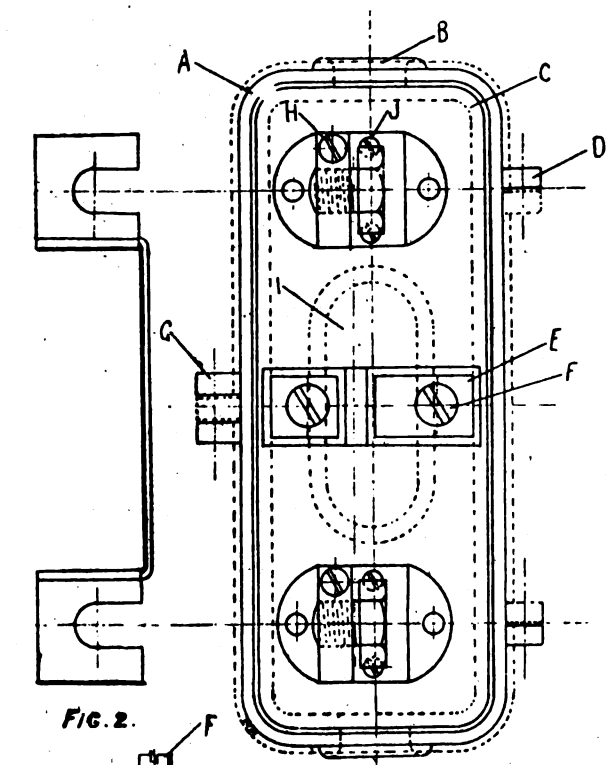


FIG. 1.

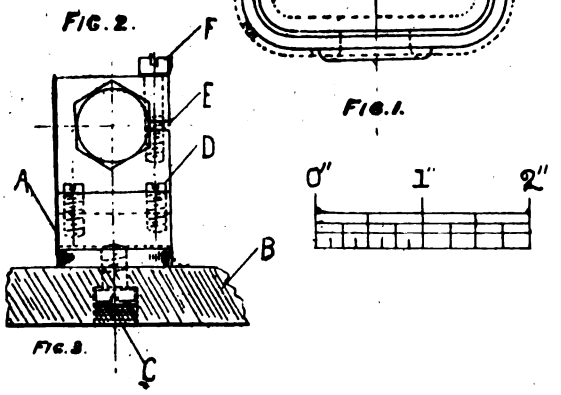


FIG. 2.

FIG. 3.

The letters on the drawings denote the following parts: Fig. 1—A, cast-iron case; B, hole for entry of cable, preferably bushed with ebonite; C, china base; D, hinge; E, china division; F, fixing screws; G, door fastener; H, fuse terminals locking screw; I, glass door; J, cable-nipping screws. Fig. 3—A, hole for cable $\frac{5}{16}$ in. diameter; B, porcelain base; C, shellac; D, cable-nipping screws; E, sawcut for clamping arrangement of fuse terminal; F, clamping screw.

I think the above will meet the requirements. The price will come within what is named for a pair if they are manufactured in any quantity.—W. B. DALE.

Answer to No. 280 (*awarded* 5*s.*).—General arrangement of consumer's double-pole fuse box is shown in Fig. 1. Box is of cast iron, lightly made, and provided with lugs at the corners for fixing, and with holes bushed with wood or fibre to admit the service cables and house wires. The poles are separated by a partition of common roofing slate dropped into a groove, formed by casting two parallel ridges down sides of box as shown. Contacts are mounted on porcelain blocks screwed to the back of box at the four corners. The lid has a glass front, and is easily removed. Fig. 5 shows back view and section of lid. Fig. 6 shows simple arrangement for sealing. On the lid and box two lugs are cast, so arranged that with lid in position these lugs lie one over the other (Figs. 4 and 6). To seal the box, a piece of string is passed through a hole drilled in each lug, tied on the top, and the wax dropped on the knot

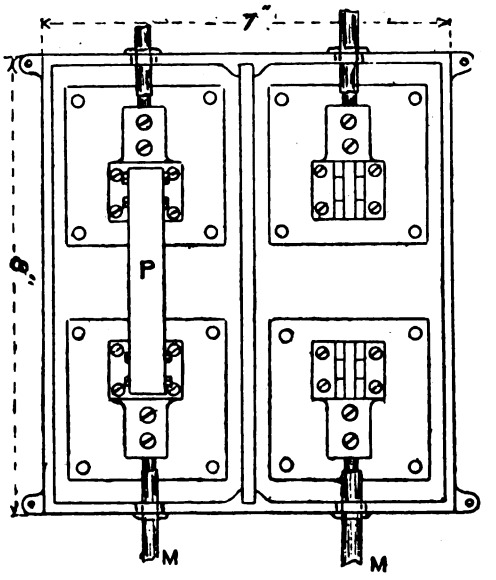


FIG. 1.—General Arrangement of Fuse-Box

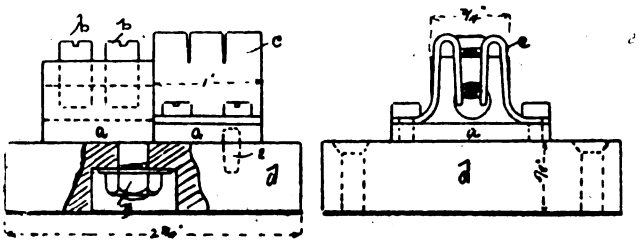


FIG. 2.—Detail of Contact.

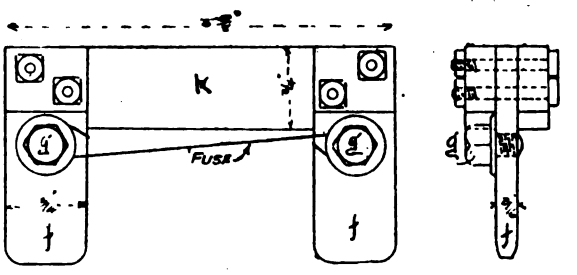


FIG. 3.—Detail of Plug.

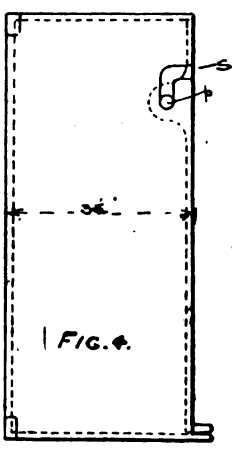
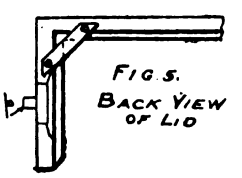
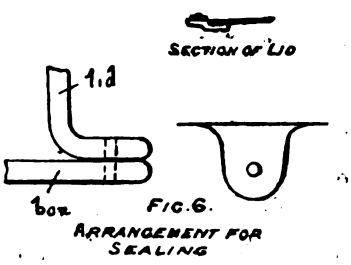


FIG. 4.



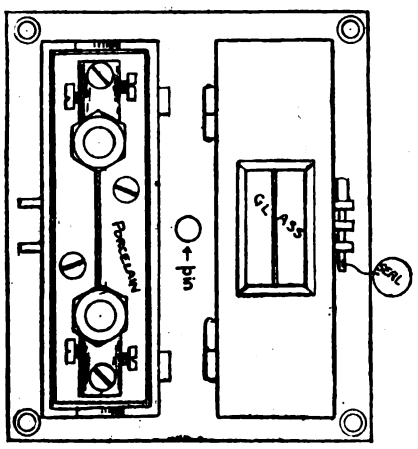


and stamped. To remove cover the lid must be swung forward at the bottom (the dividing partition is made to allow this) and lifted upward until pin, *p* (Figs. 4 and 5), is brought out of right-angled slot, *s*. The lid is then free. The form of contact is clear from Fig. 2. The brass casting,

Digitized by Google

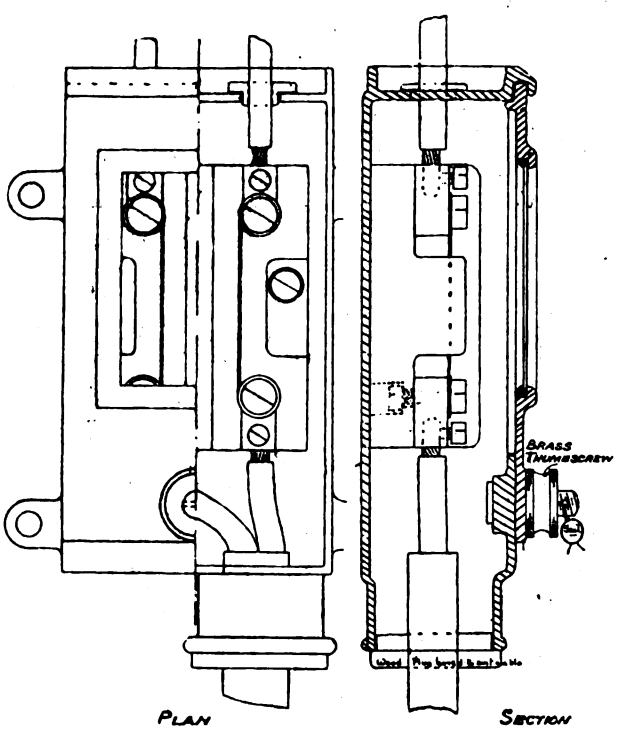
a, is drilled to receive the cable, which is held firmly by the set screws, *b b*, which have the same diameter as the hole, thus making the contact as secure as possible. On the broadened end two spring clips, *c*, are fastened as shown. The whole is held to the block by nut, *n*, and side movement prevented by steady pin, *e*. The recess may, if thought necessary, be run up with sulphur. The arrangement of the plug fuse is shown in Fig. 3. A stout fibre bar is recessed at each end, and into these recesses are bolted two brass contact pieces, *f f*. The fuse is stretched across as shown, being held at each end by set bolts, *g g*. Fig. 1 shows one plug, P, in position, the other being removed. To replace fuses the plugs are withdrawn by means of the fibre bar, *k*, the fuse wire stretched across as shown, and the plugs again inserted. The above arrangement is as cheap as it is safe to go, if convenience, mechanical strength, and durability are factors entering into the consideration of the question.—P. S. T.

Answer to No. 280 (*awarded* 5*s.*).—The sketch shows plan of a fuse-box arrangement which answers to the above specification: (1) The boxes are mounted on a base of varnished wood with their hinges facing one another, so that the opening of one box prevents the other one being opened. Between the boxes is a wooden pin upon which the opened cover rests. (In the sketch one cover is taken



off its hinges.) To open a box, simply cut the seal off and pull out steel pin. A glass front is provided for inspecting fuse. (2) The fuse wire is twisted around a brass bolt (part of thimble) and secured by a nut and washer. (3) Thimbles are provided with several set screws for securing cable, but there should be no slackness in fit where sweating is not allowable. (4) Excellent insulation is secured by using glazed porcelain slabs $\frac{3}{4}$in. thick. Care should be taken to fill up the screw head holes at the back of the slabs with paraffin wax. The porcelain fixing screws go through holes in the bottom of the box and fasten in the wood base. It is assumed that single rubber or diatrine service cables are used in damp situations, and that the boxes are bored to fit their outside diameters. (5) Seals are fixed on the end of steel pins threaded through lug holes cast on top and bottom halves of boxes, as shown. (6) The cost is under 10*s*. The arrangement is Reason type.—J. H. C. B.

Answer to No. 280 (*awarded* 5*s.*).—The accompanying sketch of a house fuse box fulfils all the conditions laid down. The shell is of cast iron. The lid, which has a glass front, is quite separate, but is rigidly held by the brass thumbscrew. A hole for sealing is provided. The porcelain base is screwed to the cast-iron shell, but has a thin sheet of mica placed between it and the shell. The fuse terminals are mounted on the porcelain base. At one end of each terminal a hole is bored to take the house or service cable, which is firmly held by a screw. No sweating is required. At the other ends screws are provided which fasten the fuse wire. There is a wall of porcelain between each pole and the sides of the box. Additional features of this box are: Suitable compound may be run on to the top of the box, and will prevent moisture getting in down the leads. The lower part of the box can be filled to level of terminals with compound after the service cables have been attached. This will effectually prevent moisture getting into the insulation, and makes the box suitable for



use with paper or jute insulated cables. The cost should not exceed 10*s*.—L. H. E.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

King's Lynn.—The Corporation invite tenders for extensions to the electricity station at the old waterworks. Tenders by July 9.

Bermondsey.—The Vestry invite tenders for the erection of a generating station in Neckinger, Spa-road. Tenders by 26th inst.

Manchester.—The Corporation invite tenders for alterations required to the existing wiring at the Victoria Hotel. Tenders by 10th inst.

Croydon.—The Council invite tenders for the building of an electricity sub-station at Pollard's-hill North. Tenders by 12th inst.

Croydon.—The Council invite tenders for the erection of car sheds at the Thornton Heath and Brighton-road depôts. Tenders by July 18.

Beckenham.—The Urban District Council invite tenders for Section G, free wiring contract. Tenders by July 16. Details in our advertisement columns.

London, N.E.—The Electric Lighting Committee of the Hackney Vestry invite tenders for the supply of 220 arc lamp pillars. Tenders by July 11.

Edinburgh.—The Corporation invite tenders for the supply of copper strip for electric conductors. Tenders by July 9. Details in our advertisement columns.

Rochdale.—The Committee of the Rochdale Municipal Technical School invite tenders for the wiring, etc., of the Rochdale Technical School. Tenders by 14th inst.

Lowestoft.—The Corporation are prepared to receive tenders for meters (direct-current) and cut-outs. Tenders by 10th inst. Details in our advertisement columns.

Southend-on-Sea.—Tenders are invited for the supply and delivery of about 1,180 tons of steel girder rails and about 46 tons of steel fishplates. Tenders by July 25.

Huddersfield.—The Corporation invite tenders for the overhead equipment of two short sections of tramways (total length about 2 miles 300 yards). Tenders by 9th inst.

Huddersfield.—The Corporation invite tenders for excavator, mason, and bricklayer's work in the construction of a conduit from the electricity works. Tenders by 9th inst.

Croydon.—The Town Council invite tenders for the reconstruction of the present tramway track and the construction of new tramways and paving of roads. Tenders by 10th inst.

Madrid.—The Secretary for Public Works invites tenders for the construction and working of an electric tramway from Puerto de Hierro to Aravaca and Pozuelo. Tenders by July 7.

Birkenhead.—The Corporation invite tenders for constructing and erecting a new car shed in connection with the electric tramways in Laird-street, Birkenhead. Tenders by July 24.

Newport (Mon.).—The Corporation invite tenders for the construction of a double line of tramways along Corporation-road

Digitized by Google

(length about 1½ miles), and other incidental works. Tenders by 9th inst.

Algemesi (Valencia, Spain).—The Municipal Authorities will receive tenders for the installation and working of the electric lighting by July 21. Specifications may be inspected at this office.

Tunbridge Wells.—The Corporation invite tenders for the supplying, laying, and jointing of armoured telephone cables; also instruments, etc. Tenders by July 12. Details in our advertisement columns.

Huddersfield.—The Electricity Committee invite tenders for a single-phase steam generating plant, having an output of about 1,000 kw. Tenders by July 12. Details in our advertisement columns.

Leeds.—The Tramways Committee of the Leeds Corporation invite tenders for supplying and fixing two, four, or six steel boilers (Lancashire type) at the generating station, Crown Point, Leeds. Tenders by July 9.

Wimbledon.—The Urban District Council invite tenders for supplying and fixing telephones intercommunicating between the various buildings forming the isolation hospital. Tenders by 18th inst. Details in our advertisement columns.

Beckenham.—The Urban District Council invite tenders for the erection of brick transformer stations, 11ft. by 11ft. in size internally, and six in number, the sites of the stations being at various points in the district. Tenders by July 9.

Cardiff.—The Corporation invite tenders for the manufacture of about 1,000 tons of steel tramway rails; also for fishplates, sole-plates, tie bars, bolts and nuts, points and crossings, drain rails, copper rail bonds, etc. Tenders by July 12.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the overhead equipment for the tramways in the borough, exclusive of the steel poles, but inclusive of their erection. Tenders by July 16. Details in our advertisement columns.

Hammersmith.—The Electricity and Lighting Committee invite tenders for the supply and delivery of insulated high and low-tension cables, junction boxes, etc., cast-iron pipes, drawbox covers, etc. Tenders by July 12. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for the supply and erection of boilers and auxiliaries, steam generators and switchboard and cranes, feeders and distributors, line equipments, trucks and car equipments. Tenders by July 25. Details in our advertisement columns.

Islington.—The Electric Lighting Committee invite tenders for relaying York and other stone and providing new York and other stone where necessary over the conduits and mains, as required, during the three years next. Tenders by 25th inst. Full details in our advertisement columns.

Blackpool.—The Corporation invite tenders for the following works in connection with tramways extension: (Section A) trolley poles; (B) cables and trolley wires; (C) boosters and switchboards; (D) storage battery. Tenders will be received for any one or more sections, but not for part of a section. Tenders by July 23.

Madrid.—The Spanish Government invite tenders, not later than Aug. 18 for the concession of a system of electric tramway lines in Barcelona. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Partick.—The Commissioners invite tenders for the supply and laying of insulated electric mains, conduits, junction-boxes, etc., the supply and erection of cast-iron arc and incandescent lamp standards, arc lamps, automatic switches, and other fittings. Tenders by July 10. Full details in our advertisement columns.

South Shields.—The Guardians invite tenders for the complete installation of the electric light at the union workhouse, Harton, South Shields. The proposed works consist of (Section A) engines, dynamos, battery, and main switchboard; (B) wiring, cables, and fittings. Tenders by July 14. Details in our advertisement columns.

Grays Thurrock.—The Council invite tenders for the supply, delivery, and erection of two Lancashire boilers and pipework, two 100-kw. steam dynamos, with boosters and balancer, fuel economiser, switchboard, battery, travelling crane, and mains and street lamp fittings. Tenders by Aug. 9. Details in our advertisement columns.

London, S.W.—Tenders are invited for the supply, within three months of the order being given, of about 70 arc-lamp standards, required in connection with the electric light installation for the Victoria-embankment, for the London County Council. The standards are to carry the lamps suspended, at about 23ft. from the ground level, at the end of a curved arm extending over the carriageway. Each person tendering is to submit his own design for the standard, or, if he so desire, he may submit alternative designs. A short description of the standard, showing generally what is required, may be obtained at once on application to the Clerk to the Council. Specification may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 10.

Durban.—The Corporation invite tenders for supply, delivery, and erection of materials under the three following sections: (Part A) comprising the supply, delivery, and erection of the entire overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, etc.; (B) comprising the supply, delivery, and erection of 22 double-deck motorcars, complete; (C) comprising the supply and putting into working order of a complete steam and electric generating plant in a power station to be built by the Corporation, including three 250-kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, etc. Parts A and B will not be separated, but will be let to one contractor. Part C may be let separately. Preference will, however, be given to a contractor who will undertake all three sections, and a separate form of tender for all three sections will be supplied. Specifications, bills of quantities, forms of tender, and lithographic drawings may be obtained on application to Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation. A deposit of £10. 10s. must accompany application for specifications and forms of tender. The deposit will be returned on the receipt of a bona fide tender. Sealed tenders, in duplicate, under separate cover, in specially-provided envelopes, to be delivered to the Town Clerk of Durban by mail delivery on or about July 23. The successful tender will be accepted by cable from Durban.

RESULTS OF TENDERS.

Keighley.—The tender of Mr. T. E. Sugden, for the erection of municipal electricty works, at £3,260, has been recommended for acceptance.

Blackpool.—The Corporation have contracted with the British Thomson-Houston Company for the supply and erection of 15 electrical tramcar equipments.

Tower Wagons.—The Blackburn, Darwen, and Poplar Electricity Works have given orders for telescopic tower wagons and ladders to Messrs. J. H. Heathman and Co., London.

Dover.—The Electricity Supply Company have obtained the Corporation's order for the illumination of the sea-front the same as last year on the same terms, £45 for the installation and £20 per week for current.

Manchester.—The tender of Messrs. Macartney, M'Elroy, and Co., of London, for the electrical equipment of three tram routes in the city has been recommended for acceptance. The contract is for £16,251. 6s. 6d., and covers the cost of providing the overhead and other traction appliances for Cheetham Hill, Rochdale-road, and Bury New-road routes (about 10 miles).

West Ham.—The Guardians have accepted the tender of Messrs. Frank Suter and Co., Limited, 66, Berners-street, W., at £5,252 (subject to the sanction of the Local Government Board), for the execution of the following separate contracts: (1) supplying and laying cables and wiring the buildings and premises, and supplying and fixing the lamps, switches, and all other necessary fittings; (2) supplying and erecting the plant complete, including storage battery, switchboard, instruments, and engines and dynamos in duplicate.

London, S.E.—The Bermondsey Vestry have received the following tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc.:

W. T. Glover and Co., Salford (accepted)	£8,134	7	9
St. Helens Cable Company, Warrington	8,109	16	8
Siemens Bros., Queen Anne's-gate, S.W.	8,113	9	11
Callender's Cable Company, 90, Cannon-street, E.C.	8 212	7	1
Western Electric Company, North Woolwich	8,219	11	11
British Insulated Wire Company, Prescot	8,643	15	10

London, W.—The Directors of Madame Tussaud and Sons, Limited, have received the following tenders for an extension of their electric lighting plant. The specification for this included two 30-kw. steam dynamos, two Babcock and Wilcox steam-boilers (each with 526 square feet of heating surface), switchboard, and connecting cables:

Johnson and Phillips (own dynamo, Alley-Maclellan engine)	£1 775
Crompton and Co. (own dynamo, Willans engine)	1,963
Crompton and Co. (own dynamo, Reavell engine)	1,722
Bruce Peebles and Co. (own dynamo, Willans engine)	2 158
Bruce Peebles and Co. (own dynamo, Browett-Lindley engine)	1,948
Bruce Peebles and Co. (own dynamo, Reavell engine)	1,928
Bruce Peebles and Co. (own dynamo, Alley-Maclellan engine)	1 918
Drake and Gorham (Parker's dynamo, Willans engine)	2 058
Christy Bros. and Middleton (Crompton dynamo, Browett-Lindley engine)	2,126
Christy Bros. and Middleton (Crompton dynamo, Willans engine)	2,154
Christy Bros. and Middleton (Crompton dynamo, Reavell engine)	1,924
Christy Bros. and Middleton (Crompton dynamo, Allen engine)	2 116
J. H. Holmes and Co. (own dynamo, Willans engine)	2 150

The tender of Messrs. Johnson and Phillips was accepted under guarantee to deliver and erect one steam dynamo in eight weeks. The tender of Messrs. J. Simpson and Co., Pimlico, was accepted at the same Board meeting for the supply of the steam and exhaust pipes, feed pumps, feed heater, calorifier, and all the necessary apparatus to enable the exhaust steam to heat the building on the system of the Atmospheric Steam Heating Company. The amount of this tender was £560. Mr. R. W. Weekes, M.I.E.E., A.M.I.C.E., is the consulting engineer for the work.

Johnstone.—The Council are in communication with the promoters of the Tramway Bill in Parliament in reference to certain adjustments.

Digitized by Google

BUSINESS NOTES.

TRACTION.

Fleetwood.—The Corporation propose to spend £9,300 on new electric tramcars.

Manchester.—The Corporation have come to an agreement with the Manchester Carriage and Tramways Company.

Dundee.—The construction of the proposed tramway between Dundee and Monifieth appears now to be a settled matter.

Bournemouth.—At a special meeting of the Council on Monday, it was resolved that the parliamentary agent be instructed to proceed with the Corporation tramways order.

Lincoln.—At the last meeting of the Town Council it was stated that the Tramways Bill had now advanced so far that it was beyond opposition. The scheme would not be other than successful, and would be a revenue-producing scheme.

Middlesex.—The County Council resolved on Thursday last week to persevere in their opposition to the Bill of the London United Tramways Company when it comes before the House of Lords. The attitude of the Council is severely criticised in the local Press.

Gloucester.—Mr. Alfred Dickinson, of Birmingham, who was formerly general manager and engineer of the Birmingham Tramway Company, has been asked to report generally upon the negotiations now pending between the tramway company and the Corporation.

Gravesend.—The Town Council will oppose the application to be made to the Board of Trade by the National Electric Traction Company, Limited, for an extension of time for the commencement of the works authorised by the Gravesend, Rosherville, and Northfleet Tramways Order, 1899.

Swansea.—The local paper states that an alternative route is proposed for the Swansea Corporation tramways, powers for the construction of which are now being sought. This, if carried out, would deviate the published route, and result in an important and valuable new street being opened up.

Kirkcaldy.—At a meeting of the Town Council on the 2nd inst. the report of Prof. Kennedy in connection with tramways and electric lighting for Kirkcaldy was discussed. The matter was remitted back to a committee to consider and report the relative cost of the alternative routes proposed.

Blackpool.—The Town Council have decided to oppose the Blackpool, St. Annes, and Lytham Tramways Bill when it comes before the House of Lords Committee. It is thought that clauses are now being introduced in the Bill respecting the supply of electricity to the company that are inimical to the interests of the Corporation.

Lyndhurst.—The Council are considering favourably a proposal with regard to the construction of an electric tramway and electric lighting for Lyndhurst. Mr. C. J. Wharton, Westminster, has been over the proposed route, and his suggestion is to construct a line commencing at the Lyndhurst-road railway station to Lyndhurst. Electric current would be available for public and private lighting.

Glasgow.—The tramways report for the last year shows a continued increase in every item. In consequence of the introduction of electric traction on parts of the system there is a gain of 2·45d. per tram mile in receipts, and a saving of 2·55d. in expenses. It is expected that fares will be lowered again when the conversion of the system is completed. In the contemplated urban extensions Paisley, Clydebank, and Renfrew are included.

Bolton.—It is stated that the makers of the cars have promised to deliver the cars on order within the next three months. In regard to the resignation of the tramways manager and electrical engineer on his appointment to a similar position at Cardiff, it was suggested at the last Council meeting that separate managers would be appointed for the two departments, and that the dual management system hitherto adopted would be abolished.

Southport.—The Board of Trade inspection for the electric tramways is fixed for July 17, and the formal opening of the tramway service for the following day. Last Friday the first official trial over the completed parts of the route was undertaken upon the one car that has recently arrived from Preston by members of the Electricity Tramways Committee, other members of the Town Council, and various officials connected with the work.

South Staffordshire Tramways.—The South Staffordshire Tramway Lessee Company have formally taken over the working of the whole of the tramway systems of the old South Staffordshire Tramways Company, and we learn that the management will remain in the hands of Messrs. H. Hatchett and J. J. Robins. The former will still retain the secretaryship of the old South Staffordshire Company, which position he has held for the past 15 years.

Aston.—At the last meeting of the Council a letter was received from Sir R. Nicholson, stating that the Parliamentary Committee are prepared to recommend the County Council to limit its opposition to the London United Tramways Bill to clauses, if the District Council will consent to the County Council being the purchasing authority of the whole of the tramways proposed to be authorised by the Bill. A motion not to accede to the wish of the County Council was passed.

Aberdeen.—At the meeting of the Town Council on Tuesday a recommendation of the Tramways Committee to the effect that Councillor Wilkie (convener of the committee), Mr. Moonie (superintendent of the tramways), and Mr. Bell (electrical engineer) be delegated to visit the International Tramways and Light Railways Exhibition in London to examine the latest apparatus designed for the equipment of mechanical tramways and light railways, both surface and underground, was agreed to.

Derby.—The Tramways Committee were authorised on Tuesday to prepare a scheme of electric tramways and extensions for submission to the Council for their approval, and to apply for parliamentary powers in the ensuing session through the Parliamentary Committee. A resolution to instruct the Tramways Committee to arrange for the discontinuance of the Sunday traffic on the tramways at the earliest possible moment was brought forward, but the motion, after some discussion, was negatived.

Portrush.—At Monday's meeting of the Urban District Council Mr. H A Macaulay, solicitor to the Council, submitted a consent entered into between the Portrush and Giant's Causeway Tramway Company and the Urban District Council, by which both parties agreed to a settlement of the action raised by the Council against the tramway company to obtain an injunction restraining the latter from obstructing the streets at Portrush by the poles carrying the overhead electric wires, the Council to pay the costs as between party and party. The costs amounted to about £70.

Liverpool.—The electric lines having now been completed in Prescot-street, the old route will be put in use immediately. Rapid progress is being made with the electric equipment in the London-road districts, and Mr. Bellamy expects to have the electric cars running by the August bank holiday. The laying of the rails on the Wavertree route is proceeding, and when this portion is finished the eastern section will have been completed. The dispatch with which the work has been carried out is very favourably commented upon.

Wimbledon.—At last week's meeting of the Council the report of the Tramways Committee was adopted containing the surveyor's report upon the proposed tramway between Wimbledon and Tooting, and also plans showing three schemes as under: (1) tramways laid as a single track, except between Miller's Mead and Terrier's Bridge; (2) tramway laid as a double track, with lines interlacing throughout; (3) tramway laid as a double track, except between Miller's Mead and Terrier's Bridge. The Croydon Rural District Council will be asked to appoint a committee to form with the Wimbledon committee a joint committee for the purpose of considering the schemes submitted by the surveyor.

Hampstead.—At the meeting of the Vestry on Thursday last week a letter was received from the hon. secretary of the committee formed to oppose the Haverstock-hill and Hampstead Heath tramway scheme of the London County Council, expressing their best thanks to the Vestry for their prompt and unanimous refusal of consent to the application of the Council for permission to construct such tramway. Sir Henry Harben, chairman of the Vestry, drew attention to the danger of accepting a single penny from any company, omnibus or otherwise, towards any widening or improvement scheme. He hoped this Vestry would discourage any payment whatever, and adopt any action that might be decided upon entirely on public grounds.

Blackpool.—At the meeting on Tuesday a clause in the Electric Lighting Committee's minutes dealing with the committee's visit to the London Electrical Exhibition, was objected to on account of the large number of members who proposed to go away at the expense of the ratepayers. It was proposed that the clause be referred back, the Mayor pointing out that the Corporation contemplated spending £100,000 on tramway extensions, and it was only right that the committee should see that they got the very latest and best. The reason why the whole of the committee were invited was because very few could promise that they would be able to go, and, in reality, only seven undertook the journey instead of 20. The clause was accepted.

Carlisle.—Mr. A. P. Trotter, inspector of the Board of Trade, inspected the electrical plant of the Carlisle tramway system last Thursday. He also visited the electric lighting station in James-street. The inspector expressed himself generally satisfied with what he had seen. There will be a formal Board of Trade inspection of the permanent way, Mr. Trotter's duties being confined to the electrical plant, which will probably not interfere with the starting of the tramways for the service of the public. The company intend to use 12 cars, nine of the double and three of the single-deck description, which have been built by the Electric Railway and Tramway Carriage Works Company, Limited, Preston. After the inspection the inspector and other guests were entertained at luncheon at the County Hotel by the tramways company.

York.—At the meeting of the City Council on the 2nd inst. a resolution was carried providing for the giving of notice to the City of York Tramways Company, Limited, requiring them to sell so much of their undertaking within the city as is authorised by the York Tramways Order, 1879, and all lands, buildings, plant, etc., used by them in connection with it; and for application being made to the Board of Trade for their approval to the Council giving the notice. The minutes of the Streets and Buildings Committee, which were adopted at the ordinary meeting of the Council, contained a report on the subject of the tramways by the town clerk, stating that, according to cases decided in the House of Lords, the price to be paid was the value of the tramways as measured by what the cost of construction would be at the date of sale, subject to a proper deduction for depreciation, and not on the basis of a rental valuation. Neither the amount of the capital of the company nor the goodwill was taken into consideration.

Digitized by Google

St. Helens.—At the meeting of the Council on Wednesday the Mayor moved the adoption of the minutes of the Electric Supply and Tramways Committee, and gave a brief sketch of the progress of matters electrical as worked by the Corporation. On March 31, 1898, he said, 4,526 lamps were connected, and the cost to produce the current was 4·04d. per unit, and the total cost 6d., while the sale was over 35,000 units to 63 consumers. In 1899 they had 6,463 lamps, the works cost had dropped to a little over 3d., the total cost to rather less than 4½d., and 65,091 units were sold to 79 consumers at the price of 6d. At the end of March this year they had 13,981 lamps connected, the works cost had gone down to less than 1d., and the total cost to nearly 1½d. The sale was 320,160 units, which, of course, included that supplied for the tramways. The number of consumers was 190, and there had been an increase in the supply for motors. The output for May was 57,434 units, which was at the rate of 689,800 units per annum, or about double the output last year. Seeing that May was one of the lightest months in the year the increase was most promising. A profit of £10. 12s. 7d. had been made last year, but this would be increased next year. In spite of difficulties and the changing over from the Warrington Old-road station, there had been no serious failure in supplying electricity. The minutes were confirmed.

Northwich.—On Friday a deputation, consisting of Major Tulloch, R.E., Mr. H. W. Handcock (electrical engineer), Mr. John Parnell, C.E., and Mr. Walter J. Lomax, C.E., waited upon the Rural District Council for the purpose of conferring with them respecting the proposal of the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, London, to construct a line of tramways connecting Northwich, Middlewich, and Winsford. The matter was fully discussed, and a resolution favourable to the scheme was passed. The deputation also met the members of the Winsford Urban District Council, and explained to them the proposals of the system of tramways. Mr. Prince Lewis presided, and there were also present Messrs. T. Massey, S. Leach, R. Chesters, J.P., Jackson, J. M. Dean, J. H. Cooke (clerk), H. Hulse (surveyor). The deputation explained the scheme, after which the following resolution was passed: "The Urban District Council of Winsford, having heard the explanation of Major Tulloch and Mr. Handcock, of the United Kingdom Tramway, Light Railway, and Electrical Syndicate, hereby express themselves as generally favourable to the scheme of tramways connecting Northwich, Winsford, and Middlewich, as suggested by the explanation given, subject to the details to be submitted to a future meeting and agreement being arrived at between the Council and the syndicate. The Council further consider it most advisable that the line of rails should approach the town by way of Wharton-road."

LIGHTING AND GENERAL.

Leeds.—The salary of Mr. Street, electrical engineer, is to be increased by £100 per annum.

Chelsea.—The surveyor is now making experiments in the use of motor-vans for sweeping, etc.

Belfast.—The Council propose to apply for sanction to a loan of £95,000 for electric light purposes.

Finchley.—Circulars are being issued to the ratepayers asking if they desired to have the electric light.

Mexborough.—The electrical engineer has been instructed to proceed with the work of lighting the town by electricity forthwith.

Padstow.—The Lighting Committee is about to make enquiries as to whether the town can be advantageously lighted by electricity.

Charlton.—The Blackheath and Greenwich Electric Light Company propose to lay down a main along the Old Charlton-road very shortly.

East Grinstead.—The Urban District Council have decided to interview Mr. Elvey Robb, of Tunbridge Wells, with reference to the electric lighting.

Limehouse.—The electric lighting provisional order of the Board of Works will come before the committee of the House of Commons on the 16th inst.

Gloucester.—It is stated that the trial run of the electric light in the shops is highly satisfactory. The official opening of the works will take place next week.

Lewes.—The transfer of the Lewes Electric Lighting Order, 1898, to the County of Sussex Electrical Power distribution Company, Limited, has been completed.

Wakefield.—Mr. H. P. Boulnois held an enquiry on Wednesday into the application of the City Council to borrow £25,000 to extend their electric lighting scheme.

Cheltenham.—Colonel W. R. Slacke, R.E., has held an enquiry into the application of the Town Council for sanction to borrow £20,100 for purposes of electric lighting.

Pickering.—The Urban District Council on Monday decided to meet representatives of an electrical supply company to discuss the merits of electricity for public lighting.

Coventry.—Stock is to be raised, subject to the approval of the Local Government Board, for a quarter of a million sterling. This amount includes £33,671 for electric lighting.

Ilford.—A temporary loan of £10,000 for electric lighting purposes has been obtained. The foundation stones of the electric lighting station and the chimney shaft will be laid shortly.

Southport.—Colonel A. J. Hepper, R.E., has held an enquiry into an application of the Town Council to borrow £9,000 for the provision and laying down of continuous-current cables. There was no opposition.

Friern Barnet.—The District Council are greatly concerned about the increase in the charges for gas, and it is suggested that they will shortly have to be seriously considering the introduction of electric lighting.

Leicester Electricians.—It has been officially reported by the War Office that the Leicester members of the Electrical Engineer Detachment, Royal Engineers—Messrs. D. F. Colson, A. Charlton, and G. Charlton—are prisoners.

Halifax.—The Electricity Committee of the Town Council have agreed that the salary of Mr. H. F. Street, the electrical engineer, be advanced on Oct. 1 by £100 per annum, and at the expiration of 12 months from that date to £500 per annum.

Leamington.—The Town Council have decided to make an offer to the Midland Electric Light Company of £17,000 for their undertaking outside the order, the offer to be subject to the order obtained in 1900 being transferred to the Corporation.

Wrexham.—Tenders for the boiler-house for the destructor in connection with the electric light works will be invited on a specification to be prepared by the borough surveyor. Provision has been made at the waterworks for an electric motor and pump.

Kidderminster.—At Tuesday's meeting of the Guardians the House Committee reported favourably upon the question of having the electric light in the house if the cable were brought into the locality. The matter was referred back for further consideration.

West Bromwich.—Sanction has been obtained to the borrowing of £30,000 for land, buildings, and plant for the electricity works, the repayment to be extended over 25 years. The foundation stone of the new electricity works will be laid by the Mayor on the 16th inst.

Ilfracombe.—It is proposed that the electric lighting order be handed over to the firm who could give the best terms. The Council could not at present undertake the electric lighting of the town. The matter has been referred to the General Purposes Committee.

Walsall.—At the last meeting of the council of the Chamber of Commerce it was resolved to support the Dover Chamber in a memorial to Trinity House asking that there should be wireless telegraphic communication between lightships and lighthouses and the shore.

Lymington.—The electric light and power company commenced laying cables on Monday. A part of the shipyard abutting Bath-road has been secured as the generating station, and 9, High-street has been taken as the offices of the company, of which Mr. G. R. Masters is the secretary.

Birstall.—At the last meeting of the District Council a letter was read from the North British Electrical Supply Company intimating their intention to apply to the Board of Trade for powers to supply electrical energy for public or private purposes within the Birstall urban district.

Shoreham.—A communication from the Brighton Corporation asking the Shoreham Council to concur in the Corporation's application to establish a system of telephonic communication and include Shoreham in the area has been referred to a committee of the Urban District Council.

Newburn.—At Wednesday's meeting of the District Council a letter was read from the Tyneside Electric Power Company that, in view of the fact that they had been unable to prove the preamble, and the Bill had been thrown out, they gave notice of their intention to apply for a provisional order.

Aston.—The incorporation question formed the chief subject of discussion at the last meeting of the District Council. It was said they had an electric lighting and tramways schemes before them, and if those could be properly matured 5d. or 6d. in the pound would be put in the pockets of the ratepayers.

Tamworth.—The Town Council recently decided not to support the application of Messrs. Handley and Shanks for a provisional order to generate and supply electricity for light and power within the borough. The promoters, however, intend taking the necessary steps to secure a provisional order without the support of the Council.

Hull.—At a recent meeting of the Corporation Electric Lighting Committee a communication was read from the Hull Chamber of Trade asking the committee to reduce the price of the electric current for motive power. It was decided to leave the matter with a sub-committee for their report. Various applications for the supply of current were agreed to.

Salford.—A motion is to come before the Town Council to the effect that the proceedings of June 20 appointing certain members on the Electric Lighting Committee be rescinded, and that the Selection Committee be instructed to submit in their stead the names of three members of the Council who were not members of the old Electric Lighting Committee.

Heswall.—The Heswall Gas and Lighting Company, Limited, intend to apply for a provisional order during the ensuing session empowering them to construct electric lighting works at Heswall, and to generate, accumulate, and distribute supply of electricity to enable the company to light the parishes of Heswall-cum-Oldfield, Barnston, Gayton, and Pensly.

Electrical Power Storage Co.—From the report of the Electrical Power Storage Company we gather that the orders for E.P.S. batteries are increasing for tramways and power stations. The profit for the year amounted to £5 309 and the directors, after carrying £1,243 to reserve and contingent funds, recommend a dividend of 5 per cent. on the ordinary shares.

Digitized by Google

Bexhill.—The Urban District Council have decided to apply for sanction to borrow £7,772 for additional machinery, extension of mains, lamp-posts, fittings, etc. It was pointed out that Mr. Preece had made allowance for 7,000 lights, and if all these were taken up the engines would be running at full pressure, and should a breakdown occur one engine could not do the work.

Hereford.—At the meeting of the Town Council on Tuesday the Electric Lighting Committee reported that the estimated expenditure in respect to the supply of the electric light during the current year was only £532 in excess of the estimated income, As the expenditure included a repayment of £800 on account of capital, the working for the first year showed a profit of £268.

Egremont.—Messrs. Baker, Lees, and Co., London, have informed the Urban District Council that the Bill to confirm the provisional order had passed through committee of the House of Lords, and was afterwards reported to the House without amendment. The Bill had been read a third time, and now only awaited the Royal assent, which it would receive at the next commission.

Colchester.—On Wednesday a report was adopted in which the Electric Lighting Committee stated, with regard to the appointment of an electrical engineer to take charge after Nov. 30 next, that they had no hesitation at all in recommending the Council to offer the appointment to the present electrical engineer, Mr. Sillar, who had the reputation of being an economical station manager).

Increase in Prices.—We notice that the Electrical Power Storage Company, Limited, have informed their customers that from the 2nd inst. all prices in their catalogue will be increased 5 per cent. on account of the continued advance in the prices of raw materials, especially lead, during the past few months. We understand that this increase also applies to all outstanding estimates.

Bradford.—At the last meeting of the Electricity Committee of the Corporation, plans for the proposed extension of the existing generating station at Valley-road were approved. The committee also resolved to apply for sanction to borrow a further sum of £140,000 for the erection of a new generating station at Valley-road, for additions to existing stations, and for further machinery and plant.

Newark.—The town clerk has been instructed to enquire as to the cost of obtaining a license from the Postmaster-General for providing a system of telephonic communication in the borough. The provisional order authorising the Council to supply electricity has been passed and confirmed. Mr. Vesey Brown is to be consulted with the view to preparing a scheme for carrying out the provisional order.

Larne.—With regard to the electric lighting tender referred to in our last issue, and which was referred to a committee, the latter on Tuesday reported that they did not see their way to take it upon themselves to recommend this large expenditure, believing that it was a matter rather for the consideration of a committee of the whole Council. After some discussion it was agreed to consider the question at a special meeting.

Provisional Orders.—Bills to confirm the Brecon and the Llandilo provisional orders made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, came on Monday before the examiners of the House of Commons for proof of compliance with the further Standing Orders, they having already been passed by the House of Lords. There was no opposition at this stage, and the Bills were ordered to be reported for second reading.

New Issues.—A company has been registered by Messrs. Jordan and Sons, Limited, of 120, Chancery-lane, London, under the title of the Anti-Collision Alarm Telegraph Company, Limited, with a capital of £1,500, divided into 1,500 shares of £1 each, to carry on business as denoted by its name.—Rosling, Appleby, and Fynn, Limited, announce an issue at par of £15,000 first mortgage 4½ per cent. debenture bonds, and £15,000 cumulative 6 per cent. preference shares.

Barking.—At a meeting of the Urban District Council, a report on the street-lighting was received from the consulting engineer stating that he had allowed for cables large enough to supply two 16-c.p. lamps in each post if they wished them at any future date. The cost of doing this and the extra switches was £2,700. The interest and sinking fund would be £148. 10s., but they would only require one lamplighter instead of three, which would mean a saving of £169.

Filey.—At the last meeting of the Urban District Council a letter was read from the Northern Counties Electricity Supply Company, stating that it was the intention of the company to apply in the next session of Parliament for a provisional order for electric lighting in the Council's area, and asking the Council to appoint a deputation to meet representatives of the company to discuss the proposals. The Council decided not to grant the interview, and to have nothing to do with the matter.

Eastbourne.—The resolution passed at the meeting of the Council on March 5, 1900, authorising application to the Local Government Board for power to borrow the sum of £800 for extensions of electric light mains has been rescinded, and in lieu thereof application is to be made for power to borrow the sum of £2,000 for extensions of electric light mains, the purchase of transformers, meters, and electrical instruments. Gildredge-road has been added to the roads which it is proposed to light by means of arc lamps.

Partick.—At a special sitting of Partick Dean of Guild Court on the 2nd inst., the town clerk appeared in support of a petition by the Commissioners of the burgh for permission to erect a dust and refuse destructor and electric lighting station, with offices, on a piece of vacant ground situated between Partick West Station and Clyde-street. It was ultimately decided to postpone the application till Monday next, when parties will be heard. The estimated cost, including the laying of the street cables for the electric light, is £60,000.

Personal.—Mr. Arthur Ellis, M.I.E.E., at present electrical engineer and tramway manager for the Corporation of Bolton, Lancashire, has been appointed electrical engineer to the Corporation of Cardiff.—Mr. A. H. Howard, who has been for some time manager to W. T. Glover and Co., Limited, has been elected to a seat on the board of directors.—The Brush Electrical Engineering Company have appointed Mr. Edward A. Leeson to the position of works manager at the Falcon Works, Loughborough. His predecessor was Mr. C. E. Hodgkin.

Croydon.—Application is to be made for a loan of £3 360, the cost involved in laying cables for the extension of arc lighting on the whole of the new tramway route. The salary of Mr. T. H. Minshall, borough electrical engineer, is to be increased by £50 per annum, with annual increments of £25 to a maximum of £600, the increase to date from April 1 last. The salary also of Mr. W. Jensen, the assistant electrical engineer, will be increased from the same date by £25, with an annual rise of £25 to a maximum of £275 The salaries of 13 other members of the staff have been raised.

Wedding.—On Wednesday last at the parish church, Knaresborough, the wedding took place between Miss Marguerite Emily Simpson, only daughter of Mr. G. E. Simpson, Parliament-street, York, and Woodville, Knaresborough, and Mr. Charles Midgley, son of Superintendent Midgley, of Dewsbury. After the ceremony a reception was held at Woodville. Nearly 90 employés from the Parliament-street works, York, came in three saloon carriages from York, and were entertained to tea in the town hall, Knaresborough, by Mr. Simpson. Our best wishes accompany the young couple.

London Gazette.—The reconstruction of the Premier Electric Lamp Syndicate, Limited, has been agreed to.—The first meeting in the estate of W. J. S. Green, 45, Birchfield-road, Aston, will be held on July 13, at 11 a.m., at 174, Corporation-street, Birmingham, and the public examination at the County Court, Birmingham, on July 30 at 2 p.m. An adjudication order has also been made out against the above.—Mr. George F. Clarke, 71, Cross-lane, Earlestown, Lancs., incorporated accountant, has been appointed trustee in the estate of G. H. Bentley, 63, Cross-lane, Earlestown, Lancs.

Appointments Vacant.—The Salford Electric Light Committee require an engineer to the electrical undertaking of the Corporation.—The Swansea Corporation require the services of a resident electrical engineer to take charge, under the superintendence and direction of the consulting engineers, of the erection of electric and steam machinery in their electric generating station at Swansea, and of the laying of electric mains in the streets of the borough.—The Wimbledon Urban District Council invite applications for the position of a temporary draughtsman for the extension of the Council's electricity works.—The British North Borneo Company invite applications for the post of superintendent of telegraphs. Full particulars appear in our advertisement columns.

Cardiff.—On Thursday last week Mr. Shepherd, the provincial manager, and Mr. Bell, the district manager, of the National Telephone Company, waited upon the Cardiff Public Works Committee with reference to the subject of placing the telephone wires underground. Mr. Shepherd stated that the overhead wires were so constructed that in some cases it was absolutely impossible to make the connections. They were prepared to pay a wayleave of 2s. per subscriber per annum (there are about 1,200 subscribers). The work of tearing up the street would be done by the Corporation's men and charged to the company. After some discussion the representatives of the company agreed to put their terms in writing, and forward them to the committee in time for their next meeting.

Presentation.—At the Leith Corporation electricity works on Monday, the 2nd inst., Mr. Bryson, the burgh electrical engineer, was presented by his staff with a handsome oak study chair, with silver name-plate attached, on the occasion of his leaving to take up consulting work. The presentation was made by the oldest employé, who wished Mr. Bryson every success, and hoped that he would be long spared to carry on his work—a wish which was heartily endorsed by those present. Mr. Bryson, in thanking his staff, referred to the excellent relations which had existed between them. He complimented them on the excellent way in which they had done their work, and said that as his new office at 16, Charlotte-street was so near, he would often look in to see how his "boys" were getting on. A photograph of the staff was also sent to Mrs. Bryson.

Fulham.—The Vestry are advertising that they will shortly be in a position to supply electricity for lighting, power, and heating purposes. They have decided to charge for lighting purposes 5d., and for heating or power purposes 2½d. per Board of Trade unit. No rent will be charged for the use of meters. With regard to the combined electric lighting, dust destructor, and disinfecting works it is proposed to make the following appointments: chief engineer and manager, £400 per annum, rising to £600 in increments of £50 per annum; destructor superintendent, £160 per annum, rising to £240 per annum in increments of £20 per annum; mains superintendent, £160 per annum, rising to £240 per annum in increments of £20 per annum; chief clerk, £160 per annum, rising to £240 per annum in increments of £20 per annum; three engineers in charge of shifts, £2. 5s. per week, rising to £3. 5s per week in increments of 5s. per week per annum.

Digitized by Google

Devonport.—Colonel C. H. Luard, R.E., has held an enquiry into an application by the Corporation for sanction to borrow £69 727 for electric lighting. The Town Clerk (Mr. A. B. Pilling) stated that it was proposed to locate the electricity station at Newport Quay, Stonehouse, which the Corporation had agreed to purchase for £15,000. Mr. C. Furness, electrical engineer, said three engines and dynamos capable of developing 1,500 h.p. would be laid down. One would be used for electric lighting, another for supplying current for electric traction, and the third held in reserve for either purpose. It was proposed to light the borough with 41 arc lights until midnight, and after that hour with 82 incandescent lamps. Altogether the plant, besides supplying the tramways with electric power, would be of sufficient capacity to light 10,000 8 c.p. lamps.

Hammersmith.—At a meeting of the Vestry on Wednesday the following report of the Electricity and Lighting Committee, which had been standing over from last meeting, was adopted: "The committee have thoroughly gone into the whole question of extensions of mains, and recommend that the streets mentioned in the report be scheduled, and the work carried out at a total estimated cost of £8,877, and that it be referred to them to execute the work from time to time as the demand may arise. In order to meet the cost of these extensions, the necessary transformers for the increasing demand, the connection to the new consumers, and the cost of the extensions of mains already sanctioned by the Vestry and carried out, the Vestry will obtain a loan from the London County Council or otherwise for a sum of £15,500, made up as follows: mains, £8,877. 9s. 1d.; transformers (300 kw.), £1,284; work sanctioned and carried out, £2,550; services, £2,500; contingencies, £288. 10s. 11d.

Obituary.—With much regret we have to record the death of Mr. Montagu Charles Dent, A.M.I.E.E. (of Messrs. Wallis-Jones and Dent, 36, Great George street, Westminster), on June 28, 1900, after a very short illness, subsequent to an internal operation. Mr. Dent received his education from 1885 to 1889 at Eton, and at King's College, London, from 1890 to 1891. He served his time with Messrs. Robey and Co., Lincoln, from 1892 to 1894, and also at the works of the Brush Electrical Engineering Company, Limited, Loughborough, Leicestershire, from 1894 to 1896. During 1896 and part of 1897 he was employed on installation work at Arundel Castle, on central-station work at the Wandsworth electric light station, and in the erection of the exhibition plant at the Earl's Court Exhibition. On Oct. 1, 1898, he joined Mr. Reginald J. Wallis-Jones in partnership as consulting engineers at 36, Great George-street, Westminster, and carried out several important installations of electric light and power plants.

Stock Exchange.—The Stock Exchange Committee have appointed July 11 as a special settling day for Alliance Electrical Company's 70,000 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 70,000, and Edison and Swan United Electric Light Company's fully and partly paid provisional certificates for £100,000 5 per cent. second debenture stock. The committee have also ordered to be quoted in the official list Alliance Electrical Company's 70,000 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 70 000. Applications have been made for a special settling day in and to grant a quotation to St. James's and Pall Mall Electric Light Company's £150,000 3½ per cent. debenture stock, and the Westminster Electric Supply Corporation's further issue of 30,100 ordinary shares of £5 each. The committee have been asked to allow to be quoted in the official list the National Telephone Company's £500,000 4 per cent. debenture stock; and a further issue of 100,000 ordinary shares of £5 each, fully paid, Nos. 490 001 to 590,000.

Blackheath and Greenwich District Electric Light Co.—An extraordinary general meeting was held on Tuesday at the Cannon-street Hotel, London, to consider resolutions for increasing the capital to £300,000 by the issue of 150,000 new shares of £1 each, entitled to receive out of the profits a fixed cumulative preferential dividend of 7 per cent. per annum, and authorising the directors to create and issue £120,000 of debenture stock carrying 4½ per cent. per annum interest. Mr. J. A. Willox, M.P., who presided, said when the Company began their own supply in February the number of lamps connected was equivalent to 5,900 8 c.p., while at the present time 10,000 lamps were connected. The total expenditure to date had been £128,000, but there were other charges to be brought in. To meet these liabilities, and to extend their area of supply, for which powers had been obtained, additional capital was required. Mr. H. W. Bowden seconded the motion. A discussion followed, and in the result the Chairman promised that the Board would issue no preference shares, except for the purpose of exchange, without first consulting the shareholders. The resolutions were approved.

Electric Fans.—We have received from the Edison and Swan United Electric Light Company, Limited, leaflet No. 137, which deals with fan motors. The "Paragon" fan motor which is listed is for use with continuous current, and of 1900 pattern. It is suitable for use in hotels, ship saloons, smokerooms, etc., and is made in three types—hanging from ceiling, fixing on wall, and standing on desk or table. As usual, the parts are interchangeable, and the armatures can be easily removed. Illustrations of the various types of "Paragon" motor are given, and telegraphic code words to save expense when ordering.—The British Thomson-Houston Company, Limited, have also sent us a list of 1900 fan motors which they are just bringing out. These motors also are made to be used for ceiling, wall, and ordinary positions. These motors are designed with special brush-holders having pressure arms so hinged and held that the pressure on the commutator is constant during the life of the brush, and the brushes wear evenly and cannot turn a sharp edge to the commutator. There are also new electrical features in these motors, the field coils being secured to a magnet frame composed of pure soft-iron laminations. The armature core is also of pure soft iron. Other particulars and illustrations of the motors are to be found in the pamphlet.

Catalogues.—We have received from Messrs. John Fowler and Co., Limited, of Leeds, a copy of their new catalogue of electrical machinery and apparatus. This firm, though principally noted for heavy machinery, has yet a large electrical department. Thus in the catalogue we find listed transformers of the Lowrie-Hall type. The price of these transformers range from £8. 10s. to £137, they being made for frequencies of either 85 or 50 cycles. Terminal covers, underground transformer boxes, transformer switches, and fuses are catalogued. One of these fuses (Hall and Fuller's patent) consists of a fuse wire in an asbestos sheathing, so that an arc cannot be maintained. Surface and junction boxes, the Lowrie-Hall synchronising base, resistances, boosters, and, finally, larger machinery, such as motors, dynamos, and alternators, appear in the catalogue. The list gives descriptions of the various pieces of machinery, and is well illustrated throughout.—We have also received from the Fairbanks Company, of the U.S.A., a booklet which at first sight appears to be a catalogue of tall buildings. On further investigation, however, one finds that it is in these large buildings, which, by the way, are in New York City, that the Fairbanks valves for heating apparatus have been installed. A description of the valves follows the illustrations. We are informed that the Fairbanks Company will be pleased to forward a copy of this book, post free, to any reader sending his name and address to the London office, 16, Great Eastern street, E.C.

Parliament.—The London United Tramways Bill has passed the second reading in the House of Lords. The Dublin and St. Marylebone Lighting Bills have failed to pass the House of Commons. During the past week it was announced before the Select Committee of the House of Lords, which had previously refused to sanction a double tramway or the use of electricity over the level crossing on the North-Eastern Railway in Hedon-road, Hull, that there was the greatest hope an agreement had been or would be come to between the Corporation and the railway company which would enable the tramway to be carried under the railway, by the road being lowered to a certain extent and the railway line raised a little, so as to allow of a workable gradient. The Select Committee of the House of Commons appointed to consider several Bills seeking the sanction of Parliament to the supply of electrical energy in bulk last week, decided that, in the cases of Durham, Lancashire, and South Wales, the preambles had been proved, but that in the Tyneside case it had not been proved. The committee proceeded to go through the clauses of the Bills. At the House of Lords the various local authorities affected by the South Lancashire Tramways Bill met in Lord Morley's room to consider certain objections taken by his lordship's counsel to the clauses put in by the House of Commons Committee to satisfy opponents and accepted by the promoters. After considering the views put forward by the local authorities, Lord Morley agreed to reinstate the clauses, so that the Bill as it now stands is exactly the Bill as it issued from the House of Commons' Committee, and the Bill in the House of Lords will now be practically unopposed. The Batley Corporation Tramways and the Camborne and Redruth Tramways Bills have passed the committee of the House of Lords. Mr. J. W. Lowther's committee have passed the Bill conferring further powers on the Newcastle-upon-Tyne electric supply of electrical energy. Reading Tramways Bill has passed through the Lords. Mr. W. H. Holland's committee passed the Bill promoted by the London County Council asking for powers to equip electrically and operate the Westminster to Tooting tramway and the Blackfriars to Kennington line, to erect a generating station at Camberwell, with sub-stations, and to construct 11 junction lines and extensions in connection with the Council's tramways on the northern side of the Thames, inclusive of all the new tramways asked for. The applications of the local authorities of Lambeth and Wandsworth for a veto on the use of the surface-contact system of electric traction, and in regard to other matters, were refused. The Bill confirming the provisional order obtained by the Weston-super Mare and District Electric Supply Company, Limited, from the Board of Trade, authorising them to construct tramways to be worked by electricity within the urban district of Weston-super Mare has been passed, subject to the insertion of a clause preserving the rights which the Commercial Cable Company may possess in regard to the uninterrupted user or enjoyment of their submarine telegraph cable running to Weston. In the House of Lords the Manchester Corporation Tramways Bill has been read a third time.

Hanley.—A special sub-committee recently appointed to make investigations as to reasons for the electric lighting accounts for 1899 showing a deficiency on the year's working after paying interest and sinking fund charges, reported to the Council last week that they were of opinion that the deficiency in the revenue account was to be attributed to the following causes: (1) too early reduction in the price of current before a reserve fund had been formed; (2) increased cost of fuel, wages, and materials; (3) abnormal repairs to generating plant; (4) increased charges to sinking fund and interest on further capital. The special committee recommended that the Council be recommended to increase the present prices for the supply of electricity of 5d. and 2½d. to 6d. and 3d. per unit from July 1 next, less discount as before. The General Committee recommended that the charge for the supply of electrical energy to places of worship be increased from 4d. to 4½d. per unit, and for heating and power supplied through

Digitized by Google

separate meter from 2½d. to 3d. per unit up to four hours' consumption per day and 1d. per unit afterwards. The minutes were adopted.

Brighouse.—On Saturday week the Mayor (Councillor J. W. Clay) officially opened the sewage outfall works at Cooper Bridge. The works are lighted by electricity, outside by means of arc lamps suspended from elegant pillars and brackets attached to the buildings, and the interior of the works, committee-rooms, and caretaker's house are effectively lighted by incandescent lamps. The wires connecting the arc lamps are laid in iron pipes in the ground. Electric current is generated by a "Churton" dynamo of the standard No. C 12 type, and provision is made by a storage battery for lighting part of the installation while the machinery is not running. The switchboard and other apparatus for controlling the installation, as well as the dynamo, were constructed at Mr. T. Harding Churton's works in Great Wilson-street, Leeds, by whom also the installation has been carried out. The "Ark" lamps have been supplied by Messrs. Johnson and Phillips, and an accumulator of the Chloride type is used in connection with the incandescent lighting of the works, manager's house, and committee-rooms when the dynamo is not running. The whole of the works have been carried out under the direction of the engineer, Mr. Alfred M. Fowler.

Worthing.—At Tuesday's meeting of the Town Council the Electric Lighting Committee reported that they had reconsidered the system of lighting so far as it related to the several streets in which it was proposed to have incandescent lamps of 50 c.p., or their equivalent in cost of arc lamps of 1,000 c.p. The committee also decided to recommend that the streets referred to in Mr. Monkhouse's report be lighted with 40 arc lamps of 1,000 c.p. each (in lieu of the 76 incandescent lamps of 50 c.p. as previously proposed), in accordance with the engineer's report. The Council were recommended, as advised by the consulting engineer, to adopt the "Edinburgh" design for arc-lamp posts as in use in London; and Messrs. Burstall and Monkhouse were authorised to have the various specifications, forms of tender, etc., printed in London as suggested by them, and to advertise for tenders. The action taken by the consulting engineers and the borough surveyor in obtaining 150 yards of conduit casing for putting down in Chapel-road, between Richmond road and Stoke Abbott road, in which new paving is about to be laid, and which will obviate the subsequent lifting of the pavement, was approved and confirmed. These proceedings were agreed to.

London County Council.—At the meeting of the Council on Tuesday it was agreed to lend the Poplar District Board £20,000 for electric lighting purposes; the Strand District Board £1,500 for the purchase of motor-vans; the Battersea Vestry £5,147 for street-lighting purposes; and the Islington Vestry £6,606 for electric lighting purposes. Sanction was given to the Postmaster-General (*a*) to the placing of steel troughing to carry Post Office cables, for which there was not room in the Queen Victoria-street subway, at three places over the subway, and for this purpose to reduce the headway of the subway about 3in. for a distance of between 13ft. and 14ft. near the Post Office Savings Bank, and by rather more at the junction of the north and south subways in the street, while at the third place, near Blackfriars Bridge, it was not contemplated that the subway itself should be interfered with; and (*b*) to the placing of cables in the subways in Northumberland-avenue, Charing Cross-road, and Shaftesbury-avenue. At a subsequent special meeting the proposals of the Highways Committee for serving notices on the London, Deptford, and Greenwich Tramways Company and the South London Tramways Company for the purchase of their undertakings were carried without discussion.

Aberdeen.—A report from Mr. J. A. Bell, Corporation electrical engineer, on the system of charging for electrical energy for lighting and power, came before the Town Council on the 2nd inst. The present scale of charges in Aberdeen for lighting is 6d. per Board of Trade unit for all energy supplied till the meter registers the number of units that would be consumed for one hour per day per half-year by the maximum number of lamps switched on at one time during that half-year. All subsequent units are charged for at 3d. per Board of Trade unit. For power the rates are based on the same principle, the rates being, however, 3d. and 1d. per Board of Trade unit respectively. For display purposes consumers are allowed, by resolution of the Council, to have their indicators disconnected so that the half year's bill is not affected by such displays further than by the increased number of units chargeable at the lower price. Mr. Bell considers the adoption of the maximum demand indicator system has tended largely to the present flourishing condition of the undertaking. He finds that 62 per cent. of the consumers benefit by the rebate system during the year, and states: "Two essential elements of cheap supply are generation on a large scale and a good load factor, and Aberdeen is still poor in the latter respect. In 1899 the generated units in Aberdeen amounted to 655,479, of which probably 600,925 were sold to consumers." An interesting table of charges and other information is also issued, giving details from 57 towns throughout England and Scotland as to electric lighting. It was resolved to defer consideration of the matter for a fortnight.

Norwich.—The Town Council have prepared an agreement subject to which they will support the application to the Postmaster-General by the Norwich Mutual Telephone Company, Limited, for a license from the Postmaster-General for the establishment of a telephone exchange in the Norwich exchange area. The agreement provides for the supply by the company of a constant and continuous telephonic service at low rates; that no preference is given to any subscriber; that a reduction be made for the cost of telephonic service to subscribers when the company's receipts exceed a specified aggregate amount; that the Corporation, under sanction of the Postmaster General, may purchase the plans compulsorily on Dec. 31, 1916 (in 1911 at fair market value as a going concern, with an additional sum equal to three years' profit in addition; in 1916 on the same terms, but with two years' profits in addition); that, subject to any prior rights of the Postmaster-General, the Corporation be able to purchase at the revocation or determination of the license; that the company does not assign, underlet, or otherwise dispose of the license; that the Corporation be represented in the company by two directors with equal votes to other directors of the company; that wayleaves, poles, tubes, etc., be allowed subject to the direction of the city engineer; that the Corporation may determine the agreement if a telephone exchange for 200 subscribers and with three miles of cable is not laid down in three years, or in the event of failure to perform other conditions of the agreement, or if the company is ordered to be wound up.

New Companies.—The following new companies have been registered: Mangano Electric Process, Limited, with a capital of £50,000 in £1 shares, the objects being to adopt an agreement made between G. Bourgoin and H. H. Lavollay and J. F. Medina and M. Urrulla for the acquisition of the rights of G. E. Bourgoin and H. Lavollay in a certain invention for the epuration and decolouration of sugar juices by mangano electric treatment, and to carry on the businesses of electricians, electrical engineers, producers and suppliers of electricity, etc.—The Electrical Testing Laboratories, Limited, with a capital of £3,000 in £1 shares, the object being to acquire the Westminster Electrical Testing Laboratories, 14, Great Smith-street, S.W., and to own and maintain any laboratories and other places where electrical, chemical, or other machinery or other apparatus can be tested, calibrated, or standardised.—The Electromagnetic Traction Company, Limited, with a capital of £1,500 in £1 shares, the objects being to adopt an agreement with H. Lane and W. Griffiths, and to carry on the business of electricians, electric and mechanical engineers, and any business connected with electro magnetism and electric tramway and light railway traction.—The St. Austell and District Electric Lighting and Power Company, Limited, with a capital of £10,000 in £1 shares (300 founders'), the objects being to adopt an agreement with the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, and to carry on the business of an electric lighting company in all its branches.

Whitechapel.—At a meeting of the District Board of Works on Monday the Electrical Committee recommended: (1) That the approval of the Board be given to the election of Mr. John Harris by the committee as chairman of the Electrical Committee for the ensuing year, he having held the office of chairman during the past year. (2) That the proposal of Mr. Arthur Wright, the electrical engineer of the Board, to extend the supply of electricity in the district for lighting and supply of motive power purposes in the manner suggested by the report of Mr. Wright, dated April 27, 1900, be adopted, and that arrangements be forthwith made to carry out the further work contemplated by such report, at the estimated additional cost of £44,670, and that the necessary steps be taken to obtain a loan of £44,670 (the cost of the additional work contemplated) from the London County Council upon the instalment system at the most favourable rate of interest that can be obtained, such loan to be taken up in such instalments as may be required by the Board. (3) That the sum of £20,500, the balance of the loan of £60,500 originally applied for by this Board from the London County Council, be now borrowed from the London County Council in order to carry out a portion of the work of erecting the electric lighting installation in the district, as contemplated by the report of Mr. Wright, the electrical engineer of the Board, dated Nov. 23, 1898, and such further work as may have been since determined upon; such loan of £20,500 to be upon the instalment system, repayable in 42 years, by equal annual instalments, at the most favourable rate of interest that can be obtained, such interest to be payable quarterly; such loan to be taken up at once, the Board paying the costs of such loan and upon the understanding that if any works require to be renewed during the currency of any part of the loan the cost of such renewal shall be provided for out of a sinking fund for the purpose and shall constitute a maintenance charge, and shall not be made the subject of a fresh loan, no part of the principal to be repaid until the expiration of three years from the date of the loan, and that the seal of the Board be affixed to such mortgage when ready, and that a cheque be drawn in favour of the London County Council for the fees in connection with such mortgage when received. (4) That it be referred to the Electrical Committee, with instructions to enter into negotiations with the Guardians of Whitechapel, for the purchase, or a grant to the Board, of a lease of a piece of land belonging to the Guardians, upon which there is a railway siding, and that the committee be instructed to report to the Board the terms (if any) upon which the Guardians will be prepared to dispose of such property to the Board. This was agreed to without discussion.

COMPANIES' MEETINGS AND REPORTS.

BASTIAN METER.

The third ordinary general meeting of this Company was held on Thursday at the offices, Kentish Town, under the presidency of **Mr. C. Orme Bastian**, who, in moving the adoption of the report and accounts, said that the results of the past year could be summed up in two words—viz., "Rapid progress." They had

Digitized by Google

converted a loss of £2,000 shown last year into a profit of nearly £400 this year. During the past three weeks the orders for meters were larger than for the whole of the first six months of the year. They were glad to be able to pay the preference dividend in full, and he believed that the ordinary shareholders would soon receive ample reward for their patience.

Mr. Umberto Ciantar seconded the adoption of the report, which was unanimously agreed to.

THOMAS PARKER, LIMITED.

The annual meeting of Thomas Parker, Limited, electrical engineers and contractors, Wolverhampton, was held at the works, Wednesfield-road, last Friday, Mr. C. T. Mander (chairman of the directors) presiding.

The directors' report, published in our last issue, was adopted, as was also a formal resolution declaring the 10 per cent. dividend.

On the motion of **Mr. J. E. Underhill**, seconded by **Mr. W. Armistead**, Mr. C. T. Mander was re-elected a director, and Messrs. Allen Edwards and Smith were reappointed auditors to the Company.

The meeting lasted 8 minutes and 43 seconds.

ELECTRIC CONSTRUCTION.

Directors: Sir Daniel Cooper, Bart., G.C.M.G., chairman; James William Barclay, deputy chairman; Philip Edward Beachcroft; John Irving Courtenay; Sir Henry C. Mance, C.I.E.; Sir James Pender, Bart., M.P. Manager: A. B. Blackburn, M.I.C.E. Secretary: James Gray.

Report of the directors to be submitted to the shareholders at the seventh annual general meeting of the Electric Construction Company, Limited, to be held on Thursday, July 12, 1900, at Winchester House, Old Broad-street, E.C., at 12 noon:

The profit of the year ending May 31 last, including the balance of £1,441 6s. 2d. brought forward, is £21,729. 1s. 9d., which your directors recommend be appropriated as follows—viz.: in providing a dividend of 7 per cent. on the preference shares (to be paid on July 31 next) £3,500; and a dividend of 6 per cent. on the ordinary shares (one-half to be paid on July 31 next and one half on Jan. 31, 1901), £13,452; leaving a surplus of £4,777. 1s. 9d. to be carried to next year's accounts. The buildings and plant have been thoroughly maintained, and £5,000, as usual, has been credited to depreciation account, which now amounts to £33,000. The buildings of the extensions, referred to in last year's report, have been finished, and the shops are now being equipped with the latest labour-saving tools and appliances, capable of turning out economically and with dispatch the largest electrical machinery that may be required. Among the more important works of last year may be mentioned the power-house and line equipment with British machinery and appliances throughout of the extensions of the City and South London Electric Railway. The works are well supplied with orders at remunerative prices, the relations with all classes of employés are thoroughly harmonious, and the directors have had much pleasure in awarding the usual bonus in recognition of good service. It has been considered expedient to foreclose the mortgage on the Madras electric tramways and to acquire the undertaking, but it is not intended that this should be a permanent investment. Meanwhile the working of the tramway yields a moderate return on the cost, and the traffic is developing satisfactorily. The compensation paid under the Workmen's Compensation (1897) Act is for the year less than £20, but £150 of last year's profit has been credited to the fund to meet such claims. The directors who retire by rotation at the general meeting, and who are eligible for re-election, are Sir Daniel Cooper and Sir James Pender. The auditors, Messrs. James Meston and Co., offer themselves for re-election.

PROFIT AND LOSS ACCOUNT.

Expenditure.	£	s.	d.
Interest on loans and debentures, paid and accrued	8,392	14	3
General charges—Salaries of office staff and engineers	12,382	3	4
Rents, rates, and taxes	990	0	3
Insurances	353	4	5
Advertising	491	1	3
Travelling expenses	436	19	10
Patent fees and royalties	1,031	9	1
Law charges	277	11	5
Printing and stationery, postages and telegrams	785	4	7
General expenses	1,186	7	11
Trustees' fees, under first and second mortgages	105	0	0
Auditors' fee	120	0	0
Directors' fees	1,500	0	0
Maintenance of plant and buildings	2,121	1	7
Depreciation account—amount set aside	5,000	0	0
	35,172	17	11
Net profit carried to balance-sheet	20,287	15	7
	£55,460	13	6

Income.	£	s.	d.
Gross profit on manufacturing and contracting	49,299	16	5
Rents, pupils' premiums, and sundry profits	3,050	11	11
Interest and dividends on debentures and shares of other companies	3,074	5	2
Transfer and registration fees	36	0	0
	£55,460	13	6

BALANCE SHEET.

Capital and Liabilities.	£	s.	d.
Capital authorised: 150,000 ordinary shares of £2 each	300,000	0	0
50,000 cumulative 7 per cent. preference shares of £2 each	100,000	0	0
	400,000	0	0
Capital issued: 112,100 ordinary shares of £2 each, fully paid, £224,200; 25,000 cumulative 7 per cent. preference shares of £2 each, fully paid, £50,000	274,200	0	0
Debentures issued: 4 per cent. perpetual first mortgage debenture stock, £182,500; 4½ per cent. redeemable second mortgage debenture stock, £50,000	232,500	0	0
Loans (secured by deposit of debentures in other companies)	50,000	0	0
Creditors: sundry creditors, £44.159. 3s. 8d.; debenture interest accrued, £2,737. 10s.	46,896	13	8
Bills payable	3,718	9	4
Depreciation account: amount at credit per last account, £28,000; credited from profits for year, £5,000; general reserve account, £20,000	53,000	0	0
Profit and loss account: amount brought forward from last year, £1,441. 6s. 2d.; net profit for year, £20,287. 15s. 7d.	21,729	1	9
	£682,043	4	9

Assets.	£	s.	d.
Properties, patents, goodwill, buildings, plant, etc.	331,669	5	2
Additions to plant and furniture during the year	15,583	11	1
Additions to buildings	10,666	9	10
	357,919	6	1
Shares and debentures of other companies	83,876	6	11
Sundry debtors	65,259	13	9
Madras electric tramways	80,500	0	0
Bills receivable	2,457	10	6
Work and contracts in progress—cost	26 717	13	2
Stock—finished goods and materials on hand	35,601	15	0
Cash at bankers and in hand	29,711	19	4
	£682,044	4	9

WEST AFRICAN TELEGRAPH.

The ordinary general meeting of this Company was held on Friday at Winchester House.

The Marquis of Tweeddale, who presided, moved the adoption of the report, which appeared in our last issue.

The report was adopted, and a resolution afterwards carried authorising the directors to carry out the necessary arrangements for the establishment of a staff pension fund and superannuation fund, or for joining such funds already established by the Associated Telegraph Companies as they might consider desirable.

EDMUNDSON'S ELECTRICITY.

Directors: John R. Wigham, J.P. (chairman); W. R. Davies; Joshua W. Edmundson; Walter B. Hopkins, M.I.C.E.; Francis E. Gripper, M.I.E.E. (managing director).

Report of the directors, and abstract of accounts, for the year ended March 31, 1900, to be presented to the shareholders at the third annual meeting to be held at the offices of the Corporation to-day (Friday), at 3 p.m.:

Including the sum of £2,572. 5s. brought forward from last year, the net profit, after payment of debenture interest, amounts to £19,832. 6s. 9d. The directors recommend that £5,000 be written off goodwill, and that a dividend of 6 per cent. be paid upon the ordinary and deferred shares for the year ended March 31, 1900, amounting to £10,674. 4s. 2d., leaving a sum of £4,152. 2s. 7d. to be carried forward to the next account. The electric lighting stations at Folkestone, Winchester, Woolwich, Bromley (Kent), High Wycombe, Salisbury, Ventnor, Chislehurst, and Newmarket, all of which were completed a year ago, have been working satisfactorily, and dividends have been paid to the shareholders of the five first-mentioned companies as the result of the first year's working. These results, obtained at so early a stage, must be looked upon as most encouraging, and confirm the belief of the directors that electric lighting in such towns will prove a profitable investment. During the year the stations at Guernsey and Alderley Edge have been completed, and are now working. Details showing the progress of the various stations are given in the accompanying schedule. Work has been commenced for central stations at Montrose, Brechin, Melton Mowbray, Lymington, Sandown, Shanklin, Newport, and Cowes, and parliamentary powers are being obtained, with the consent of the local authorities, for several other towns. A considerable number of private installations for country houses, etc., have been carried out, and this department of the business has been well maintained. Investments in the local companies in which the Corporation is interested have been taken in the balance-sheet at cost price. During the year 9,400 ordinary £5 shares, being the balance of authorised capital, have been issued, and fully paid up. Further capital will be required for the works in progress, and the directors recommend that the nominal capital of the Company be increased to £400,000 by the addition of 40,000 shares of £5 each, and they propose that £100,000 should be issued as 6 per cent.

Digitized by Google

preference shares, reserving the other £100,000 for issue at a future time. One of the directors, Mr. W. R. Davies, retires by rotation, and is eligible for re-election. The auditor, Mr. W. H. May, retires, and offers himself for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rent	500	0	0
Office and sundry expenses	359	17	7
Advertising, stationery, and postage	528	13	4
Salaries	3,268	3	0
Insurance	77	18	0
Bad debts	78	4	0
Income tax	29	18	2
Depreciation of office furniture	39	9	3
Directors' fees	1,000	0	0
Auditor's fee	52	10	0
Trustees' fees	100	0	0
Interest on debenture stock	3,116	15	10
Debenture issues expenses	142	16	6
	9,294	5	8
Balance, being net profit	17,260	1	9
	£26,554	7	5

Cr.	£	s.	d.
Gross profit	21,809	12	5
Transfer fees	13	3	0
Interest on deposits	292	13	8
Interest and dividends from investments	4,438	18	4
	£26,554	7	5

BALANCE-SHEET.

Capital issued: Liabilities.	£	s.	d.
35,500 ordinary shares, £5 each	177,500	0	0
4,500 deferred shares, £5 each	22,500	0	0
	200,000	0	0
4½ per cent. debentures	75,000	0	0
Interest accrued thereon	693	9	10
Trade creditors	29,246	9	10
Loan from bankers	7,000	0	0
Balance from profit and loss account, £10,822. 6s. 4d.; less dividend paid, £7,975. 6s. 5d.; and income tax, £274. 14s. 11d.	2 572	5	0
Balance from profit and loss account	17,260	1	9
	£331,772	6	5

Assets.	£	s.	d.
Goodwill, leases, etc.	45,000	0	0
Sundry debtors, including advances	121,055	1	10
Stock	4,757	3	7
Outlay on works in progress—town-lighting	22 427	3	6
Ditto—private house-lighting	21,862	7	8
Office furniture, £394. 12s. 5d.; less depreciation, £39. 9s. 3d.	355	3	2
Investments at cost	111,305	7	10
Cash on deposit	2 250	0	0
Cash in hand and at bank	2,759	18	10
	£331,772	6	5

PROVISIONAL PATENTS, 1900.

JUNE 25.

11471. Improvements in electromagnetic brakes. Henry Edmond Walter, 43, Albemarle-street, London.

11486. Improvements in means for preventing sparking in electric switches, commutators, current-conductor contacts, contact breakers, and other electric devices. John Vaughan Sherrin, 77, Chancery-lane, London.

11500. Improvements in arc lamps. Peter H. F. Spies, 18, Southampton-buildings, Chancery-lane, London.

11512. Improvements in telegraphic receiving and translating arrangements. Alexander Muirhead, 323, High Holborn, London.

11519. Improvements in frogs to be used in connection with overhead conductors of electrical tramways and railways. Hugh Godfrey Nicholson, 47, Lincoln's-inn-fields, London.

JUNE 26.

11547. Improvements in fittings for overhead trolley systems of electric tramways. George Hill, 17, St. Ann's-square, Manchester.

11556. Improvements in terminals and supports for Nernst lamp glowers. Marshall Wilfred Hanks, 46, Lincoln's-inn-fields, London. (Complete specification.)

11557. Improvements in ballast resistances and cut-outs for Nernst lamps. Henry Noel Potter, 46, Lincoln's-inn-fields, London. (Complete specification.)

11558. Improvements in systems for lighting by Nernst lamps. Alexander Jay Wurts, 46, Lincoln's-inn-fields, London. (Complete specification.)

11559. Improvements in starting apparatus and cut-outs for Nernst lamps. Alexander John Wurts, Henry Noel Potter, and Marshall Wilfred Hanks, 46, Lincoln's-inn-fields, London. (Complete specification.)

11560. Improvements in terminal connections and supports for Nernst lamps. Alexander Jay Wurts and Marshall Wilfred Hanks, 46, Lincoln's-inn-fields, London. (Complete specification.)

11561. Improvements in Nernst lamps and heaters therefor. Alexander Jay Wurts, Henry Noel Potter, Edward Bennett, and Murray Charles Beebe, 46, Lincoln's-inn-fields, London. (Complete specification.)

11562. Improvements in electric lighting. Peter Cooper Hewitt, 46, Lincoln's-inn-fields, London. (Complete specification.)

11584. Improvements relating to incandescent electric lamps. Casimir Pauthonier, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 30, 1900, being date of application in France.)

11588. Improvements in electric railway systems. George Edward Kent, 18, Buckingham-street, Strand, London.

11597. Improvements in flexible conduits for electrical conductors. Harry Gould Osburn, 18, Buckingham-street, Strand, London. (Complete specification.)

11609. Improvements in means for protecting electrical apparatus from abrupt changes in static potential. Percy Holbrook Thomas, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 27, 1899, being date of application in United States.)

11610. Improvements in means for protecting electrical apparatus from abrupt changes in static potential. Percy Holbrook Thomas, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 27, 1899, being date of application in United States.)

11620. Improvements in dynamo-electric machines and electric meters. Henry Francis Joel, sen., 74, Windsor-road, Forest Gate, Essex.

JUNE 27.

11643. Improved switch for lampholders. Frederick Rawlings, 71, Carey-street, Lincoln's-inn, London. (Complete specification.)

11677. Improvements in apparatus relating to the parallel running of alternate-current machinery. Henry Cooke Leake, 322, High Holborn, London.

11692. Improvements in or connected with electrical tramways or railways. Hugh Godfrey Nicholson, 47, Lincoln's-inn-fields, London.

11695. Improvements in alternating-current wattmeters. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Union Elektricitäts-Gesellschaft, Germany.)

JUNE 28.

11764. New or improved electric brush-holder. William Ernest Burnand, 119, St. Mary's-road, Sheffield.

11769. Improvements in the construction of electric lamp-pillars. Hardy and Padmore, Limited, and Joseph Southall, The Worcester Foundry, Worcester.

11720. Improvements in or relating to electrical ignition apparatus for exploding the charges in internal-combustion motors and for other similar purposes. Henry Thomas Dawson and Henry Alfred Dawson, 18, Hertford-street, Coventry.

11727. Improvements in or connected with electric switches having intermittent or step-by-step motions. William Kingsland, 33, Chancery-lane, London.

11768. Improvements in electric light brackets or fittings, James Fraser Cornaund, 4, South-street, Finsbury, London.

JUNE 29.

11787. Improvements in electrical starting and regulating switches. Arthur Henry Hickley, 10, St. George's-crescent, Liverpool.

11797. Improvements in regulating devices for alternating electric current circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

11808. Improvements in automatic switches for telegraph and telephone circuits. Luigi Cerebotani and Carl Moradelli, 111, Hatton-garden, London. (Complete specification.)

11812. An improved method of fixing the china or other insulator and also conducting wire in sparking plug for ignition by electricity for gas or other explosive vapour or oil engines. Arthur Marmaduke Hart, 15, Vicarage-park, Plumstead, London.

11819. An instrument for measuring rotary field currents. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

11824. Improvements in telegraphy and in apparatus connected therewith. Anders Bull 115, Cannon-street, London. (Complete specification.

11825. Improvements relating to electrical installation and distribution. Joseph Frank Smith, 11, Burlington-chambers, New-street, Birmingham.

Digitized by Google

11835. Improvements in electro-pneumatic controlling apparatus. Ernest Rowland Hill, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 13, 1900, being date of application in United States.)

11840. Improvements in means for preventing sparking in electric switches, commutators, current-conductor contacts, contact breakers, and other electric devices. John Vaughan Sherrin, 77, Chancery-lane, London.

JUNE 30.

11853. Improvements in and relating to flag or banner poles or for use in connection with arc lamps or for other like purposes. James Kershaw Grindred, 2, Old Market-chambers, Yorkshire-street, Rochdale.

11861. Improvements in or connected with secondary batteries. Rankin Kennedy, 33, Chancery-lane, London.

11869. Electric generators for military and other cycles. Henry Vander Weyde, 53, Chancery-lane, London.

11891. Improvements relating to electric traction for tramway and other similar vehicles. Arthur Baisieux, 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on July 21.

1899.

7370. Control of electrically-propelled vehicles and trains. Leigh. (Sprague.)

13610. Motor electric meters, parts of which are applicable to motors and dynamos generally. Evershed and Vignoles, Limited, and Evershed.

13617. Electrical measuring instruments. Rimington.

13646. Electrical motive-power apparatus. Hollick.

13846. Manufacture of a composition from rhea fibre applicable for electric insulation and other purposes. Cordner.

14467. Electric traction with overhead conductors. Pease and Burdon.

14563. Electrical alarm apparatus. Eggerding.

14999. Dynamo electric machines. Lamme. (Date applied for under International Convention, April 14, 1899.)

16225. Conduits for laying electrical cables. Nichols and W. T. Henley's Telegraph Works Company, Limited.

16300. Safety fuses for electric circuits. Goslin.

16311. Dry-core electrical cables. Savage and W. T. Henley's Telegraph Works Company, Limited.

16623. Arc lamps. Andrews.

16956. Conduits for electric conductors. Bate.

21470. Automatic charging device for electric meter carriages. Mühlberg.

1900.

1445. Electric transformers. Loring and Clarke. (Date applied for under International Convention, June 24, 1899.)

2964. Manufacture of pipes or conduits for electrical conductors or for conveying liquids or gases or for analogous purposes. Howard.

4169. Electric clock. Golby. (Hansen.)

8476. Induction electric meters. British Thomson-Houston Company, Limited, and Hobart.

9231. Electrolysing apparatus. Haas.

9563. Electric igniters for explosion engines. Bergmann.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 30	694	601	+ 93	2,860	2,487
Birmingham Tramways Co.	,, 30	4,451	4,357	+ 94	110,192	103,751
Blackburn Corp'rat'n	,, 30	458	446	+ 12	9,635	11,049
Blackpool Corporatn.	,, 28	729	528	+ 201	7,317	5,795
Blackpool-Fleetwood	,, 30	724	609	+ 115	10,125	9,931
Bolton Corporation..	—	—	—	—	—	—
Bradford City Trams	July 1	463	356	+ 107	6,419*a*	5,026
Bristol Tramways Co.	June 29	3,148	3,214	− 66	—	—
City & South London	July 1	1,490	980	+ 510	23,724	26,894
Dover Tramways ...	June 30	213	210	+ 3	4,501	4,231
Dublin U.T., elec. cars	,, 29	3,602	1,317	+2,285	—	—
Dublin S.D. Electric	,, 29	963	1,036	− 93	—	—
Halifax Corporation	,, 25	780	589	+ 191	8,715	6,116
Hull Corporat'n E.S.	,, 23	1,347	—	—	14,106*a*	—
Liverpool Corporat'n	,, 23*b*	8,251	6,744	+1,507	181,001	158,510
Liverpool Overhead	July 1	1,682	1,462	+ 220	37,502	36,192
Sheffield Corporation	,, 1	2,385	—	—	—	—
South Staffordshire	June 22	714	656	+ 58	16,915	15,826

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Monday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 —	½-¾
British Insulated Wire, Ord., 1-40,000	5 —	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5 ..	6-6½
—— 5 per cent. Mortgage Debentures	100 —	98-102
British Electric Works, Ordinary, 50,001-95,000	1 —	½-¾
—— 6 per cent. Cum. Pref., 1-50,000	1 —	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	100 —	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 —	4½-5½
Brush Electrical Engineering, Ordinary	2 —	13-13½
—— Non. Cum., 6 per cent. Pref.	2 —	2-2½
—— 4½ per cent. Debenture Stock	100 ..	109-114
—— 4½ per cent. 2nd Debenture Stock	100 —	101-103 xd
Callender's Cable, Debentures	100 —	110-114 xd
—— Ordinary	5 —	13½-14½
—— 5 per cent. Pref.	5 —	5½-5¾ xd
Crompton and Co.	2 —	3½-4
—— 5 per cent. Debentures	— —	98-101 xd
Edison and Swan United, Ordinary	2 —	2-2½
—— 5 per cent. Debentures	5 —	3½-4½
—— 4 per cent. Deb. Stock, Red.	100 —	91-93 xd
Electric Construction	2 —	2-2½
—— 7 per cent. Cumulative Pref.	2 —	2-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	103-106
W. T. Henley's Telegraph Works, Ordinary	5 —	13½-14½
—— 4½ per cent. Preference	5 —	5½-5¾
—— 4½ per cent. Debentures	100 —	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 —	21-22
—— 4 per cent. Debentures	100 —	100-103
Telegraph Construction and Maintenance	12 —	35-39
—— 5 per cent. Bonds	100 —	101-104 xd
Telegraph Manufacturing, Ordinary	5 —	10½-11½
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-80,000	5 ..	10½-11½
—— 6 per cent. Cum. Pref., 80,001-80,000	5 ..	6½-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-108
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	½-¾
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 ..	10-11
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 —	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	6½-7½
Charing Cross and Strand	5 ..	9½-10½
—— 4½ per cent. Cum. Pref.	5 —	5½-6
Chelsea Electricity Supply	5 —	6-7
—— 4½ per cent. Debentures	100 —	107-110
City of London, Ordinary	10 ..	8½-9½
—— 6 per cent. Cumulative Pref.	10 ..	12½-13½
—— 5 per cent. Debenture Stock	100 ..	122-127 xd
County of London and Brush Provincial, Ordinary	10 ..	9-10
—— 6 per cent. Cum. Pref.	10 —	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	— —	108-111 xd
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4½-5
—— 4½ per cent. First Mort. Deb.	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	9½-10½
London Electric, Ordinary	2 ..	1-1½
—— 6 per cent. Pref.	5 ..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	98-100
Metropolitan, Ordinary	10 ..	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100 —	111-114 xd
—— 3½ per cent. Mortgage Debenture, Red	100 ..	96-98 xd
Notting Hill Electric Lighting	10 ..	15½-16½ xd
Oriental, 1879	1 ..	1½-1¾
—— £5 Shares	5 ..	7½-7¾
—— £4½ Shares, New	4½ ..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,510	5 ..	6-6½
Riv r Plate Electric Light and Traction, Deb.	100 ..	75-85
Royal Electrical Company of Montreal	$100 ..	105-125
—— 4½ per cent. First Shares Mortgage Debentures	$100 ..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	95-98
South London, Ordinary	3 ..	3-4½
St. James's and Pall Mall, Ordinary, 101-20,000	5 ..	14-15
—— 7 per cent. Pref.	5 ..	8½-9½
Westminster, Ordinary	5 —	11-12
Electric Railways.—		
Central London, Ordinary	10 ..	9½-10½ xd
—— Pref. Half-Shares	5 ..	4½-5½ xd
—— ,, ,, deferred	5 ..	4½-5½ xd
City and South London, Consolidated Ordinary	100 ..	64-66
—— Ordinary	10 —	6-7
—— 4 per cent. Debenture Stock	100 —	123-128
—— 5 per cent. Pref. Stock '91	100 ..	140-145
—— ,, ,, ,, '96	100 ..	132-137
Liverpool Overhead, 5 per cent. Pref.	— —	12½-13½
Waterloo and City, Ordinary	100 ..	98-101
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 ..	17½-18½
Brisbane Tramway	100 ..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10 ..	10½-10¾
British Electric Traction, Ordinary, 1-30,000	10 ..	14-15
—— 60,001-75,000	10 ..	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10 —	12-13
—— 5 per cent. Perpetual Debenture Stock	100 ..	123-126
—— ,, ,, ,, 1900	100 —	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 —	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4-4½
—— 5 per cent. Deb. Stock, Red.	100 ..	101-104
Isle of Man Electric Power, 1-95,000	1 ..	½-9/16
—— 6 per cent. Preference, 100,001-170,000	1 ..	3/16-¼
Kidderminster and District Lighting and Traction, Pref.	10 ..	9½-10½
New General Traction, Ordinary	5 —	2½-3½
—— 6 per cent. Cum. Pref.	5 —	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	16-18
—— 5 per cent. Cum. Pref.	10 ..	10½-10¾
Potteries Electric Traction, Ordinary, 23,667-40,000	10 ..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 —	10-11
Telephones.—		
National Telephone, Ordinary	5 ..	5-5½
—— 6 per cent. Cum. First Pref.	10 —	12-13
—— 6 per cent. Cum. Second Pref.	10 —	13-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5-5½
—— 3½ per cent. Deb. Stock, Red.	100 —	98-101 xd
Oriental Telephone and Electric Company	1 —	½-¾

Digitized by Google

NOTES.

Municipal and County Engineers.—The annual dinner of the Incorporated Association of Municipal and County Engineers is to be held on July 19, at 7 p.m., the place of meeting being the Criterion Restaurant, Piccadilly-circus, W.

Another Exhibition.—Yet another electrical exhibition is announced for 1903, the *Elektrotechnische Verein* of Vienna having decided to organise an exhibition from May to October in the above-mentioned year in order to celebrate its twentieth year of existence.

"The Stone Trades' Journal."—The *Stone Trades' Journal*, which has just made its appearance under that title, is by no means a new publication. It has been in existence for nearly 20 years under the name of the *Stonemason*, and as such no doubt it will be known to many of our readers. The first number of the new series, which is published monthly, is very well printed and illustrated, and should find a ready sale.

Indian Electricity.—We noted recently the fact that in certain of the military stations in Northern India the punkah-wallah was to be superseded in the barrack buildings by electric motors. We are glad to notice that not in India alone has the benefit been recognised of having a reliable machine for this absolutely necessary work. Thus we learn that a grant of a quarter of a lakh of rupees has been sanctioned in the current year's budget for providing motors for punkah-pulling and electric light for the public offices in Rangoon.

Wireless Telegraphy.—Experiments were recently made at Brest with wireless telegraphy by Lieutenant Tissot, who has made a special study of this subject. We are not informed what system he employed, but he was enabled to receive very clear messages from the "Masséna," 35 miles at sea. The "Friant," arriving in port, also sent messages, and though sent to the same receiver they were only slightly mixed with those of the "Masséna," and could be easily read. These and other experiments which have been made are with the view of the adoption of aerial telegraphy in the French navy.

Electric Lettuce.—We notice that the New York *Literary Digest* makes some observations on the electrical forcing of plants, and says that the method of horticulture under the influence of electric light has made such advances that the growing of lettuce for salads, in spacious greenhouses, with the aid of electric light, is already carried on as a profitable industrial pursuit near Chicago and elsewhere in the U.S.A. The action of electric currents in stimulating vegetation still remains unsettled, but with what is now known of the influence of micro-organisms upon vegetation, further research on similar lines is thought to be most desirable and very promising.

Uranium Radiations.—At a recent meeting of the Academie des Sciences, M. Henri Becquerel showed that, if on treating a fair quantity of chloride of uranium a very small quantity of barium chloride were put in, the precipitation was richer in active material. The radio activity of sulphate of barium then greatly exceeds that of the commercial uranium chloride. The material in question produced on a photographic plate wrapped in black paper a stronger impression than the uranium. These experiments showed that a portion of the uranium mingled with a very active product which was able to be the actinum, and that, on the other hand, the purified uranium was still active.

Steam v. Electric Trams.—As may be known to some of our readers, the electrical and steam tramways in Sydney (N.S.W.) in some instances run over the same route, and the question of overcrowding on the cars has brought to light the curious fact that the public prefer overcrowding in an electric tram to riding in comfort in a steam one. In Sydney the steam trams are put on as a relief service to the electric trams during the portions of the day when the traffic is heaviest, but although with this relief service a quite sufficient accommodation is provided, the passengers yet insist on getting on to an electric car, in spite of the fact that standing by its side is a steam car which is almost empty.

The Rise in Gas.—The rise in the price of gas has had the result which was only to be expected—namely, to advance the demand for electricity for lighting. This is illustrated in the case of Leyton, where the Urban District Council have decided, on being notified by the West Ham Gas Company that after Midsummer the charge for lighting the public lamps would be increased to £4. 7s. 6d. for each lamp per annum, to at once request the Electric Lighting Committee to convert all gas lamps along the existing lines of electric mains. The Leyton authorities are in our opinion only among the first to take measures of this kind, and we shall probably hear in a few weeks' time that a number of other authorities all over the country have preferred to replace gas with electricity in consequence of the almost general rise in gas prices.

Electrical Street-Sweeping.—We notice that the Budapest Tramway Company had in use during last winter an electric sweeping car for clearing their lines of snow. This apparatus chiefly consisted of an ordinary tramcar frame, under which, both back and front, were placed cylindrical brushes. The brushes were put in motion by a 20-kw. series motor, and were made to revolve rapidly. The total weight of the car was 12 5 tons, and it ran at a speed of from 5 to 7½ miles per hour by the aid of two 20-kw. motors, also worked in series. The cylindrical brushes were of the same width as the track, and had a diameter of 3ft. 7in. They were combined with four other brushes, made to move backwards and forwards, and specially arranged to clear snow and dirt from the metals themselves. The motors for propelling the car and those operating the brushes were quite independent of each other, and the flexible contact cable was in consequence composed of two distinct parts.

Horses and Motorcars.—It is now becoming recognised that it is necessary in order that motorcar and horse traffic may proceed peacefully side by side in our streets, that horses, especially of the better kinds, such as are used in carriages, should be taught not to fear vehicles operated by mechanical power. For this reason, and acting on a suggestion made by Lord Alverstone at a dinner of the Automobile Club, the committee of that club have arranged with the committee of the Ranelagh Club that members of Ranelagh should have an opportunity of sending their horses there on Saturday, July 14, on which day the automobile gymkhana at Ranelagh takes place, in order that they may be trained to encounter motor vehicles without fear, by having an opportunity of examining and becoming familiar with motor vehicles, which will be driven there for the purpose by members of the Automobile Club. In view of the importance of horses being familiarised with motorcars, the Automobile Club would also, we are informed, be glad to make similar arrangements with other clubs.

The British Association.—The annual meeting of the British Association is next year to be held in Glasgow, and a local committee has been appointed to make the necessary arrangements. At a meeting of this local committee last week, it was pointed out by Prof. Young that the jubilee of Glasgow University, the conference of the engineers, and the meeting of the British Association would

Digitized by Google

all take place about the same time. As it was very desirable that these three important meetings should not clash, so that as large an attendance as possible might be secured for each, and that Glasgow might be able to do its very best for all of them, he suggested that a committee should be appointed from the executive to arrange as to the most suitable dates. The suggestion was agreed to, and a representative committee was appointed. It was also agreed to recommend to the British Association as vice-presidents the following gentlemen: Lord Blythswood, Lord Kelvin, Sir John Stirling Maxwell, M.P., the Earl of Glasgow, Lord Provost Chisholm, Mr. J. Parker Smith, M.P., Mr. John Inglis, LL.D., and Mr. Andrew Stewart, LL.D.

Electrically-Cured Disease.—We notice in the *Lancet* a description of an electrical method used for curing lupus. The apparatus used is that secured by Mr. Malcolm Morris from Copenhagen, and has just been put into systematic use in this country. The apparatus for the treatment by a powerful electric light consists of three portions. In the first place, a powerful arc lamp is required, taking from 55 to 75 ampereres; secondly, a means for cooling the light must be provided; and thirdly, it is essential that the operator should be readily able to concentrate the light in a suitable manner. The arc lamp is used, as it is found to be richer in chemical rays and cooler than sunlight. The light is passed through special telescopes with crystal lenses and distilled water to stop the heat rays. Provision is also made for concentrating the light in one spot of about the size of a half-crown. The whole subject, we understand, is to a very large extent experimental, but the progress made is considered very satisfactory. The method is painless, and no anæsthetic is required, and the nerves of the patient are not upset. The drawback of the operation is its tediousness, but the treatment is to be further investigated.

Atomic Magnetism.—The following abstract of a paper by Mr. S. Meyer, contributed to the *Annalen der Physik und Chemie*, appears in the *Journal* of the Chemical Society: "Results previously recorded are supplemented by an investigation of the magnetic susceptibility of copper compounds. The fundamental difference in the magnetic behaviour of cupric and cuprous salts, suggested by Wiedemann, is not borne out by the experiments; cupric and cuprous sulphides are about equally diamagnetic. The molecular volume and molecular magnetism are compared with the sum of the atomic volumes and atomic magnetisms respectively, and it is seen that when contraction takes place in the formation of the compound, the molecular magnetism is increased; when an increase of volume takes place, the diamagnetic character becomes more marked. Hence it is permissible to calculate the atomic magnetism of an element from the molecular magnetism of its compounds only when the molecular volume of the compound is equal to the sum of the atomic volumes. The author points out the advantages of his method of determining magnetic susceptibility over that of du Bois and Liebknecht."

The Original Automobilist.—We gather from the Paris correspondent of the *Daily Telegraph* that the pioneer of automobilism has been unearthed by the French Automobile Club. This gentleman, whose name is Etienne Lenoir, is 98 years of age, and in 1860 took out a patent for a motor worked by the carburation process, and the principle was very similar to that used in gasoline automobiles at the present time. He afterwards made various improvements on his invention, and built a motorcar which worked for a considerable time. Other inventions are also placed to his credit, amongst them being an electric brake, a system of signals, a method of metal galvanising, etc. Like a very large number of other inventors, however, Mr. Lenoir has not profited much by his inventions, and has made neither money nor reputation from them. The Automobile Club of France, however, now intends that recognition, though tardy, shall be paid to the aged inventor's talents, and a deputation of members, headed by the president, will visit Lenoir next week in his suburban residence to present him with a silver-gilt medal in the name of devotees of the new locomotion of which he was the pioneer. We think that a more correct expression would be "one of the pioneers."

Our Volunteers.—We stated in our issue of June 22 that certain of the Electrical Engineers Volunteers in the service contingent in South Africa had been reported as missing. Of these, Corporals A. Charleton, D. F. Colson, and G. Charlton belonged to the Leicester Corporation lighting works, and the father of Mr. Colson has received a cablegram, of which he has kindly forwarded us a copy. This telegram is dated "Capetown, July 4, 1.30 p.m.," and contains but the single word "Safe." There is absolutely no evidence as to the present whereabouts of the senders, and it is supposed that they are yet prisoners of war. The fact that the corps has come into touch with the enemy would intimate that both apparatus and men are proving useful to our army in South Africa. Since we received the above telegram from Mr. Colson we find in the *Times* in the list of prisoners, etc., issued by the War Office on July 10, the information that Sapper G. Charlton, Electrical Engineers, prisoner of war, escaped near Reitz on June 24. He states that the following are prisoners: Lieut. North, Corporal Charleton, Corporal Sellon, Sapper Colson, Sapper Landon, and Sapper Peart, Royal Engineers; Sergeant Hugh, Electrical Engineers, and about 30 sappers.

Swiss Water Power.—The water-power station at Thysy-Hauterine is, we learn, to be opened at the beginning of next year, and will furnish power to various works in the district at from £3. 12s. to £4. 12s. per horse-power per annum, instead of from £6. 8s. to £7. 4s., which is the present rate. This reduced tariff will make it possible for electricity to be used in agricultural undertakings by furnishing the motive power to fixed machines, such as thrashers, straw-cutters, stonebreakers, etc. The installation will be composed as follows: Above the Thuzy Bridge on the River Sarine is a dam to raise the level of the water and bring it in an open canal about 550 yards long. The dam is provided with automatic doors, which open when the water attains a certain height. This arrangement permits a regular flow into the canal. From the open canal the water enters an underground canal about 9,800 yards long, which extends to Monteynan, opposite Hauterine, where the water-power station is being built. The construction of the tunnel is the most important part of this undertaking, and the water which is not used for the turbines will run to waste by an overflow canal. Water under pressure reaches the station by two conduits 160 yards long and about a yard in diameter, and sets in motion the turbines and dynamos which will produce the electrical energy.

The Northampton Institute.—We have received from Mr. R. Mullineux Walmsley, D.Sc., the principal of the Northampton Institute, an announcement of a new departure in the form of day courses in engineering, which is to be introduced this coming session. The courses are intended for students who desire to obtain a good technical training in engineering before being apprenticed in engineering works, or for those already engaged in actual engineering work who are desirous of consolidating and extending their knowledge of the fundamental principles under-

Digitized by Google

lying such work, and the most recent applications in particular directions; and who are desirous of benefiting by the instruction provided, with a view to proceeding later on to the highest technical instruction which can be obtained. The engineering day courses are divided into three departments — viz., mechanical engineering, electrical engineering, and horological engineering. In the electrical engineering department, besides ordinary electrical lighting and power work, special attention is to be paid to electric traction and electro-chemistry. Before being admitted to these classes, as the authorities think it essential that a student should have a sound preliminary education, an examination is to be held, only students passing this being allowed to enter the classes. The examination would appear from the subjects taken to be about equal to that for matriculation. The fee for the day students for any one complete course is to be £15, or £16 if paid in instalments at the beginning of each term.

Steel Rails.—The committee which was appointed in 1896 to enquire into the loss of strength of steel rails after long use on railways, and to see what steps could be taken to prevent accidents arising from this cause, has recently issued its report. The committee, which had Mr. Ritchie as formal president, consisted of the Right Hon. Lord Blythswood (chairman), Sir Benjamin Baker, K.C.M.G., F.R.S, Sir Isaac Lowthian Bell, Bart., F.R.S., Prof. Wyndham Dunstan, F.R.S., Prof. A. B. W. Kennedy, F.R.S., the late Sir F. A. Marindin, R.E., C.M.G., Mr. E. P. Martin, Prof. W. C. Roberts-Austen, C.B., F.R.S., Dr. Thomas Edward Thorpe, F.R.S., Prof. W. Cawthorne Unwin, F.R.S., and Mr. Edward Windsor Richards. The committee do not appear to suggest any very decided remedies, such as the management of the State railways in Austria-Hungary employ. On these railways a rail must be renewed as soon as it has suffered a diminution in height of 6mm. on a total height of 125mm. In Germany no precise limit is fixed, but both in that country and in Austria trial stretches of rails from one cast of steel—the chemical composition and physical qualities of which have been ascertained—are laid down and are carefully observed. The results of the chemical and mechanical experiments with fractured rails which the committee have made suggest generally that the durability of rails depends largely on the structure, but beyond suggesting strength and care they offer no very positive recommendations. As regards chemical composition, they think it undesirable to insist on too high a proportion of carbon, manganese, or silicon in the steel.

Coal Tests by X-Rays.—We notice in *Kühlow's Trade Review* a description of some coal tests carried out with Röntgen rays. The article states that previous experiments having led to the conclusion that the permeability of coal towards the Röntgen rays affords no reliable indication of the ash content of the sample, in that the accompanying slate is relatively transparent under their influence, whereas the presence of a comparatively small quantity of oxides of the heavy metals is sufficient to offer considerable hindrance to the passage of the rays, the matter was subjected to further investigation. A selection of the purest of a number of lumps of coal was made by examination with a Röntgen ray apparatus. These samples were reduced to powder and passed through a fine sieve, the ash content being determined by direct calcination at 1·66 per cent. After this, six kinds of pitstone were powdered and sifted in the same way, their percentage of residue and iron content being also determined. The kinds of stone tried were grey slate which had a residue of 93·14 per cent. and 0·79 per cent. of iron, three kinds of black band having percentage residues varying between 43 and 65 per cent. and iron between 25 and 39 per cent., and two kinds of ferruginous slate having residues of 43 and 44 per cent. and iron 19 and 13 per cent. Mixtures were then made of the coal and stone samples, so that the percentage of ash was in each case alike—viz., 10 per cent. These mixtures, placed in paper boxes, were then exposed to the Röntgen rays for three minutes, the distance between the tube and plate being 9in. In spite of the uniformity of their ash content, the samples showed great difference in regard to their permeability, the hindrance to the passage of the rays being in direct proportion to the amount of iron present. The sample containing the smallest quantity (0·07 per cent.) of iron was almost perfectly transparent, whilst that at the other extreme of the series (5·4 per cent. of iron) gave a fairly dense black print, the others ranging in depth of colour between these limits. As for practical use the total percentage of ash is the sole point in question, the author of the article therefore concludes that, however interesting it may be from a scientific standpoint, the Röntgen ray test for ash determinations is quite valueless commercially.

New York Journalism.—We have had to complain several times of the utter nonsense which is published in the American daily papers under the heading of interviews with Edison and Tesla. It is our belief that a large proportion of these interviews are sheer fiction from beginning to end, and that in other cases the ignorance of the interviewer is responsible for a lot of the statements. The fact remains, however, that both Mr. Edison and Mr. Nikola Tesla are fond of expressing their views in the non-technical Press. This failing is commented on in the New York *Morning Journal* by the well-known writer, Mr. Ambrose Bierce. The following is an extract from this gentleman's statement of the case, and it would be interesting to know if he has been in the past responsible for any of the high-flown interviews which he now condemns. Mr. Bierce says: "In creating the new science of electrology the Author of all things seems, for some reason to us unknown, to have decreed that only fools should attain to proficiency in it. Of Thomas Edison, the Blind Tom of the science, it may be said that he knows more about electricity, and less about everything else, than any man living except Nikola Tesla. Neither of these men ever opens his head to tell us what he knows without diverting attention from the performance to the gigantic sum of what he does not know. Both appear to suffer from an incontinence of words aggravated by an impediment in sense. They always think 'the time has come,' as the walrus said, 'to speak of many things,' and of many things accordingly they do everlastingly and pitilessly speak; but mostly of what they are about to accomplish in the way of turning the world inside out and the universe outside in. A favourite topic with these peaceful civilians is war, which they are always going to 'revolutionise' or 'abolish.' Many of this paper's readers will recall Mr. Edison's leglong utterances on this topic just before the Yanko-Spanko unpleasantness—how his electrified water fired from a garden hose was to paralyse entire legions, his electrified chains flung out of two guns each were to mow them down, his torpedoes travelling on endless trolley lines under water were to make smithereens of battle craft, and the rest of it; all showing with clarity his fitness for the great leather medal of the Society of Friends for distinguished services as one of the horrors of peace. Mr. Edison's conception of what war is like would, if it could be photographed, resemble a combat between a set of ten-pins and a row of beer bottles."

The Motorcar Tour.—The report of the committee of judges on the results of the 1,000-mile trial of motor vehicles, which was carried out between April 23 and

Digitized by Google

May 12, has just been published. The judges state that they have allotted marks under 24 headings, such as price, weight, mechanical efficiency (as shown by hill-climbing trials), accessibility of mechanism, workmanship, regularity of running, etc. Eighty-three vehicles were entered for the trial, but some of these, for various reasons, were not ready at the time of the start. Sixty-five vehicles actually started, and, with few exceptions, all covered the whole or the greater part of the course. The cars were divided into two sections—viz., those entered by manufacturers and agents, and those privately owned. In the first section, seven maintained a speed of 12 miles per hour in England and 10 miles per hour in Scotland over the whole course; in Section 2, five performing the same feat. A very large number of other cars completed the entire trial, but either failed to maintain an average speed up to the legal limit in one or more of the stages, or were unable to supply the official records for the whole journey. The gold medal for the most meritorious vehicle, irrespective of class, the owner having accompanied the vehicle throughout and having driven and steered at least half the distance, is awarded to the 12-h.p. Panhard owned by the Hon. C. S. Rolls, in addition to which 10 silver medals were awarded to other competitors. The report describes in detail the performances of the various cars throughout the trial, and dealing with the causes of the failures which occurred, the judges state that enquiries tend to show that most of these were due, not to defects in the motors or in the transmission gear, but to structural weaknesses in other parts of the carriage. For example, breakage of axles took place in three instances, and the puncture of pneumatic tyres was especially responsible for delays. The judges trust that manufacturers of wheels, springs, axles, and tyres will pay especial attention to the manufacture of parts of suitable material, design, and proportion for use in the construction of motor vehicles. They consider that extremely satisfactory progress has been made, not only in the construction of the vehicles generally, but in the arrangement, accessibility, and workmanship, particularly in this country, of the transmission and other gear of many of them. They also note marked improvement in the carriage-builder's work of several of the cars.

The New South Wales Electrical Association. The annual meeting of this association was held recently at Sydney. Mr. O. W. Brain, acting electrical engineer to the New South Wales Railway Department, was president, and in his address gave some useful information as to the progress of electricity in Australia. Thus, he stated, the most important event last year was the opening of the tramways in George-street, which was the first step towards an entirely electric system of tramways in Sydney. This was being brought about as quickly as the Railway Commissioners could do so. There were then 180 cars working on the electric lines, and the number increased weekly. In Perth (W.A.) also during the past year a system of electric trams had been installed, the plant comprising two generators coupled to Canadian engines, and each having an output of 225 kw. The cars, of which there were 20 now running, were furnished with 25-h.p. motors and the usual American double motor equipments. In Brisbane, Queensland, there were now about 60 cars, and the length of track was 20 miles. The Westinghouse Company had secured the option of purchase of the Adelaide (S.A.) tramways, and there seemed a probability that the entire system would shortly be converted and extended. The same company also propose to electrically equip portions of track at Dunedin (N.Z.), and an English syndicate has a complete electric tramway plant under order for Auckland. The most interesting lighting event of the year in Australian lighting was stated to be the installation of the Parsons steam-turbine plant in the Victoria Commissioners' lighting station at Spencer-street railway station, Melbourne. There are three "turbine-alternators" installed, each consisting of a turbine coupled direct to a bipolar generator, the output of which is 150 kw. at 3,000 revolutions per minute. The supply is 2,000-volt single-phase alternate-current, with a periodicity of 50 cycles per second. The exciter armature is on an extension of the engine shaft. Ferranti rectifiers are provided in the Spencer-street station to meet the arc lighting requirements. The president then went on to speak of the signalling arrangements as used by the New South Wales Railway Commissioners, and stated that the track electrically protected by block, staff, or tablet had increased from 123 miles to 1,170 miles, the length of electric line wires, other than for power and lighting, from 2,000 miles to over 6,000 miles, and the number of telephones from 75 to 1,150, other electrical appliances having increased in similar proportion. The president finally thinks that with electrical tramways and lighting, and the electrical disposal of sewage, electricity seemed destined to play an important part in the improvement of the town.

Reduction by Electrolytic Metals.—The following abstract, which appears in the *Journal* of the Chemical Society, is of a paper by Messrs. A. Binz and A. Hagenbach, which appeared in the *Zeitschrift fuer Elektrochemie*. The abstract reads as follows: "When indigotin is suspended (*a*) in a solution of sodium hydroxide, (*b*) in a solution of zinc oxide in sodium hydroxide, and the two liquids are placed in the cathode compartments of two electrolytic cells with zinc cathodes through which the same current is passed, then the indigotin in solution (*b*) is more rapidly reduced than that in solution (*a*). The deposition of zinc at the cathode would thus appear to exercise a more vigorous reducing action than the evolution of hydrogen. Indigotin is not a very suitable substance, however, since it is insoluble in the liquids used. Subsequent experiments were made with solutions of diamine-pure-blue, Ponceau R, and patent blue N. The influence of the cathode metal was first investigated. The solution was placed in the cathode compartments of two cells which differed only in the nature of the cathode metal, and through which the same current was passed. The colouring matters were dissolved in solutions of potassium hydroxide or of potassium or sodium acetate. The metals used were copper, platinum, zinc, and mercury, and in the case of the latter no amalgam was formed, the alkali metal being redissolved as fast as it separated. Practically no difference was found in the rate of reduction with the different cathodes. By using a concentrated solution of pure potassium hydroxide, an amalgam of potassium is obtained at a mercury cathode which is acted on very slowly by the solution. With a dilute solution of potassium hydroxide, the potassium is dissolved out of the amalgam much more rapidly. By using a concentrated and a dilute solution of potassium hydroxide, it is therefore possible to have evolution of hydrogen in one cell, and formation of amalgam in another. In this way it is shown that, when hydrogen is evolved, the reduction of the colouring matters takes place very much more slowly than when an amalgam is produced. These experiments point to the alkali metal being the real reducing agent, and not the hydrogen liberated by the action of the metal on water. To test this further, zinc is caused to separate at a mercury cathode from a saturated solution of zinc oxide in sodium hydroxide in one cell, and hydrogen to separate from a

Digitized by Google

solution of sodium hydroxide at a copper electrode in the other, both cells containing the same colouring matter. No hydrogen is evolved by the contact of the zinc amalgam with the solution, so that any reduction which which occurs must be due to zinc. As a matter of fact, it is found that the reduction always takes place more rapidly in the cell with the zinc than in that in which the equivalent quantity of hydrogen is liberated. The authors conclude that many cases of supposed reduction by nascent hydrogen are really cases of direct reduction by a metal."

"The Tramway and Railway World."—We have received the July number of the *Tramway and Light Railway World*, which, as would be expected from the part which the proprietors took in promoting the Tramways and Light Railways Exhibition, is a special exhibition number. The issue contains some very interesting and well-illustrated articles, and the printing quite comes up to the special numbers of similar American papers, in which the printing has received special praise. The first article deals with the new works of the English Electric Manufacturing Company, Limited, of Preston. On looking at the views given, which show the interior of the various departments, one hardly needs to look at the printed matter to understand the large size and splendid equipment of these works. The question of economy by the subdivision of power into small units has been carefully considered, and sections of shaft are driven by individual motors of 50 h.p. The shaft of 800ft. is divided into eight sections, any one of which can be driven independently by its own motor. The power-house, at which the electrical energy is produced, is 144ft. long and 120ft. wide, and contains a coal-storage room, boiler-room, engine-room, battery-room, and reservoir. The boiler-room contains three 500-h.p. Lancashire boilers, a Green's economiser, and boiler feed pumps. The engine-room contains two cross-compound Corliss engines direct coupled to 400-h.p. generators. The whole of the buildings of the company are lighted throughout by electricity. Another article of the greatest interest to residents in London at the present time is a description, by Mr. J. Clifton Robinson, of the London United Tramway Company's new overhead system. The article is divided up into three parts — the history, description, and argument of electric traction for tramways—and we regret that the actual description of these new tramways should take so small a place in the article. The illustrations of the overhead work and of the progress of the new buildings are, however, very interesting. "Electric Canal Haulage," "The Power Bills," interviews with various leading municipalists on the "Prospects of Electric Traction in the United Kingdom," "Westinghouse Traction Apparatus in Paris," a description of the opening ceremony of the Tramways Exhibition, etc., make up this very good number of the *Tramway World*.

A National Physical Laboratory.—Mr. Hanbury M.P., on Thursday week duly received the deputation of eminent scientists who wish to obtain a site in Old Deer Park, Richmond, for a new National Physical Laboratory. Amongst the deputation were Lord Lister, Lord Rayleigh, Lord Kelvin, Sir Courtenay Boyle, Sir John Wolfe Barry, Sir M. Foster, M.P., Sir E Carbutt, Sir N. Barnaby, Sir Andrew Noble, and Profs. Rücker, Clifton, Schuster, Fitzgerald, and Elliott. Lord Lister said the Royal Society was deeply interested in the question of the new National Physical Laboratory, and they were supported by all the scientific bodies in the kingdom. Lord Rayleigh, as chairman of the National Physical Laboratory, said they recommended "That the institution should be established by extending the Kew Observatory in the Old Deer Park, Richmond, and that the scheme should include the improvement of the existing buildings at some distance from the present observatory." The Kew Observatory had been doing very valuable work of a similar character to that proposed to be undertaken in the new institution, and this alone suggested the Deer Park as a natural site. There were very few sites that were likely to be at all suitable, as the character of the work to be carried out was of the kind which must be removed from mechanical and electrical disturbances. Electrical disturbance was a new feature, but one that might be made from tramways anywhere. No private site could, therefore, meet the case, because there was no security from other buildings creating mechanical and electrical disturbances. As to the distances at which these disturbances would be felt, it was stated that a scientific committee were advising the Board of Trade on the subject. It was this consideration which greatly limited the choice of sites for the laboratory, and it was recognised by the Greenwich Observatory being placed in the middle of a park; the German institution at Potsdam was in a park, and the International Bureau of Weights and Measures stood in the park of Sèvres. In a public park they had some guarantee that the buildings would be free from electrical and other disturbances. Some comment had been made as to the 15 acres required, but one of the reasons for that large area being taken was that they wanted one of their buildings to be at a considerable distance from the other. It had never been proposed to cover the whole 15 acres with buildings. The actual area proposed to be covered with buildings was only a quarter of an acre, or the sixtieth part of the whole area proposed to be taken. As to whether Kew could be protected from disturbances and if the observatory would not have to be removed, it was stated that the importance of continuity in keeping the observation at Kew made it desirable to have all the new buildings there. As to the buildings proving a nuisance, it was to get away from nuisances that they wished to go there, and absolute quiet was needed for their observations. A great advantage of the Kew site would be its nearness to London. In reply to the deputation, Mr. Hanbury said he hoped they were under no misapprehension whatever as to their strong desire that the scheme for a physical laboratory should be carried out. The money had been promised, and they were anxious to find a site. As to the absolute importance to the country of having a laboratory of that kind there was no doubt whatever. That was not the question raised by the Treasury or by any deputation. The real difficulty had been how far the undertaking would interfere with the amenities of Kew Gardens. They wanted to satisfy both the scientists and the lovers of nature. Undoubtedly there had been some alarm among a certain portion of the public, especially those interested in Kew Gardens and open spaces, that this might to a certain extent interfere with the amenities of Kew. He was bound to say that the impression he had gathered from them that day was to a great extent that alarm was unnecessary. From what Lord Kelvin and others had said he was satisfied that as to noise there need not be any alarm. The most important point that had come out was as to whether, after all, on this site they were secure against electrical disturbance. They ought to wait for the report of the Board of Trade committee to see how far it would meet their requirements. He understood that if there were any extensions of the buildings required it would be only to a small extent, and the public need not fear that the whole of the 15 acres would be built over.

Digitized by Google

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 908, Vol. XXV.)

The second paper, contributed by Herr von Moltke, attempted to define the essential requirements which a system of fire-alarms for towns of medium and large dimensions should be designed to meet. The author expressed these requirements in two sentences: (1) every person in any part of a town should be provided by the system with ready means of communicating at any time with the fire brigade; (2) the apparatus serving to transmit the alarm should be so designed as to practically exclude the possibility of failure, while the transmission of the alarm should be quick, and overlooking or false interpretation of the same at the fire brigade station impossible. Continuing, the author enlarged upon these points. One of the principal advantages of an electrical system of fire-alarms, he pointed out, was that the same might be supervised and kept in order by any intelligent person, no technical knowledge being requisite. Still further simplification of the electrical systems of fire-alarms now in vogue might, however, be anticipated, as all improvements tended that way. But the degree of perfection already attained was such that no town not already in possession of an electrical system of fire-alarms should hesitate longer to adopt the system in the common interest. The danger of serious fires, with all their attendant suffering and inconvenience, would be lessened thereby. The cost of installation incurred by an authority in putting down an electrical system of fire-alarms was so abundantly repaid by the greater security obtained, that persons in authority who neglected or opposed improvement in this direction took upon themselves a grave responsibility. In conclusion, the speaker hoped his words would help to strengthen general confidence in electrical systems of fire-alarms.

Following the above paper, Herr Anhagen, superintendent of the fire brigade at Kiel, gave a detailed description of the network of fire-alarms installed in the town, and of the electrical apparatus employed in connection therewith. The accompanying diagram (Fig. 1) shows the arrangement of the fire-alarm pillars and the method of connection employed between these and the several brigade stations. It would be needless here to enter into further details of the system, beyond mentioning that the aggregate length of the three circuits employed amounts to about 16 miles.

Several papers of a more technical character followed, to which we may refer at greater length later on. An interesting contribution was that by Herr George Dettmar upon the necessity of formulating rules for the determination and quotation of the output, temperature rise, and efficiency of electrical machinery. In concluding his remarks, Herr Dettmar introduced a proposal by the Hanover branch of the Verband that the above question should be submitted to a special commission, a proposition which was duly acted upon.

Business concluded for the day at about 4 p.m., whereupon excursions to various works, etc., of interest in the neighbourhood were undertaken. But before following these, brief reference may be made to an interesting demonstration with the Slaby-Arco modification of Marconi's system of wireless telegraphy by the Allgemeine Elektricitäts-Gesellschaft, with the active support of the marine authorities, on the spot. Great interest was excited by the experiments, which were conducted between the Marine Academy and some of the ships-of-war lying off Kiel. Messages were exchanged with two of the ships, even to Press correspondence being successfully transmitted from sea to shore. It deserves incidental mention that messages have already been transmitted with the system in question over distances up to 37 miles without difficulty.

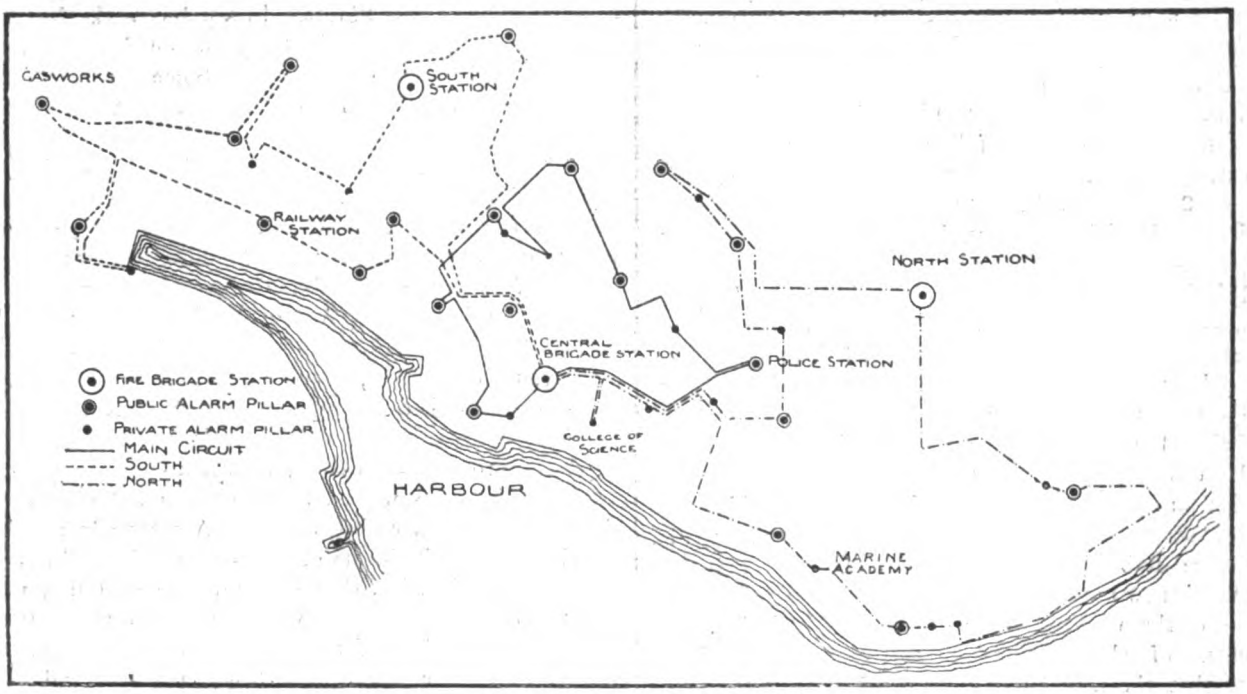


FIG. 1.—Arrangement of Fire Alarms, Kiel.

Considerable interest was also shown in an exhibition arranged to give those present a practical idea of the progress made in electrical matters during the year. An exhibition for this useful purpose has become one of the annual features of the meeting, and its popularity is growing year by year in a rapid manner. The exhibition with which we are at present concerned was larger and at the same time more interesting than its predecessors, a result no doubt largely contributed to by the considerable space devoted to apparatus employed on modern warships or during the construction of the same. Visitors to the exhibition hence obtained a grand opportunity to study both the direct and indirect application of electricity to the appliances of modern sea warfare. Individual reference to the exhibits of note must, however, be left over for the time being, while I deal more fully with the objectives of some of the excursions mentioned above. In doing this I shall not attempt to adhere to the order of the programme, but first of all proceed to the Kaiser Wilhelm Canal, an inspection of the electrical and hydraulic arrangements of which constituted, perhaps, the principal attraction of the day's entertainment. Much has been written about the canal in question, which, as is well known, connects the North Sea with the Baltic, and constitutes one of Germany's most recent and important engineering achievements. An illustration of one of the principal bridges—all of which are noted for their

Digitized by Google

great span—over the canal, with the Imperial yacht "Hohenzollern" passing underneath, appeared with the first instalment of this article. But it is with the electrical arrangements for lighting a canal some 62 miles in length from end to end, so as to enable navigation by night, that I have to deal with more particularly here. The order sounds a big one, and great praise must be accorded to the Helios Elektricitäts Aktien-Gesellschaft, Cologne, for its successful execution. I believe I am right in stating there was no precedent to the work which I am about to describe. Electricity had certainly been previously transmitted to considerable distances for power and lighting purposes, but amongst the many examples of the successful application of electricity at points more or less remote from the generating source, not one involved a tithe of the difficulties which had to be overcome in lighting the Kaiser Wilhelm Canal throughout its length. Not only the lighting of the canal itself, but also the considerable demand for the locks, harbours, buildings, etc., had to be provided for. To meet these several requirements two generating stations have been erected—one in Holtenau and the other in Brunsbüttel—situated respectively at the Kiel and Cuxhaven ends of the canal. In the equipment of these stations great care was taken to provide reliable and economical machinery, while, as an additional safeguard against breakdown, a complete reserve of plant has been installed. The pressure of the current generated is maintained constant by means of automatic regulation, no matter how the load may vary. Each lamp fixed is completely independent of the others, so that the switching out or extinction of a large number of lamps through any cause has no influence upon the working of the remainder.

So much for general particulars; now to proceed to detail. Near the locks situated respectively at Holtenau and Brunsbüttel are erected two pumping stations, which serve to provide the requisite hydraulic pressure for working the lock gates, etc. The boilers in which steam is generated for driving the pumps serve at the same time to supply steam for driving the electrical generators, which are situated at each station in close proximity to the pumping machinery, though in a separate room. The equipment of each generating station comprises two slow-speed steam-engines of the compound tandem horizontal type so much favoured in Germany. These machines run at 85 revolutions per minute, each developing about 200 effective horse-power at that speed. The high and low pressure cylinders have diameters of 16in. and 24½in. respectively, the stroke being 3ft 4in. Centrifugal governors are fitted. At the Holtenau station separate surface condensers are installed, but the machines are arranged so that they may exhaust into the central condenser of the hydraulic department if necessary, or work non-condensing. Mounted between the driving shaft bearings of each engine is an alternate-current generator, having a stationary armature supported from the bed-plate carrying the bearings, and a rotating field system built up on the periphery of the flywheel. The magnet cores, which are bolted to the periphery of this flywheel, are composed of ½mm. iron plate, and number 72. Care has been taken in the design to obtain a magnetic circuit of low resistance. The exciting coils are supported by heavy shoes. The diameter of the magnet wheel being 15ft. 7in., the velocity at which the armature coils are cut by the field lines is therefore 4,000ft. per minute, which gives a frequency of 50. The armature is not only divided through the plane of its axis, so that the upper portion may be lifted off; but, in addition, may also be removed bodily to one side over slide bearings provided for the purpose, thus rendering both the armature and field coils completely accessible. Moreover, the armature coils are so arranged that each may be removed from the side, together with its respective core, upon loosening four screws. The Helios Company have abandoned in this type of machine the ⊥-form of armature coil and core formerly employed. In the newer form (Fig. 2) each core overlaps its winding on the magnet side to such an extent that the complete armature presents an iron surface to the influence of the field excitation, which is broken only by small interstices between the individual cores. The pressure of the current generated at the terminals of the machine amounts to 2,000 volts. The current curve and magnetic and electrical ratios are proportioned to obtain, on the one hand, an economical supply of energy to an installation of arc lamps with 28 volts terminal pressure at the lamps, and, on the other hand, to ensure minimum disturbance through the distortion of phase arising from the long-distance transmission. A four-pole shunt-wound dynamo, with a disc armature, mounted on an extension of the main driving shaft, serves to generate the requisite exciting current for the field-magnet system. The pressure of the exciting current amounts from 120 to 150 volts.

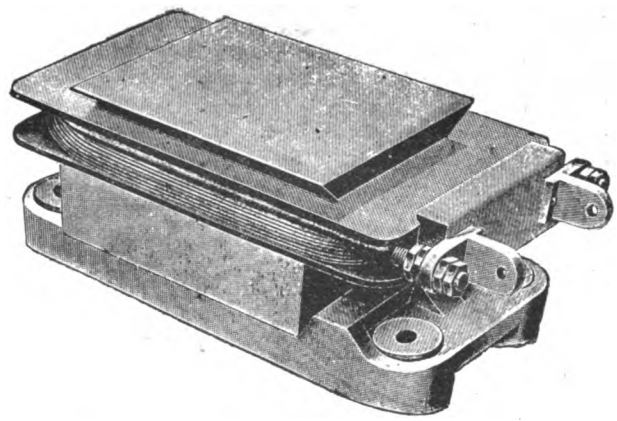


FIG. 2.—Armature Coil, Helios Alternator, Kaiser Wilhelm Canal.

The field of the exciter is automatically regulated by means of a Tesla motor without a commutator or collector ring. At a higher pressure than that of 72 volts transformed in the engine-room, the motor switches resistance into the field circuit of the exciter, or switches resistance out at a lower pressure. A maximum current of one ampere suffices to actuate the regulator. On normal load the steam generators, with a steam pressure equal to 90lb. per square inch in their valve chests, develop 1,000 kw. each on a steam consumption of 2,750lb.—that is to say, 1 kw. for 27·5lb. steam per hour.

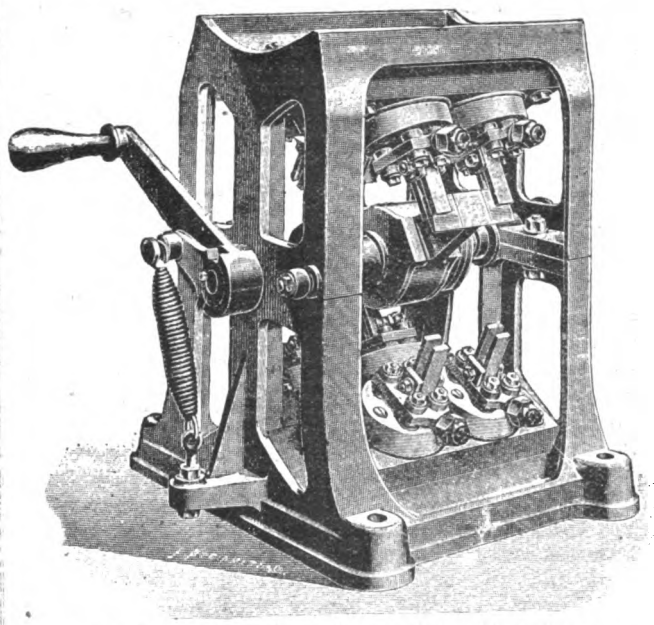


FIG. 3.—High-Tension Switch, Helios type, Kaiser Wilhelm Canal.

One steam set suffices both at the Holtenau station and at Brunsbüttel to take the full load, so that the second machine in each station provides a complete reserve. A small steam dynamo, capable of developing an output of from 9 h.p. to 12 h.p., serves for the day lighting load in Brunsbüttel. This set runs at 150 revolutions per minute, and may also be employed for exciting the alternators if necessary. A day-load generating set has also been installed in Holtenau. The switchboards in both stations are of very handsome appearance, having surroundings of gold coloured bronze in ornamental relief. The

Digitized by Google

high-tension switches, situated behind the boards, are actuated by strong levers (see Fig. 3), from which it will be seen that all the contacts are double-pole. Triple insulation is employed on these switches, one being of porcelain and two of vulcanite. The measuring instruments, mounted upon white marble with vulcanite insulation, record the pressure and current strength of the

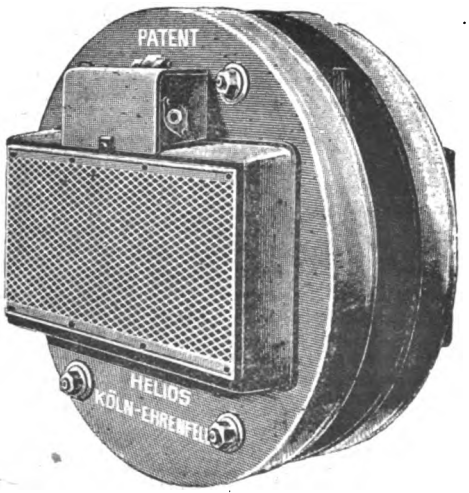
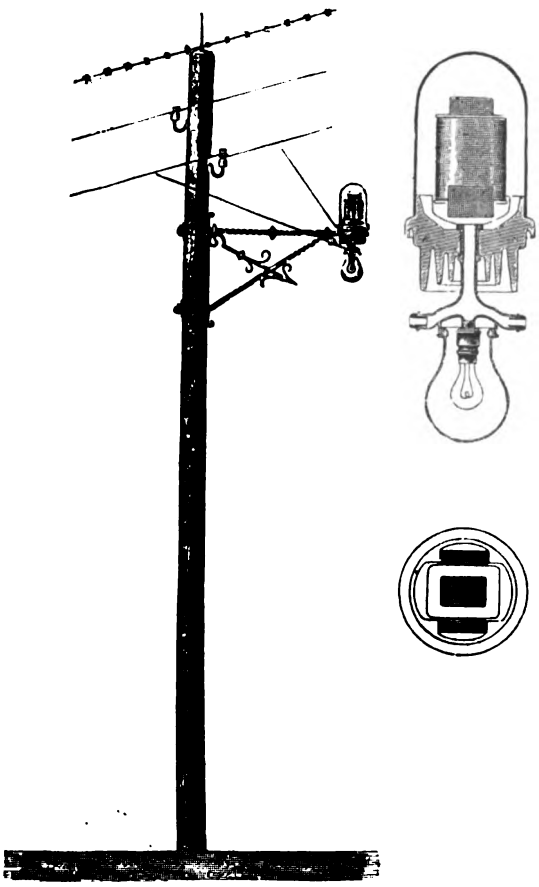


FIG. 4.—Step-down Transformer, Helios type, Kaiser Wilhelm Canal.

excitation, the pressure and current strength generated by the alternators, and also the watts supplied to the line. For paralleling purposes artificial resistances, consisting of asbestos ropes wound round with nickel wire, are provided. The phases are not only indicated by two lamps fed by a transformer with duplicate primary windings energised by both machines, but also by a phase indicator. This



FIGS. 5 AND 6.—Line Post and Lamp Details, Kaiser Wilhelm Canal.

latter consists of a movable disc pivoted in front of two magnet poles energised by both machines. If the phases of the two machines correspond, the disc remains stationary, but otherwise the disc rotates in the one or other direction in response to the leading phase. For the lighting of the station buildings, the primary current is transformed down to the required pressure by Helios transformers, of the type shown in Fig. 4. The lanterns employed for lighting the locks contain four 25-c.p. lamps each. The feeders are almost exclusively of the concentric armoured type. Both at Holtenau and at Brunsbüttel the lighting of the station buildings and locks is very effective, no lack of arc and incandescent lamps being apparent.

The 62 miles stretch of canal is divided into four distributing sections in such a manner that from Holtenau one of these sections extends along the north bank, and a second along the south bank of the canal to a point about 29½ miles remote from the station. At this point the remaining two sections commence, one following the north and the other the south bank of the canal to the second generating station in Brunsbüttel. Thus there are four lines of lamps, for each of which lead and return cables had to be provided. From Brunsbüttel to the central division point the aggregate length of the lead and return conductors along the north bank of the canal amounts to 62½ miles and along the south bank to 63 miles, while the Holtenau circuits have lengths amounting respectively to 62 miles and 61 miles along the north and south banks. To each of these four sections or circuits are connected 250 25-c.p. incandescent lamps, which gives a mean distance from lamp to lamp of 215 yards. As, however, the lakes which are intersected by the canal are not electrically lighted (the navigable channels through the lakes are marked by gas buoys at night), the mean distance between the lamps is really about 174 yards. As a matter of fact, the actual distance between the lamps varies from 85 to 270 yards, since where the course of the canal is straight the illumination given by the lamps placed at intervals of 270 yards is amply sufficient, whereas the distance between the lamps at curves had to be correspondingly less to obtain equivalent effect, the aim being to provide sufficient light at all parts of the canal to render its navigation by night safe and easy. The conductor employed for these circuits consists of 4mm. copper wire, and is supported overhead by double-bell porcelain insulators of the treble heavy type first introduced by the Helios Company. These insulators are in turn carried by stout posts of wood (Fig. 5), placed at intervals of 43½ yards. At the points where the lamps (Fig. 6) are connected the line is in no way broken, a choking coil being placed in parallel with each lamp. The ratios between the magnetic and electrical quantities of the choking coils and lamps respectively are so proportioned, that 9 per cent. only of the current consumed at each point is diverted through the choking coil so long as the lamp burns. Should, however, the lamps become defective, the whole of the current is then deflected through the coil, so that no interruption of the current can occur.

The proportions are so finely calculated, that of the 250 lamps connected up to each circuit over one-third may be destroyed or cut off without entailing any regulation whatever of the system from the generating station. The terminal pressure at each lamp amounts to 25 volts, in addition to which the great resistance offered by the conductor itself has to be overcome, the combined resistance rendering the maintenance of a constant pressure of about 7,500 volts at the generating station ends essential. This potential is obtained by transforming up the current generated by the machines, which, as previously mentioned, give a terminal pressure of 2,000 volts.

It may be added that the overhead system is protected from lightning by means of barbed wire. The conductors serving the north side pass under the canal and also under the various streams which flow through it, special sections of armoured cable being employed. These sections are buried to a depth of about 3ft. in the canal bed, and consist of two inductionless rubber-covered cables, with a further protection of guttapercha, and over that armour to preserve the whole from mechanical injury. No trouble has been experienced with the system, which may be said to have satisfied the most sanguine expectations. For this happy result credit must be duly accorded to the Helios Company, who were the responsible firm throughout. Great interest was taken by the Verband in the inspection of the installation in Holtenau, and all expressed their admiration of the arrangements seen there.

(To be continued.)

Digitized by Google

THE MUNICIPAL ELECTRICAL ASSOCIATION.

HUDDERSFIELD CONVENTION.

(Continued from page 16.)

As though to make up for the late hour at which the members went to bed after the dinner, the committee arranged that everyone should start for Leeds by the 9.30 a.m. train on Friday, June 22. When they arrived there, there was the usual heavy programme of papers to be read and discussed. The meeting-place was the Albert Hall, and Mr. Mountain took the chair almost punctually at 10 a.m.

The first subject brought before the meeting was the "Distribution of Electricity in Scattered Areas." There were two papers read in abstract on this subject, one by Mr. L. Andrews, of Hastings, and the other by Mr. G. Wilkinson, of Harrogate. The following are these papers *in extenso*:

The Distribution of Electricity to Scattered Areas.

BY L. ANDREWS, BOROUGH ELECTRICAL ENGINEER, HASTINGS.

A few years ago, if a scattered area was mentioned in connection with the distribution of electricity, everyone would have known, without further explanation, that reference was made to a district covering an area of a few square miles but very sparsely populated. At the present time, however, a scattered area to many electrical engineers means a district containing a number of towns, several miles apart, all supplied from one generating station. This paper will, however, be confined to the question of supplying electricity to the old-fashioned scattered area. It will also be old-fashioned in another respect, for it will deal with the old and many times discussed question of alternating currents *versus* continuous. Until comparatively recently the advocates of the respective systems have each been willing to admit that neither system was altogether best; that the system best for one town was quite unsuitable for another. But with the successful introduction of high-voltage lamps, many of the continuous-current advocates are again attempting to claim that there is not a town in the country that could not be more advantageously supplied by continuous currents than by alternating. Others, on the contrary, still contend that a large and scattered district can be fed more economically by high-tension alternating currents than by the extreme limit of low-pressure supply yet sanctioned by the Board of Trade.

To compare the merits of the two systems, it is necessary to consider (*a*) the relative capital outlay involved; (*b*) the relative annual cost of upkeep; (*c*) the comparative reliability of each system. Instead of taking a hypothetical case for these comparisons, it is proposed to consider the relative merits of the respective systems for the purpose of supplying current to a definite area—viz., that of the borough of Hastings. The cost of the distributing networks will not be taken into consideration, as it is assumed that it would be the same for either system. The positions of the feeding points on the distributing networks would also be approximately the same in either case. To provide for the immediate future requirements, 17 feeding points are required; these are generally from 800 to 900 yards apart. The generating station is in the centre of the borough and about 4,000 yards from the furthest feeding points. It is estimated that the average maximum demand on each feeder will be about 100 kw. The daily load factor will probably be about 10 per cent., or equivalent to 2½ hours daily use of the maximum demand. For the low-pressure scheme it is assumed that a single independent triple-concentric feeder would be run direct from the generating station to each of the feeding points; that all feeders in which the drop was less than 10 per cent. would be connected direct to the generating 'bus bars, which would be maintained at a pressure 10 per cent. above the declared pressure of 250 volts across each side of the three-wire system; that all feeders in which the drop exceeded 10 per cent. would be supplied from other 'bus bars boosted up to compensate for the increased drop, and that in all feeders in which the pressure at the feeding points exceeded the declared pressure by more than 2 per cent., a resistance would be inserted to compensate for the excess of pressure.

Table I. gives the actual length of the feeders required for lighting the district referred to, and other particulars *re* same.

For the high-pressure scheme it is assumed that a sub-station would be erected at each of the feeding points, and equipped with transformers to transform from 2,000 volts down to 500 or 250 volts; that instead of running independent feeders to each sub-station a pair of feeders in duplicate would feed five or six sub-stations, as shown diagrammatically in Fig. 1.

Table II. gives the size and length of feeders required for this purpose, and other particulars *re* same.

TABLE I.

Length of feeder.	Sectional area.	Max. drop per 100 yards run.	Drop at full load In feeder.	Drop at full load In resistance.	Full-load pressure	Full-load loss.	Boosted volts.
Yards.	Sq. in.	Volts.	Volts.	Volts.	Volts.	Kw.	Volts.
20	·2	4·8	1	43	504	8·8	—
700	·2	4·8	34	10	504	8·8	—
1,000	·2	4·8	48	—	500	9·6	—
1,000	·2	4·8	48	—	500	9·6	—
1,000	·2	4·8	48	—	500	9·6	—
1,700	·4	2·4	41	—	507	8·2	—
1,800	·4	2 4	44	—	504	8·8	—
2 000	·4	2·4	48	—	500	9·6	—
2,300	3	3·6	83	7	506	18	48
2,500	·3	3 6	90	—	506	18	48
2,500	·3	3·6	90	—	506	18	48
2,900	·4	2 4	70	—	510	14	32
3,000	·4	2·4	72	—	508	14·4	32
3,100	·4	2·4	75	—	505	15	32
3,300	·4	2·4	80	—	500	16	32
3,800	·4	2 4	91	—	505	18·2	48
4,000	4	2 4	96	—	500	19 2	48
						223 8	

TABLE II.

Designating letter, Fig. 1.	Distance of sub-stations from works or next sub-station.	Maximum kilowatts transmitted through feeders.	Sectional area of each feeder.	Current density amperes per square inch.	Maximum drop per 100 yards run.	Drop at full load.	Full-load loss in feeders.
	Yards.	Kw.	Sq. in.		Volts.	Volts.	Kw.
A	20	100	·0358	700	3·43	·7	·035
B	700	100	·0358	700	3·43	24	1 2
C	1,000	500	·2	625	3·0	34	8·5
D	1,000	400	·1550	650	3 06	31	6 2
E	1,000	100	·0358	700	3 43	34	1 7
F	1,700	100	·0358	700	3 43	58	2 9
G	1,800	400	·1550	650	3 18	57	11·4
H	1,000	400	·1550	650	3 18	32	6 4
I	1,300	300	·1550	500	2·45	32	4·8
J	700	100	0358	700	3 43	24	1 2
K	700	200	·0624	800	3 92	28	2 8
L	900	100	·0358	700	3·43	31	1·5
M	700	200	0624	800	3 92	28	2 8
N	1,100	200	·0624	800	3 92	44	4 4
O	800	100	·0358	700	3 43	28	1·4
P	800	100	·0358	700	3·43	28	1 4
Q	900	100	·0358	700	3·43	31	1 6
							60 235

(*a*) *Capital Outlay.*—It is estimated that the capital outlay necessary to carry out the respective schemes referred to above would be as follows:

	L T. £	H.T. £
To cost of laying and jointing the undermentioned cables, complete with necessary trench work, troughing, and pilot wires, etc.:		
7,420 yards of ·036 high-tension concentric in duplicate, at 14s. per yard	—	5,200
2,700 yards of ·062 high-tension concentric in duplicate, at 18s. per yard	—	2,250
5,100 yards of ·15 high-tension concentric in duplicate, at 23s. per yard	—	5,870
1,000 yards of ·2 high-tension concentric in duplicate, at 25s. per yard	—	1,250
3,720 yards of ·2, ·1, ·2 triple concentric, at 14s.	2,600	—
7,300 yards of ·3, ·15, ·3 triple concentric, at 18s.	6,560	—
25,600 yards of ·4, ·2, ·4 triple concentric, at 22s.	28,180	—
To cost of building 17 sub-stations	—	1,700
To cost of 68 30-kw. transformers	—	5,100
To cost of sub-station switch gear	—	3,400
To cost of feeder switch panels at generating station	1,700	300
To cost of continuous-current boosters	1,950	—
Balance in favour of high-tension scheme	—	15,920
	£40,990	£40,990

(*b*) *Annual Cost of Upkeep.*—Under this heading the following items should be considered: (1) the interest and sinking fund on the capital outlay; (2) the cost of repairs and attendance to mains and distributing apparatus; (3) the cost of energy wasted in distribution. It is assumed that the interest and sinking fund would amount to about 7 per cent. per annum on the capital expended. The cost of repairs, etc., to mains is taken at 3 per cent. per annum in the case of the high-tension scheme, and 2 per cent. per annum for the low-tension scheme. In considering the third item, the energy wasted in distributing networks, meters, etc., is not taken into account, as it is assumed that these losses would be practically the same for

Digitized by Google

either system. The C^2R losses in feeders are obtained from Tables I. and II. The transformer losses and capacity losses in connection with the high-tension scheme, are based upon recent tests. The above losses for the district and output referred to may be summarised as follows :

	L.T. Kw.	H.T. Kw.
Full-load losses :		
C^2R losses in feeders	224	60
Capacity current and transformer losses	—	60
Total full-load losses	224	120
One-third full-load losses :		
C^2R losses in feeders	25	7
Capacity and transformer losses	—	38
	25	45
One-tenth full load losses :		
C^2R losses in feeders	2	·6
Capacity and transformer losses	—	30
	2	30·6
No-load losses	0	30
	L.T. B.T.U.	H.T. B.T.U.
Daily losses :		
Full load one hour per day	224	120
One-third load four hours per day	100	180
One-tenth load one hour per day	2	30
One-fiftieth load 18 hours per day	0	540
Total daily losses	326	870

It will be seen that in spite of the very great improvements in modern transformers, the all-day losses in connection with the high-tension scheme are still very high. These may be reduced by turning off a number of the transformers during the hours of light load. But even if they are all turned off, the losses through capacity current in the feeders will still be very high. It is suggested that in some districts where the day load is always likely to be a very light one, and where, as at Hastings, it is chiefly confined within a radius of about 1,000

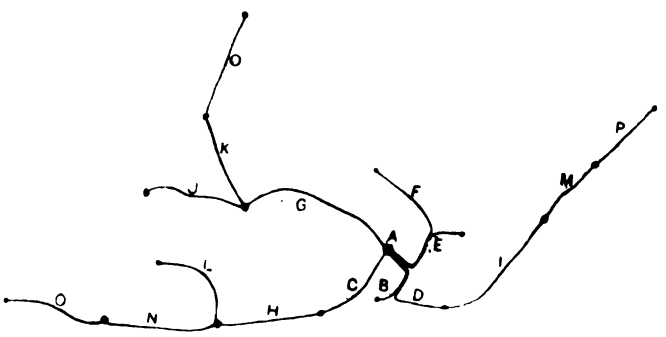


FIG. 1.

yards of the generating station, it would pay to disconnect the whole of the high-tension feeders, etc., during the hours of light load, and supply all current required through the distributing networks. If this can be done, it is estimated that the high-tension losses during the hours of light load will be reduced from 540 units per day to about 40 units per day. The relative annual losses of the respective systems would then be as follows :

Low-tension	326 units per day × 365 = 118,800
High-tension	370 units per day × 365 = 134,500

The cost of generating the above wasted units will be as follows :

	L.T. £	H.T. £
To stand-by charges :		
224 kw., at £5 per kilowatt	1,120	—
120 kw., at £5 per kilowatt	—	600
To running charges :		
118 800 units, at 1½d	618	—
134,500 units, at 1½d	—	700
	£1,738	£1,300

The total annual cost of upkeep will, therefore, be as follows :

	L.T. £	H.T. £
To interest and sinking fund :		
7 per cent. on £40,990	2,866	—
7 per cent. on £25,070	—	1,754
To repairs and attendance to feeders and other apparatus :		
2 per cent. on £40,990	820	—
3 per cent. on £25,070	—	752
Rent of sites for sub-stations	—	30
To cost of current wasted	1,738	1,300
Balance in favour of high-tension scheme	—	1,588
	£5,424	£5,424

(*c*) *Comparative Reliability.*—Doubtless continuous-current advocates will say that, on this score at any rate, the advantages are entirely with their system. It must certainly be admitted that in the past low-tension schemes have not suffered from breakdowns to quite the same extent as high-tension schemes ; but greater liability to breakdown does not necessarily mean a greater number of interruptions to the supply. If high-tension apparatus and feeders are efficiently duplicated throughout, a failure in any portion of the system will not cause an interruption to the supply in any district. It may very reasonably be objected that duplication costs money, but it has already been shown that an high-tension scheme duplicated throughout costs considerably less than an unduplicated low-tension scheme. It is not, however, sufficient to merely provide duplicate apparatus to be switched into use if necessary. The duplicate feeders, etc., must be connected in such a manner that in the event of a failure the faulty section will be automatically disconnected from the system, the duplicate feeder being left to maintain the supply. A satisfactory method of effecting this object is described in the author's Institution of Electrical Engineer's paper, "The Prevention of Interruption to Electricity Supply."

Figs. 1, 2, 3, and 4 illustrate the manner in which this special system of duplication is being applied at Hastings. Fig. 1 shows the general arrangement of the high-tension circuits. Fig. 2 is a diagram of the connections, both primary and secondary, in the sub-stations. In this diagram, F and F 1 represent the duplicate high-tension feeders entering the sub-station from the generating station. F 2 and F 3 are similar feeders leaving to supply other sub-stations. D 1 and D 2 are high-tension discriminating cut-outs connected to the

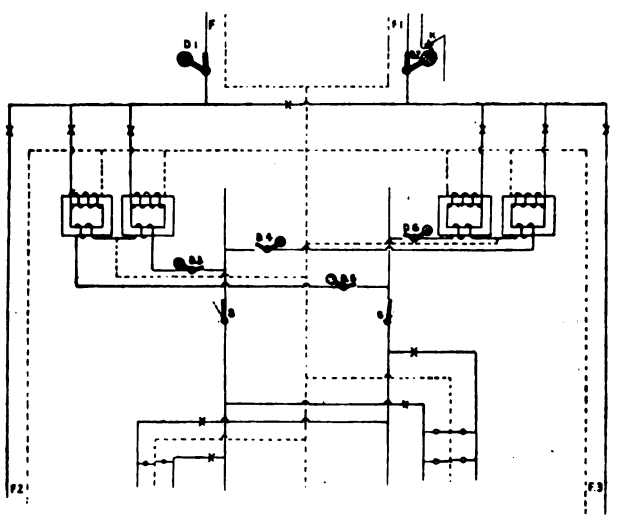


FIG. 2.

end of each feeder to prevent a heavy current from returning *vid* the sub-station to supply current to a faulty feeder. D 3, D 4, etc., are similar cut-outs on the secondaries of transformers. These serve to disconnect a faulty transformer from the secondary 'bus bar, and so prevent it from short-circuiting the remaining healthy transformers. S S is a double-pole switch inserted in series with the secondary 'bus bar. By opening this switch the secondaries of all transformers are disconnected from the distributing network. Fig. 3 shows the general arrangement of the distributing networks throughout the town. It will be seen that each distributor with its branches runs from one sub-station to another, and as all distributors are heavily fused at each end, it follows that a very heavy short-circuit on any section of the network will cut the distributor effected free from the rest of the system. The district supplied is divided into four distinct secondary networks. Each distributor is connected, either directly, or *vid* other distributors and sub-stations, to the generating station. One object of this arrangement is to enable the entire district to be supplied during the hours of light load by means of the secondary network only. Reference was made to the saving effected by this earlier in this paper.

To derive the greatest benefit from the turning off of transformers and feeders, it is necessary that this should be done as soon as the load falls below a certain point every night, and they should not be turned on again until the load begins to rise. The former it is comparatively easy to arrange, as turning off time will occur approximately the same time every night. But the time at which the transformers, etc., will need to be turned on will vary from day to day, and will also depend to a great extent upon the weather. It will often, too, need to be done at a moment's notice. It is advisable, therefore, that the turning on should be done from the generating station. The way in which this will be effected at Hastings is shown in Fig. 4. From each sub-station a pilot wire, P, will be run direct to the generating station. This pilot wire will be used for the following purposes : (*a*) to indicate on a voltmeter at the

Digitized by Google

generating station the pressure at the sub-station to which it is connected; (*b*) to indicate at the generating station the position of any fault in a transformer or feeder; (*c*) to indicate at the generating station when the secondaries of the transformers have been disconnected at the respective sub-stations; (*d*) to enable the secondaries of transformers at the sub-stations to be switched on to the distributors from the generating station.

(*a*) *Pressure Indication.*—The pilot wire is connected to one of the outer wires of the three-wire system at the sub-station, and the circuit is completed through the pilot wire, P, a two-way switch, D, and voltmeter, V, to the neutral or middle wire, B, at the generating station.

FIG. 3.

(*b*) *Fault Indication.*—A small auxiliary switch is attached to each of the discriminating cut-outs in such a manner that it is opened or closed by the opening or closing of the cut-outs. These auxiliary switches, K K 1 and K 2, are all connected in series with the pilot wire. Should, therefore, a fault occur in any high-tension feeder or in a transformer, the cut-out directly connected to it will be opened thereby, and since this will open one of the auxiliary switches in series with the pilot wire, the position of the fault will be signalled to the works by the needle of the voltmeter connected to the sub-station affected by the fault falling to zero.

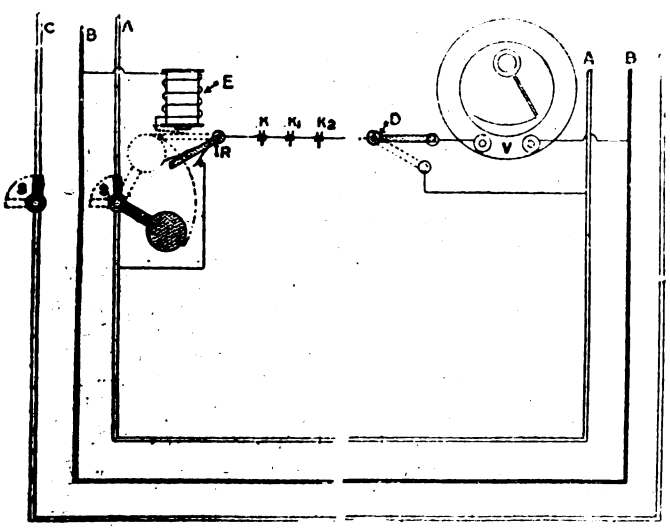


FIG. 4.

(*c*) *Indication of the Cutting off of Transformers.*—Between 11 and 12 p.m. it is intended to send one or two of the running staff, who can conveniently be spared at this time, round to the various sub-stations to switch off the transformers. This will be done by means of the double-pole switch, S S (Figs. 2 and 4). This switch is weighted in such a manner that it tends to stay closed. By lifting the weight the switch is opened, and it may be kept opened by means of a small catch, R. The action of lifting the weight to open the switch, S S, lifts the catch, R, and so interrupts the pilot wire circuit, and the voltmeter needle falling to zero indicates that the transformers at the particular sub-station have been disconnected from the distributing network. When the whole of the transformers at all the sub-stations supplied by a feeder having been disconnected, the feeder is itself disconnected at the generating station, thus cutting off all the primaries.

(*d*) *Switching on Transformers.*—When it is desired to switch the transformers on to the distributing network, the switch, D, at the generating station is placed over to make contact with the wire A. As the pilot wire at the sub-station end is connected to the neutral wire, B, through the catch, R, and coil, E, a current will now pass through the coil, E, and release the catch, R, allowing the weight to fall and close the switch, S. If the switch, D, is now replaced so that the pilot wire is connected to the voltmeter, V, this instrument should then indicate the pressure at the transformer station. The reading of the voltmeter will be a reliable indication that the switch, S S, has operated satisfactorily.

Distribution of Electricity.

BY G. WILKINSON, BOROUGH ELECTRICAL ENGINEER, HARROGATE.

The subject of the distribution of electrical energy is such a wide one that I cannot hope to treat it exhaustively in a paper of the required dimensions for this association. The question of size of conductors, types of insulation, methods of laying, regulation of pressure, methods of testing, and kindred subjects would each form an ample and appropriate theme for a paper under the above general heading, but the object of this paper is to bring before the members of this association certain practical difficulties and suggestions upon this important branch of the electric supply business which has hitherto been somewhat neglected in favour of more interesting but possibly less important engineering and electrical details. If the responsibility of an electrical engineer ceased at the 'bus bars in the works, his lot in life would be a happier one than it is at present; given good design of plant, sufficient boilers, engine and dynamo power, average care and intelligent supervision at the generating station, a steady electrical pressure and a constant supply of current is assured.

It is undoubtedly in the distribution of the electrical energy from the generating station to the consumers' premises that the greatest risks of failure of supply occur, and it is this department of the undertaking which is fraught with most risk. Here failures of a more or less serious nature are liable to occur at any moment, often without the slightest warning, occurring at widely-varying periods of time, usually during wet and unfavourable weather, and possibly at a time of night or early morning when it is desirable to be in bed or, at any rate, free from the cares and worries of business. It is not comfortable for any engineer to feel that, notwithstanding the exercise of due care and forethought, a bad fault may develop upon the mains at any moment, and effectually stop the supply of electricity to a large proportion of the consumers. Such interruptions of supply serve to destroy public confidence, cause a large amount of loss and inconvenience, and reflect more or less upon the ability of the engineer. Against faults on mains, the possession of accumulators provides no remedy, and assuming a proper subdivision of plant with an adequate reserve of power at the generating station, accumulators are not regarded as such an important adjunct to a station as they used to be, nor are they likely to assume an important place in large undertakings until they are much improved, reduced in price, less troublesome in upkeep, and of higher efficiency. It should be one of the prime motives of an engineer to make his distribution system safe and reliable under every

Digitized by Google

possible condition that can arise; no spirit of parsimony on the part of those in authority should prevent him obtaining and putting down the very best cables and joint-boxes money can buy. So far as experience has hitherto shown there is no difficulty in obtaining a variety of types of reliable cables; there are at least half-a-dozen good makers in this country, and there are as many systems of laying mains to select from, while the types and varieties of joints, joint-boxes, and accessories thereto in use are far too numerous.

For low-tension direct-current distribution recent practice has led to the almost universal use of three conductors laid side by side in the same trench, and they usually fall under one or other of the following types: (1) bare conductors carried on earthenware or glass insulators within concrete, brick, or iron conduits; (2) three insulated single conductors laid in troughs and run up solid with bitumen; (3) concentric cables, armoured, and laid directly in the ground; (4) single cables, drawn into stoneware, concrete, or bitumen conduits; (5) three-core "clover-leaf" cable, armoured, and laid directly in the ground. No. 1 is a method of distribution which is unsurpassed for durability and simplicity, and for low-tension currents it appears to be perfectly reliable, provided the conduits are kept clear of water. It can be highly commended on account of the ease and small cost of connecting consumers' installations with the mains; the service mains can be soldered to the supply mains at any point, and no joint-box is required. Notwithstanding these substantial advantages, this system appears to be making little, if any, headway owing to the difficulty of finding room for it under the street pavement, besides which owing to the cost of the conduits and supports it is probably not economical in first cost for conductors of less than ·1 square inch section, which is too large a conductor for the less important streets. I believe there are few engineers more favourably impressed by this system than Mr. Wordingham, but according to the returns published in his paper on "The Distribution of Electrical Energy," read before the Northern Society of Electrical Engineers, he has less than 6½ miles of this class of mains laid down in Manchester out of a total length of nearly 32 miles of distributing mains. The St. James's and Pall Mall Company at the commencement of their works used bare conductors laid in iron conduits very largely indeed, but there have been no extensions thereto during the last seven years, bare conductors having been discarded in favour of armoured insulated cables laid directly in the ground. Method No. 2 appears to be the most widely used system for the distribution of low-tension direct current, and possesses the important quality of durability with facility and cheapness of jointing service cables. No mechanical joint-boxes for service mains are necessary, the service cables can be soldered directly to the distributors at any point, the joints being insulated and the trough refilled with the waterproof bitumen. The troughs should in every case be covered with cast-iron covers to afford protection at the top and sides against mechanical injury, and the services used in connection with this system should also be enclosed in troughs and run up solid with bitumen, the whole being protected by metal covers. Experience in many towns appears to show that a carefully-laid network upon the solid system is remarkably free from faults. Methods Nos. 3 and 5 have been largely used, but they do not appear to possess the qualities of durability and permanence equal to methods Nos. 1 and 2, as the steel sheathing is liable to rapid corrosion in wet ground, but given freedom from mechanical injury the life of these cables is probably measured by the life of the lead covering in which they are enclosed; what length of time this represents there is as yet no experience to show. The recent practice of putting lead sheathing cables into earthenware ducts, and covering them with a continuous coating of bitumen, will doubtless increase the durability and life of the cables. Method No. 4 the writer regards as only suitable for feeders from the station to the various distributing centres. A good method is to draw feeders into some form of conduits, from which they can readily be withdrawn in case of a fault or for the substitution of a larger main to meet an increasing demand. The feeders should be laid in the longest lengths possible, so as to reduce the number of joints to a minimum. These joints in all cases should be readily accessible for examination, testing, or repairs.

For alternating currents armoured concentric cables are most frequently used as low-tension distributing mains, and give the most satisfactory results. Clover-leaf three-core and triple-concentric cables, armoured and laid directly in the ground, are also largely used. The three-core cable is somewhat more expensive in first cost than the triple cable, probably because it is not manufactured in such large quantities; it has, however, the advantage that the service joint-boxes and connections are much cheaper. A service joint-box for a triple main costs from £2 to £3. 5s., as against the half the cost for a service joint-box and connections for three-core cable of the same size; in addition to this, the triple-concentric box costs more in labour to joint. This means an average saving with three-core distributors of over 25s. for each service connected, or where two services are taken from the same box 12s. 6d. per service, which is a very substantial saving, especially in the total cost of connecting up small consumers. With triple-concentric distributors, it is necessary at every other service connection to cut through the outer and middle conductors to make joints on the inner and outer conductors, the alternate joints being made to the outer and middle, leaving the inner conductor intact; in many triple-service joint-boxes it is necessary to cut all three conductors at every joint, and this constant cutting and the frequent insertion of mechanical junctions doubtless tends to impair the conductivity of the main. In some towns, to avoid cutting the middle conductor, the triple-concentric distributors have been divided up into sections, each section being connected by a junction box which changes the polarity of the inner and middle conductors, so that the middle will be + on one section and − in the next; all joints are made upon the middle and outer conductors only, while the balance of load is thus kept approximately equal on the two sides of the neutral or outer conductor. Probably the advent of higher-voltage lamps, and the consequent raising of the electrical pressure upon the distributors, will lead to simple concentric main entirely superseding both the three-core and triple mains for alternating-current distribution purposes. For high-tension distribution, concentric mains have demonstrated their superiority over side-by-side cables, both in point of efficiency and safety.

For high-tension currents it is difficult to conceive a safer method of distribution than by concentric mains with the outer conductor earthed at the station, and the writer has known numerous instances where 2,000-volt mains have been sawn asunder by careless jointers with the current on, always with disastrous result to the saw, but with no inconvenience to the jointer beyond a blinding flash when the saw has reached the inner conductor. As a dielectric for high-pressure mains, paper impregnated with oil appears to be the most satisfactory; it possesses great resistance to electrical stresses, has sufficient flexibility if the cable is carefully handled, and the conductors can be heated to a considerable temperature before any damage is done to the insulation, which is a great advantage when sweating joints, or in case of having to overload a cable for the purpose of burning out a fault. Owing to the hygroscopic nature of the dielectric, it is necessary that the cable be enclosed in a continuous metallic envelope to keep out moisture, and this appears to be the one weak point in paper-insulated cables, though the writer has only had two instances during a long experience in which paper-insulated mains have failed owing to blow-holes in the lead covering.

Joints and Jointing-Boxes.—Probably in no branch of electricity supply undertakings is more variety of design manifested than in the matter of joint-boxes. Many engineers design their own joint-boxes, and will employ no other type. Some of these boxes are of good and reliable design, and a fair proportion of them are faulty and unreliable. Owing to the almost numberless designs of boxes used in the country and the consequent limited demand for each pattern, the cost of joint-boxes must necessarily remain high, and, in the writer's opinion, it is time an effort was made to secure standard types of joint-boxes and connections for all classes of cables, which shall be recognised as most suitable and reliable for the particular purpose for which they are designed. Until there is more uniformity of design and standardisation in joint-boxes, disconnecting boxes, house service boxes, terminal boxes and their accessories, the cost of connecting consumers' premises to the supply must remain high, and we cannot hope to be free from interruptions of supply, which, though happily in most cases occurring only at long intervals, constitute a continual source of anxiety to the engineer, and in the past have served to confirm a general impression in the mind of the public that electricity supply is unreliable, and should not be entirely depended upon either as a source of power or illumination. In the case of low-pressure supply network employing single cables, the question of joints is not serious or difficult, and probably the best form of joint is an ordinary "married" and soldered joint well lapped with insulating strip enclosed in a substantial iron case and run up solid with a waterproof bituminous compound, or, in the case of rubber-insulated cables, covered and vulcanised. For economical reasons the joints on low-pressure mains are buried beneath the pavements, and any faults which may develop are difficult to find; for this reason at every street corner an accessible distributing box should be provided, at which the network can readily be disconnected and divided up into short lengths, enabling faults to be quickly located and repaired before they became serious. The pillar distributor designed by Mr. Wordingham for Manchester is admirably adopted for this purpose. The apparatus consists of a central iron pillar within the junction box supported upon insulators. This pillar carries an iron plate for each pole; on each plate is fixed a ring-shaped porcelain insulator carrying a gunmetal ring having projecting studs, to which the cables can be clamped by means of nuts, the ends of the cable being sweated into lugs. A large funnel is slipped on to the top of the pillar and serves to collect any water that may drip into the junc-

Digitized by Google

tion box, and so prevent it from falling upon the connections. Owing to experience obtained with fuses on mains, which were always put in too light, there appears to be a wide and well-founded prejudice against the use of underground fuses, especially in big undertakings, where owing to the development of a fault upon a main such a heavy flow of current will take place through the main as to permanently damage the insulating covering thereon from excessive heat; under such conditions the conductor of smaller section would be fused before damage were done to the insulation of the main, and at the same time the faulty circuit would be isolated from the remainder of the network, and prevent failure of supply on other mains in the immediate district. This is simpler, cheaper, and more reliable than employing automatic devices to break circuit with excess of current; and such automatic devices are subject to rapid deterioration when put underground, are liable to stick at the critical moment or to open the circuit when it is not desired or necessary. In joint-boxes for concentric cables the prevalent method of clamping up the outer conductors upon the insulation of the inner conductors should be condemned, as no permanently good connection can be made upon a more or less soft and elastic substance forming the insulation. The unsatisfactory makeshift of slipping a split ferrule in between the outer conductors and the inner insulation should also be abandoned, as seldom is a sound metallic contact upon all and every outer strand of the outer conductor secured by this method; the outer conductors often being hard bound in one diameter and loose in the diameter at right angles, thus in course of time, when the main becomes loaded to its full working density heating is likely to take place at these contacts, the joint becoming impaired, and the resistance of the main increased. In every case the "outers" of concentric or triple-concentric mains should be bent out at right angles radiating from the centre of the cable, and be securely clamped between two discs of metal, which also form the necessary connections in the joint. By this means a good contact is maintained between each and every strand of the outer conductor. If these discs of metal are made whole, the centre conductor requires to be cut in order to get the discs into position, which is not good practice, although often resorted to. To avoid this, the discs should be made in halves, the division line of the front disc being set at right angles to that of the back disc, thus securing rigidity and good conductivity when fixed. For the same reason, all joint-boxes for mains should be made in halves—*i.e.*, divided horizontally in the plane of the cable—otherwise the mains have to be cut to get the joint-boxes on, which is a common though bad method.

The writer wishes to enter a protest against the far too lavish use of compound in joint-boxes. Waterproof bituminous insulating compound is a very useful and necessary article to the jointer, but it is a mistake to run up a mechanical joint-box solid with this substance; the connections within the box should be enclosed in a light internal box, preferably of incombustible material, to keep the compound off the connections, and the compound should be run in solid between this internal box and the outer box. The difficulties of clearing the connections of this compound when once they are run up solid in it are very great; the compound is seldom brittle enough to chip out with hammer and chisel, consequently it has generally to be melted out with a blow lamp. As everybody of any experience knows, this is a very tedious process, and unless great care and judgment are exercised the insulation of the incoming cables is damaged by the heat; such work as this has generally to be done when there is a fault on the main, and it makes it impossible to effect an expeditious repair, whereas if the compound simply formed a shell round the joint between the outer joint-box and a fragile inner box, the joint could be quickly cleared and the connections readily exposed for the necessary examination, alteration, or repairs. The author would like to see the prevailing custom of using wood or fibre boards in joint-boxes superseded by the use of earthenware or other incombustible material having satisfactory insulating qualities; combustible material in house switches, fuses, and distribution boxes has long been superseded by the use of porcelain, and possibly the same improvement will take place in underground joint-boxes when a serious effort at standardisation has been made. Experience has demonstrated to the writer that in many instances substantial improvements can be effected in joint-boxes if the cable ends to be joined are turned into a vertical position and enter the joint-box from the bottom. This method, which was a radical departure from the prevailing practice of that day, was probably first introduced by Mr. J. S. Raworth in 1892 on the high-pressure concentric mains laid in Huddersfield. In this case the mains are brought through glands in the bottom of a circular cast-iron base, the glands being made watertight round the cables by means of wax, thence through a disc of porcelain fixed on the said iron base and carrying the connections for the "outer" conductors; the "inners," being carried up still higher in the box by their own rigidity, support the "inner" connections, which are fixed by suitable screwed clamps to the ends of the "inner" conductors, the said clamp connections being covered by an inverted cup insulator formed of woodite. The whole joint-box is covered by a dome-shaped cast-iron cover, the lower edge of which dips into a faucet cast round the circular iron base, where it is made air and water tight by a filling of wax. This joint-box was a great advance upon many of those in use at that time for the following reasons: (1) it is easily accessible; (2) the removal of the dome-shaped cover immediately exposes all the connections for examination or manipulation; (3) the insulation of the joint is high; (4) little, if any, combustible material is used in the construction of the box; (5) the joint-box is cheap and the parts interchangeable. Joint-boxes of this type are used by Prof. Kennedy upon the low-pressure mains in Sunderland and Edinburgh, in which the ends of the single cables are turned into a vertical position and fitted with metal cone-shaped connectors; these connectors are screwed up to a heavy horizontal connecting bar, the whole being covered by a dome-shaped cover of porcelain. Four, five, or six way boxes are also used of similar construction. There may be other towns in which this class of joint is used, and probably its use will become more general in the near future for many classes of cables, owing to the simplicity of the method and the considerable advantages obtained thereby. At all points where the Raworth high-tension joint-box is used it is necessary that the cable ends be left long enough to overlap each other so as to allow enough spare cable to enter the box and reach the connecting bars, also the connections within the box are so close together that the joint is practically useless as a disconnecting box during period when the cables are carrying current.

The writer is using a reliable and inexpensive high-tension box of this type with very satisfactory results. This joint-box is cast "coffin" shaped—viz., long in one diameter and narrow in the other—in order that it may be placed upon any cable which is already laid; and by reason of the centres being wide apart in one diameter, any cable is long enough to reach up to the box terminals, provided the cable is cut at point midway between the two centres. This coffin box is supported with the outer metal pavement box just below the pavement level by means of brackets, which not only carry the joint-box, but also grip the outer lead covering of the cables, thus effectually earthing both the inner and outer boxes, and maintaining the cable ends in a vertical position at the proper centres and attitude for entering the taper glands in the bottom of the joint-box. The joint-box lid, which is shrouded round the rim, is secured by means of swivelled bolts and wing nuts, and is made watertight by compressing an indiarubber ring between the lid and box rim. It will thus be evident that the joint-box is in the best possible position for accessibility. It is above the plane of the conduits and cables, and forms no obstructions to the drawing in or manipulation of additional mains; also the joint is well above any lodgment or flow of water in the conduits or joint-pits; this latter is a valuable feature in view of the number of faults which so frequently arise through water getting into joint-boxes. The box carcase is cast so that it may be used either as a straight-through or three or four-way box, as desired. The outer conductors, after the cables are brought through the bottom of the joint-box, are spread out radially and clipped in between contact discs, the said discs being connected together by suitable connecting links, and upon each upper half of the contact disc bosses are cast, into which externally fluted hollow earthenware insulators are screwed; through these insulators the inner conductors with their insulating coverings are brought, and the inner conductors are attached to the metal terminal discs fixed on the top of these earthenware insulators. These "inner" terminals are made in various designs, according to the particular use for which the box is required, and in due form an "inner" connecting bar is used, forming a first-rate quick-break switch, which may be pulled out or replaced with perfect safety at full load should such an operation be necessary. A watertight compound is used only for luting up the conical cable glands in the bottom of the box, the whole of the internal connections being thus left exposed for examination, testing, or repairs. These boxes in any size up to 300 kw. size—viz., 150 amperes at 2,000 volts—complete with all accessories, including outer box, fixing in the pavement, jointing up, jointers' time, and all labour, cost less than £5. 5s. each, while the cost of brick pit and pavement cover alone for many types of boxes exceeds this figure. In the writer's experience, previous to the introduction of this type of high-tension box, the cost of brick pit, pavement frame, cover, and internal joint-box for concentric cables, including labour, fixing, and jointing up, was never less than £7. 7s. 6d. Doubtless in the near future triple mains of the "clover-leaf" type will be extensively used for power transmission through long distances by means of multiphase currents at extra high pressure. For these mains joint-boxes of the type just described possess valuable features, as they may be depended upon to stand any practical working pressure with safety, all the internal parts can be formed entirely of incombustible and durable material, and all inflammable compound may be entirely dispensed with. Another form of joint on concentric mains which should be mentioned is the simple soldered and wrapped joint, which is

Digitized by Google

protected from moisture by covering lead sleeve of larger diameter than the lead tube covering the cable, and to which it is united by plumbers' wiped joints; this form of joint when carefully made appears to be reliable, but no engineer would entertain the idea of using this class of joint exclusively on a distributing network.

A fruitful source of trouble and failure on high-tension alternating-current networks laid in residential neighbourhoods arises in the connections made between the concentric mains and the terminals of the small transformers installed in the houses. Usually the concentric mains are taken into a small joint-box, and united therein to "side by side" rubber-covered mains, which in turn are taken to the primary terminals of the transformers. In cases of this kind the writer has, by means of a special cable terminal end and cover, always concentric mains directly to the terminals of the transformer without the intervention of a joint-box, and in no single instance has a fault ever developed.

The discussion on these papers was opened by Mr. J. F. C. SNELL, who proceeded to dissect Mr. Andrews's figures as to the advantages of alternating currents. He also strongly criticised the figures in Mr. Andrews's paper as to the cost of direct-current feeders, on which cost comparison was made between the relative advantages of the two. Mr. Snell contended that the total cost of the feeders and switch gear for the direct current would not be more than £25,800 in the case taken by the author. This would be quite sufficient for a station with 1,700 kw. of plant. Again, he thought that the author's estimate of £100 as the cost of a sub-station was too low. Mr. Snell's conclusion as to the comparative cost of the distributing system with alternating and direct current respectively, was that there was nothing to choose between them. There was, however, an advantage in favour of the direct current, he thought, in the cost of upkeep. He complained that Mr. Andrews had given the total losses with the direct-current system, and yet had assumed reductions in his alternating-current system which had not been realised up to the present. He considered that a 2 per cent. charge for the cost of upkeep on the cost of direct-current feeders was too high, and from eight years' experience thought that 1 per cent. was ample. If corrections were made in this way, it would bring the cost of the two systems in Mr. Andrews's paper to very much the same.

Mr. COWAN said that in abstract this subject had been discussed quite sufficiently, but there was great need for practical discussion of the details which went to make up the actual cost. There was a strong feeling in favour of doing without transformers and the high tension. The direct-current system also gives them other advantages beyond the supply of light, in that they could supply motorcars, which he thought would be a profitable business in the future. As regards the cutting off the transformers in order to reduce the no-load loss, he did not think it was convenient. The supply of lighting along a long route, such as was shown in the author's plan, with transformers along it with both their high and low tensions connected in parallel, was not likely to give good regulation. He thought that the transformer in the sub-station marked B would be overloaded, and that in the sub-station marked P would be underloaded. They ought to be exceedingly careful not to switch off the high-tension feeders abruptly, as that caused a very high voltage due to surging.

Mr. C. H. WORDINGHAM agreed with Mr. Snell's comments on Mr. Andrews's paper. They had heard a discussion on the relative advantages of high-tension alternating currents and low-tension continuous currents for distribution, but he thought that the advantages of high-pressure continuous current should also be taken into consideration, as under certain circumstances this system gave more favourable results than those under discussion. With respect to Mr. Wilkinson's paper, it was not, of course, economical to put down a system of bare copper mains when only a certain section of copper was required. He thought that about a quarter of a square inch was about the minimum. In Manchester they were running bare copper to all the outlying districts where there was room under the pavement. With respect to the mechanical protection for conductors laid on the solid system, he found that a thick pitch-pine cover was the most serviceable, and that it would prevent any pick from damaging the cable. He would like to raise the question as to why metallic envelopes must be provided round cables that have a hydroscopic insulation, as stated by the author. He did not see why an insulating envelope which was waterproof could not be used.

Mr. H. FARADAY PROCTOR said that they had some 50 sub-stations in Bristol, and the cost of them did not average more than £70 each. With respect to Mr. Wilkinson's paper, he did not see any good reason or advantage in giving up the three-wire system in favour of the two.

Mr. W. A. CHAMEN said that while the bare copper mains had advantages, there were certain districts where they could not be laid. Glasgow was one of these, as the law in Glasgow allowed anyone to build a cellar under the footpath, which would entail a frequent moving of mains already laid. The Glasgow subsoil was also exceedingly wet. He had tried two systems of laying cables on the solid system—in one case iron troughs, and in the other earthenware. He found there was a tendency in certain cases for the current to get through from the lead to the iron trough. On the whole, he rather preferred the wood troughing.

Mr. A. S. BARNARD, of Hull, said it was known he had charge of a high-tension continuous-current system. They had four sub-stations, and arranged the switch gear so that they could switch in rotary transformers from the electricity works. He thought this also might be done with the alternating currents.

Mr. G. M. HARRISS asked why concrete ducts could not be formed in the streets in which to lay the cables on the solid system?

A member from West Ham here interposed with some remarks on the overpaying of the employés in the electricity works, but was reminded by the Chairman that the discussion was on the distribution of electricity over scattered areas. Mr. Mountain refused to see that the labour question had anything to do with the problem being discussed, and the member in question had thus to go back to West Ham without being relieved of his valuable speech.

Mr. L. ANDREWS, in reply, answered in part the criticisms brought against his paper by Mr. Snell. He thought that the number of feeding points he had allowed for would be wanted in practice in order to give good regulation. In Hastings they had recently signed a contract for the construction of a sub-station for £80.

Mr. WILKINSON, in reply, said that the continuous current of low-pressure system was too costly at first in scattered areas. He quite agreed with Mr. Wordingham's remarks respecting the envelopes for the hydroscopic cables, but knew of no insulating material which could be used to replace the lead.

(*To be continued.*)

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

(*Concluded from page 21.*)

Messrs. R. Blackwell and Co. had on exhibition a large exhibit, in which were four trucks of the Peckham type. The Peckham "Standard" truck shown was designed for heavy 18ft. to 20ft. open cars. Its side frames were constructed with upper members for supporting the car body springs, and a lower compression member for supporting the end extensions of the upper members of the side frames. The car-supporting springs consist of four full elliptic springs located on the end extensions as near as possible to the pedestals, and eight coil springs located four inside and four outside of the pedestals. The other trucks were an "extra long" single truck and two double trucks, one a maximum traction truck and the other a short wheelbase swing bolster truck fitted with the Price friction brake. Samples of trolley wire and insulators were shown, and four types of trolley poles as supplied to various English corporations. Other interesting objects exhibited by this company were rail bonds, switches, car fenders of the "Hipwood-Barrett" and "Dover" types, a single-truck top-seat car capable of accommodating 53 passengers,

Digitized by Google

and special track construction with joints and crossings with specially hard manganese steel centres.

Mr. Harold P. Brown exhibited a special type of rail bond invented by Mr. T. A. Edison and Mr. Brown. It is stated to be a great improvement over other rail bonds. Rail joints with these plastic rail bonds were shown. There was also shown an Eddy dynamo of 3,000 amperes capacity, and meters of various kinds.

The Electromagnetic Traction Company showed a new system of electrical traction, constructed on the closed-conduit surface-contact system. The system, which, we understand, was invented by Mr. Lane, of the Birmingham Tramways Committee, consists of a flexible magnetic electrical conductor resting normally on insulators within an hermetically sealed conduit. The conduit is made of a non-metallic metal or alloy. Into the upper surface of the conduit soft-iron pole-pieces are secured in "dovetail" sockets with insulating cement. The upper surfaces of these pole-pieces are level with the surface of the roadway; the lower extremities of the pole-pieces penetrate into the conduit, but normally do not touch the flexible conductor, which is charged with current from suitable feeders. The conduit is filled with coal gas or other gas free from oxygen, which preferably has a reducing effect. The gas is dried by passing through unslacked lime or other desiccating material. The tramcar of this system is provided with an electromagnet, which is in such a position that it passes near to the pole-pieces of the track. The magnet is also fitted with a metallic brush, which touches the pole-pieces. A small accumulator is carried on the tramcar.

The Chloride Electrical Storage Syndicate exhibited samples of storage batteries as used for pressure regulation on numerous electric tramways and railways throughout the world. The various examples of different sized cells at present working in connection with electric tramway systems in Great Britain were specially distinguished, in order that people might see what was used in Great Britain.

The Electrical Power Storage Company also showed a number of their E.P.S. and other types of accumulators, these being too well known to need description.

Messrs. Askham Bros. and Wilson had a large exhibit of tool steel, platelayers' tools, carts for carrying rails, tramway points, and also patent movable points, tramway wheels and axles, cross-over castings, tie-bars, fishbolts, springs, etc. The joint-plates which were shown were of three types, and were fitted to rail sections as in use in Glasgow, Halifax, Aberdeen, Sheffield, and other towns.

The Simplex Steel Conduit Company's exhibit consisted of a board mounted on a framework, and on which were shown specimens of the company's conduits and fittings. In the centre was a Simplex five-way double fuse distribution board, from which the sample circuits were run to various lamps, showing the surface method of wiring. Other fittings, etc., were also shown.

Mr. Washington-Hume had on show a half-size working model of a patent automatic signalling apparatus worked by the locomotives and capable of indicating to any signal-box or station the distinguishing number of any approaching train, even if late or out of its order, and also a means of signalling to the trains from the signal-boxes or stations.

The models exhibited by Messrs. Babcock and Wilcox, Limited, naturally included one representing the well-known water-tube steam boilers, for which the firm are noted. The model was on the scale of one-eighth of the ordinary size, but was complete in every particular. A model superheater was also exhibited.

Messrs. Crossley Bros. had on exhibition two of their latest types of gas-engines, one of the "S" type, giving 19 actual horse-power as a constant working load, and the other, of the O. E. type, arranged for driving a dynamo. That it is well suited to this work was shown in actual practice on the stall, some arc lamps being lighted by it without the aid of accumulators. An oil-engine of the low-tension type, and giving 2½ h.p. as a constant working load, was also on view.

Messrs. John Gibbs and Son, of Liverpool, had on exhibition a number of ventilating specialities, including their patent electrically-driven fans.

The dry-seat question on tramcars received considerable attention at this exhibition, and a large exhibition of ever-dry seats was shown. These seats were good, bad, and indifferent, the last two classes predominating. Some which were expected to stand the rough work of an ordinary tramcar could not even stand examination at the exhibition, and, although working properly on the opening day, on the third or fourth day of the exhibition were total wrecks. Most of the seats in their alternative position to secure dryness were so uncomfortable that one would rather use the seat without the dry-seat device. Some of the dry seats required careful handling, or a pat in the back from the back part or a sudden turning over of the seat awaited a passenger. Amongst them, however, were some which were noteworthy. The first prize in the competition was obtained for the new London seat (Peter Burns). This seat is automatic in its action. When the sitter rises the seat by natural action reverses, so that the sitting surface is kept dry, and it is only necessary to reverse the seat to procure a perfectly dry sitting surface. Another very good seat was the "Everdry," made by Mr. P. W. Bramwell, Leeds, and which is being introduced on the Sheffield and the Leeds tramways. It consists of a flexible cover laced over a system of rollers which are carried in a casing attached to the underpart of the seat. This cover can be drawn out at either side, if necessary, and laid over the seat, and will on being released automatically glide back into its place. Thus it will be seen that a dry cover is always awaiting the next passenger, independent of any consideration on the part of previous passengers.

There was also a comparatively new compound made of cedar wood and graphite, termed Dixon's graphited wood-grease, for the prevention of wear of gear and of noise, and which is made by the Joseph Dixon Crucible Company, of Victoria-street.

The Mossberg Roller Bearings Company had a good show and also the Granville type, a machine remarkable for a number of important improvements.

Amongst other exhibits were the Albion Clay Company, Limited, conduits and troughing (Sykes's patent); Messrs. Doulton and Co., Limited, who exhibited conduits, stoneware troughs, insulators, crucibles, water softeners, and tiles. A gas-engine was to be seen working at the stand of Messrs. Tangyes, Limited, and also an oil-engine (Pinkey's patent), a vertical steam-engine, and lifting tackle. There was also shown a serviceable portable hydraulic wheel press tested to 50 tons, for putting on and taking off one railway wagon or tramcar wheel at a time, taking solid wheels up to 27in. diameter and spoke wheels up to 36in. diameter. A hydraulic rail bender, manufactured by this firm, was also exhibited. The Electric Tramway Equipment Company, of Birmingham, had various types of insulators on show. A sample of flexible bracket arm suspension was exhibited, by the use of which the same flexibility can be obtained from bracket arms as from the span wire construction. Messrs. S. Z. de Ferranti, Limited, showed photographs of engines, dynamos, and switching gear. Messrs. Henry Pooley and Sons, Limited, exhibited, amongst other things, an enormous weighbridge. Messrs. Witting Bros. (Electricité et Hydraulique) had a good show of motors, trucks, car fittings, motor-generator, switchboard, and cables. The Worthington Pumping Engine Company showed pumps, heaters, and condensers. Examples of roller bearings were exhibited by the Roller Bearings Company, Limited; and at last the "Perfection" system of patent glazing by Messrs. Helliwell and Co., Limited, of Brighouse.

In connection with the exhibition a very well-got-up booklet on "Tramway Statistics," containing a number of useful tables, giving particulars of electrical, steam, and horse tramways, was distributed by the Ocean Accident and Guarantee Corporation, Limited. Amongst their various policies we noticed especially the "advanced" policy against accident, illness or permanent incapacity, and the third-party indemnity for drivers.

THE POWER BILLS.

The Select Committee of the House of Commons met again on Wednesday, July 4, to consider the South Wales

Digitized by Google

Electrical Power Distribution Bill. Those engaged in the case were supplied with a clause governing the conditions of supply which was drawn by the Board of Trade, and Mr. PEMBER, Q.C., for the promoters, asked if this clause might be taken as embodying the declaration made by the chairman on the previous day.

The CHAIRMAN replied that in principle it did, but the clause might be subject to detailed alterations.

The clause read as follows :

"1. Electricity shall be supplied under this Act only for use for the purpose of providing power and for the lighting by any person to whom it is so supplied for power of any premises in any part of which the power is utilised, and of any houses usually occupied by persons employed on those premises.

"2. Electricity shall not be supplied under this Act by the company in any area being at the passing of this Act the area of supply of any authorised distributors except with the consent of those distributors, but that consent shall not be unreasonably withheld. If any question arises whether that consent is unreasonably withheld or not that question shall be determined by the Board of Trade. The consent shall be deemed to be unreasonably withheld if the authorised distributors are not willing and in a position to give the requisite supply upon reasonable terms and within a reasonable time, and in considering what are reasonable terms and what is a reasonable time the Board of Trade shall have regard to the terms upon which and the time within which the company are willing and in a position to give the supply.

"3. If at any time after the passing of this Act any local authority or company become authorised distributors in any area within the area of supply under this Act, those distributors shall, subject to any provision to the contrary in the Act or provisional order under which they become so authorised, have the option to take over any supply then given by the company for use exclusively within the area of supply of the distributors upon the terms and subjects to the conditions provided in the Act or order."

The term "authorised distributors" was stated to mean any local authority, company, body, or person authorised by Act of Parliament or provisional order confirmed by Parliament to supply electricity within the area of supply.

Mr. PEMBER asked the committee to consider the advisability of making certain alterations in the clause. He pointed out that the persons, companies, or bodies who were to have the power to provide electricity were not to be prohibited from using it for their own purposes of lighting. He therefore told the committee that under the clause there was imminent danger of a state of things arising which might render the Bill useless. A great deal of his electricity could be supplied by private wayleaves. He knew no reason why, if he could supply the great number of consumers he proposed to supply, he should not be allowed to do it if the common law of the kingdom allowed him to do it, and if compulsory powers were given for generating and supplying electricity. If he were prohibited from doing that, his Bill might become useless. He reminded the committee that the term "authorised distributors" was expressly made to include the company. The effect of the third section of the clause would be that as soon as any local authority found the company was distributing energy to their own advantage, all they had got to do was to get a provisional order or an Act, and then they were entitled to buy the company up at any moment they pleased. The company ought to have a free hand to supply electricity to whomsoever they could bring it by private arrangement.

Mr. H. LLOYD, on behalf of the local authorities of Cardiff, Swansea, Newport, and Barry, complained that in the clause drafted by the Board of Trade there appeared to be no sort of definition of power. His contention was that local authorities which were ready and willing to obtain powers should be placed in as good a position as the others. Barry was not so authorised, and Barry ought to be placed on the same level as Newport, Swansea, and Cardiff.

Mr. MEAGER addressed the committee on behalf of Neath, repeating the contention of Mr. H. Lloyd that no distinction ought to be made between local authorities which had obtained powers of supply and those which had not.

The committee then considered their decision on the clause in private.

After a long deliberation, the CHAIRMAN announced several alterations in the phrasing of the clause. In the first section of the clause the sentence now read : "Electricity shall be supplied under this Act only (*a*) for a supply in bulk to authorised distributors, and (*b*) for the purpose of providing power," etc. In the second section the alteration was, with regard to the willingness or unwillingness of authorised distributors to give a requisite supply on reasonable terms and within a reasonable time, the Board of Trade should, "amongst other things," have regard to the terms on which the company were willing and in a position to give the supply. The third section as altered read as follows : "If at any time after the passing of this Act any local authority or company become authorised distributors in any area within the area of supply under this Act, the company shall be subject to any provisions which may be made by the Act or provisional order under which the distributors become authorised as to the taking over of any supply then given by the company for use exclusively within the area of supply of the distributors."

The committee also added a fourth and a fifth section to the clause. The fourth ran : "Nothing herein contained shall prevent the company from applying for provisional orders under the Electric Lighting Acts of 1882 and 1888." The fifth clause was : "Nothing in this section shall authorise the company to supply electricity for lighting other than the lighting specially mentioned in this section."

The committee then adjourned till Thursday.

THURSDAY.

On Thursday Mr. H. LLOYD, representing Barry, asked the committee to revise Sub-Section 2 of the clause which had been drafted the day before. The clause read : "Electricity shall not be supplied under this Act by the company in any area being at the passing of this Act the area of supply of any authorised distributors except with the consent of those distributors, but that consent shall not be unreasonably withheld." He desired that the words, "nor shall distributing mains be laid," should be inserted after the phrase, "electricity shall not be supplied," explaining that the local authority he represented objected to the power given under the clause to the company to break up streets and lay their distributing mains.

The committee, however, declined to insert the words.

Mr. FITZGERALD raised the question whether three or seven years was a reasonable time within which the company should give the supply, and also whether 10 or 20 per cent. on the outlay was a reasonable expenditure, and he asked the committee to give a decision on the point.

The CHAIRMAN announced that a clause to be further considered by the committee would be inserted.

Replying to further remarks, the CHAIRMAN said the committee had decided that the dividend payable by the company should be limited to 8 per cent., and that there should be a clause giving the Board of Trade power of revision after 10 years. It was desired that power should be given to introduce a sliding scale if after the experience of 10 years such a change was considered necessary.

The committee then passed to the consideration of the Durham Bill.

Later in the proceedings the committee resolved upon the representations of the counsel to reconsider their decision with regard to the maximum dividend. They deliberated in private for some time, after which it was announced that the committee adhered to their decision, that the dividend should be fixed at 8 per cent. They were also of opinion that a sliding scale should be adopted, the principle of the sliding scale to be 5 per cent. on the main charges, and the raising of the dividend 1 per cent. The Lancashire and Durham schedules as amended were accepted. The standard price for South Wales would be 2½d., and the sliding scale would be subject to revision by the Board of Trade after the experience of 10 years.

The committee then adjourned till Friday.

Digitized by Google

FRIDAY.

On Friday, as to the price for South Wales, Mr. RAM asked that they should be allowed to retain their maximum of 4d. per unit for the first 400 hours. He also asked if, instead of the 5 per cent. reduction under the sliding scale, ¼d. reduction in 1¼d. would not be better.

In the case of the South Durham Bill, Mr. MOON asked that the words "standard dividend so fixed" should be omitted from the dividend clause. He also pointed out that an 8 per cent. maximum cumulative dividend, if subject to revision, was not an 8 per cent. dividend at all, but before it was reached might be greatly cut down by such a body as the Board of Trade. He asked, therefore, that the Board of Trade should not have power to alter the sliding scale, they having plenty of power to protect the public without this.

Mr. FITZGERALD, on behalf of Walker and Wallsend, asked that the clause should not be altered in this way.

Mr. J. SHAW, for the Lancashire Bill, spoke in favour of the alteration.

Mr. MOON then said the Durham Company wanted power to carry their mains overhead, subject to the Board of Trade regulations. The overhead method of carrying mains was specially applicable to colliery districts, where ground subsidences might occur and ruin a cable, whereas an overhead line would not be so badly affected.

Mr. W. L. MADGEN, examined by Mr. Moon on the question of the overhead wires, said in his district the roads were narrow and winding lanes. There would be less likelihood of interruption of supply through subsidence of ground if the wires were carried overhead in certain places. He would be willing for the Board of Trade to say whether in any case the overhead wires should be carried over a road.

In reply to the chairman, Mr. MADGEN said Brandon was a good specimen of the place to which they wished to convey electricity by overhead wires.

The question of the cessor clause was then discussed, the clause stating that if within one year from the passing of the Act the company have not substantially commenced their works for the purpose of carrying out their powers under this Act, and if within three years after the date of the passing of this Act the company have not erected a generating station or stations sufficient in the opinion of the Board of Trade, and are not in a position to supply therefrom, the Board of Trade may order that the powers of the company under this clause shall cease, and on any such order being made these powers shall cease accordingly. After a lengthy discussion between the counsel on this clause the committee-room was cleared, and on being called in the parties were informed that the committee's decision on the South Wales Bill was that the dividend be not subject to revision. The relation between price and dividend would stand.

As to the overhead wires in the Durham district the urban authorities would have absolute veto, and rural authorities only a qualified veto. In the cessor clause two years and four years to be substituted for one year and three years.

As to the South Wales Bill the maximum price would be reduced from 4d. to 3d. In the Lancashire Bill the nature of the cable would be subject to the Board of Trade only. The committee then adjourned till Monday.

MONDAY.

On Monday the smaller clauses of the Bills were agreed to, and the measures were ordered to be reported to the House for third reading.

CHELSEA TRAMWAY SCHEMES.

The following report of Mr. T. W. E. Higgens, A.M.I C.E., surveyor to the Vestry, has been presented to the Works Committee:

"In considering the advisability of giving their assent to any tramway scheme affecting Chelsea, I desire to draw the very serious attention of the committee to an aspect of the question which too often is overlooked. Such considerations as to whether one particular route in Chelsea is superior to another, or whether the introduction of tramways into business streets is detrimental to trade, should no doubt receive attention, but the question which I wish to raise is a fundamental one—namely, is it to the benefit of the public at the present stage of progress and civilisation that any road authority in a large city should permit a tramway to be laid?

"The whole object of a tramway is to transport a certain number of persons from one place to another. This could be done by any vehicle, but the necessity for providing for the transport of large numbers of passengers arose some years ago in the suburbs, and was at that time best met by the construction of tramways, which have thus usually first been laid on the outskirts of towns, where the road surface was indifferent, and consequently the traction was difficult to ordinary vehicles, the lines of tramrails being sunk in the streets to improve the traction for the tramcars only. Or, to put it simply, the surface of the roadway for ordinary traffic was rendered more uneven and more difficult of traction in order that the vehicles belonging to some special owner should have special facilities of traction. The whole question is one of traction. And the Vestry has to face this position: if it consents to tramrails being laid in King's-road, it will consent to the traction for ordinary vehicles being made more difficult, without, I submit, improving the traction for the tramcars.

"It has been found by experiments that the tractive resistances of various surfaces on the level are as follows: asphalte, from 15lb. to 30lb. per ton; tramrails, from 15lb. to 40lb. per ton; macadam, from 45lb. to 60lb. per ton. If, therefore, tramrails were laid in the King's-road asphalte, the traction would be no better for the trams, but very much worse for the ordinary traffic and the cyclist, who would find the hollow of the rails spoil the road surface.

"Of late years, however, tramways have had an excuse for their existence. Electricity has been largely used in working them, and this motive power is suggested for the proposed scheme. So long as the perverseness of the British Legislature threw obstacles in the way of mechanical traction on ordinary roads, so long had the electric tramways an excuse. But for the last three years they have had none. Given a good smooth surface, the mechanically-propelled cars can travel as easily as the trams, can be turned in and out of the traffic, will offer no obstruction to other vehicles, will require no unsightly overhead wires or dangerous slots in the road, and will transport their passengers as conveniently and speedily as the old-fashioned trams on rails.

"I therefore do not hesitate to say that at the present time, when mechanical traction is making such advances, and can only continue to do so as enlightened public Boards provide perfectly smooth road surfaces, no scheme which proposes to provide an inferior road surface when a better one is known should receive the approval of a local authority; and as every tramway scheme does this in a large city, I feel that it is not now to the benefit of the public that tramrails should be laid in this part of London.

"The London County Council, in their letter, say that a sum of £50,000 would be spent in paving works, exclusive of laying down and paving the tram track. The cost of an overhead trolley system double track would be about £10,000 per mile, and a conduit system probably £15,000 per mile, so that for the two miles from Putney to Battersea Bridge they would spend on road surface and tram track some £60,000 to £80,000, about one-half of which would be spent in rendering the traction on the road surface more difficult for the ordinary vehicle.

"If the County Council would pause before throwing away millions of pounds in tramway work, and bring forward some scheme for widening and improving our main thoroughfares, and laying therein perfectly smooth pavements, over the whole surface of which the tractive force required to draw a vehicle could be reduced to the very smallest amount possible, and would establish thereon a suitable system of mechanically-propelled vehicles, the public who ride, the tradesmen along these routes, the cyclists, and the owners of all vehicles would be gainers, and the money spent would be laid out for the benefit of all, and not of one particular class of traffic."

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	37	The Paris Exhibition	56
The Verband Deutscher Elektrotechniker	42	Yarmouth Electric Lighting Accounts	59
The Municipal Electrical Association: The Distribution of Electricity to Scattered Areas	45	Light Railways	60
		Light Railway Commission	60
		Questions and Answers	60
		Legal Intelligence	64
Distribution of Electricity	47	Companies' Meetings and Reports	64
The Tramways and Light Railways Exhibition	50	Contracts for Electrical Supplies	65
The Power Bills	51	Traction Notes	66
Chelsea Tramway Schemes	53	Lighting Notes	67
Chelsea — London County Council and Tramways	54	Provisional Patents	71
		Specifications Accepted	72
Obituary	55	Traffic Returns	72
Electric Lighting at Willesden	55	Companies' Stock and Share List	72

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

CHELSEA—LONDON COUNTY COUNCIL AND TRAMWAYS.

The report of Mr. T. W. Higgens, the able surveyor to the Chelsea Vestry, will cause a flutter in the dovecotes of the London County Council. He gives certain reasons why the various authorities should not blindly accept the wild-cat schemes emanating from that body. The fact is, these half-ignorant, half-socialistic bodies merely look at the surface of things, and promote schemes that tend to notoriety and the immediate acquisition of votes. It has long held as axiomatic that a gift horse should not have his mouth looked at, and so these promoters of municipal tramways hope to obtain votes because of profits in aid of the rates. Practically, Mr. Higgens adopts the views we have so often urged, and we have evidence that converts are increasing in number and in influence. In the first place, we have somewhat reluctantly accepted the inevitable—that tramways will be largely used during the transition period between the killing-off of animal traction and the complete adoption of mechanical traction. Tramways are at the best but a temporary expedient, and their use will set back the time of adoption of a more perfect system, at the same time rendering the perfect system far more difficult to introduce. If anyone not fully conversant with the particular phase of the topic introduced by Mr. Higgens needs an object lesson upon the influence of tramways upon the condition and upkeep of streets, let him watch the Camberwell New-road for half a year. It will be seen that the report referred to takes into consideration the necessities of what may be termed suburban districts and of main streets. The condition of the roads outside the principal business and residential areas, and the necessity for expediting the passenger traffic between the business and residential areas, have necessitated the use of tramways, principally because the suburban street surfaces were not so good as they ought to be. That seems to be the crux of the whole matter. So far as the municipal authority is concerned, its duty is to render the whole street surface as perfect as possible for the use of all classes of traffic. The introduction of tramrails in order to make the running of special vehicles more easy, is an acknowledgment that the whole surface of the street is not what it should be. We presume that, on first principles, there is no objection to the improved running surface which is given by tramrails being provided for the benefit of a certain class, provided that there is no extra cost to the non-user, and that the rest of the street surface is not made worse. The first of these conditions applies; but, as everyone knows, the second condition is never obtained. A good street surface and tramways are mutually destructive. Again, while ordinarily there is no income derived from the use of the streets by the general community, this use represents an exceedingly valuable right to the inhabitants of the town. People are apt to forget that the unjust profits which the London County Council expect to take from the users of their tramways, and to apply to the reduction of rates, may be small in amount compared with the

Digitized by Google

monetary loss sustained by the general public in consequence of the interruption to vehicular traffic caused by the tramcars, together with the extra cost of conducting this traffic over the bad road surfaces which are inevitable when tramlines are laid in a busy street. The following paragraph in Mr. Higgens's report is worthy of most careful attention: "I therefore do not hesitate to say that at the present time, when mechanical traction is making such advances, and can only continue to do so as enlightened public Boards provide perfectly smooth road surfaces, no scheme which proposes to provide an inferior road surface when a better one is known should receive the approval of a local authority; and as every tramway scheme does this *in a large city*, I feel that it is not now to the benefit of the public that tramrails should be laid in this part of London." We particularly call attention to the four words, "In a large city," and suggest that all authorities controlling the streets should consider how far the statement in this report applies. Undoubtedly, the era of purely mechanical traction should be hurried on as fast as possible, as such a system would, if that must be the ruling point, confer a far greater aid to the saving of rates than the modicum to be obtained by the introduction of tramways under the auspices of either the London County Council or other local authorities.

OBITUARY.

The Late Mr. E. C. Short.

We regret very much to have to record the death of Mr. E. C. Short while on active service with the Electrical Engineers (Royal Engineers) Volunteers in South Africa.

THE LATE MR. E. C. SHORT, A.I.E.E.

His death, which was caused by enteric fever, took place at Kroonstadt on the 25th ult. Mr. Short was one of the original members of our Electrical Engineers Corps, and was again to the front when volunteers were asked for to proceed to South Africa. He left England for the war on March 16, and proceeded up country with his corps from Cape Town on April 17. Their first work was in connection with an important bridge at Bethulie, where a searchlight and six arc lamps were employed. On May 5 his company moved to Bloemfontein, and we fear that it was at this place that Mr. E. C. Short contracted the fever which ultimately carried him off. His electrical engineering commenced with a course at the University College, where he obtained first class. Mr. Short was then articled to the firm of Messrs. Crompton and Co., and from their employ passed on to the Willesden works of the Metropolitan Electric Supply Company, where he was an assistant engineer. While we are proud to have our young electrical engineers in the forefront of our country's wars, we grieve for the heavy toll taken of them. Our deepest sympathies are extended to the parents and relatives of Mr. Short, who was only 25 at the time of his death.

The Late Senor Don Francisco de Paula Vasquez.

We regret to report the death of Senor Don Francisco de Paula Vasquez, who died at Madrid on the 24th of last month after a comparatively short illness. Mr. Vasquez, who was only 61 years of age, had been a high official in the Cuerpo de Telegrafos, and was honorary local secretary in Madrid to the Institution of Electrical Engineers, as well as agent for the Spanish National Telegraph Company and the South American Cable Company. Many of our readers will have pleasant recollections of meeting Senor Vasquez at the telegraph conference at Paris, where his kindly humour and sympathetic manner gained for him many English friends, who we are sure will join us in expressing our condolences with his family and with his many friends in Spain.

ELECTRIC LIGHTING AT WILLESDEN.

We are pleased to announce the fact that an extensive scheme for electric lighting and traction in the Willesden district is likely to be accepted in the course of a week or so. The history of the electric lighting and tramway undertaking in this district was recently given to us by Mr. E T. Ruthven Murray, M.I.E E, the electrical engineer to the Council. In the early days some consulting engineers' reports were obtained, and a small committee was then organised to travel round the country and inspect a number of electric light stations. Amongst other places visited was Worcester, where the committee found Mr. Ruthven Murray in charge. The information he gave them was considered so very useful that he was asked to give his opinion on numerous other points that occurred to the committee when making up their final report. The Willesden District Council, after the consideration of this report, decided to advertise for an engineer who should be capable of undertaking the design of the station, and also have charge of it when erected. A large number of applications were received, and Mr. Ruthven Murray was duly appointed to the position. We believe that it is now some 18 months since he took up his duties, and that the delay in commencing work has been due to financial reasons connected with some other department of the Urban District Council. As a result Mr. Ruthven Murray has had ample time to work out his scheme of distribution, and to design the electric light station and tramway scheme.

In his report, which is dated April this year, Mr. Murray fully describes his scheme. He divides Willesden into three districts which are approximately equal in area, each containing about 2⅓ square miles. In the one section the electricity works will be placed, and transforming and accumulator sub-stations will be erected in each of the other districts. The distribution from the main generating station to the sub-stations will be carried out by means of the three-phase current at 3,000 volts pressure. In the sub-stations this will be converted into continuous current by means of motor generators. The distribution will be on the three-wire system, with 480 volts between the outer conductors and 240 volts at the consumer's terminals. The tramways will be supplied at 500 volts. Before proceeding on Mr. Murray's report, the Council obtained an opinion on the same from Mr. E. Manville, M.I.C.E., of the firm of Messrs. Kincaid, Waller, and Manville. Mr. Manville's report is dated June 18, and in it he expresses his opinion that the district is a particularly valuable one from an electrical undertaker's point of view. Mr. Manville concurs on the whole with Mr. Murray's suggestion as to the scheme to be

Digitized by Google

adopted, but advocates a drawing-in system for the feeders instead of laying them on the solid system. He also advocates increasing the amount of distributing mains to be laid in the first instance. In the conclusion of his report, Mr. Manville states his appreciation of the careful and thorough way in which Mr. Murray has thought out the details of the scheme. He adds that the scheme is a good one, and that with a district such as Willesden the prosperity of the undertaking is assured.

This report of Mr. Manville's, together with a supplementary report by Mr. Ruthven Murray, has been unanimously approved by the Electricity Committee of the Willesden District Council. It has also been before the Council, but at Mr. Murray's request it was not voted on until his supplementary report had been printed and circulated. The estimates in the new report arrange for an expenditure of £143,600 on behalf of the electric lighting section of the works, while in connection with the tramways a further expenditure of over £53,000 is advised in the first instance. Seeing that the population of the district is now nearly 120,000, and that it has practically doubled itself in the last 10 years, we are sure that the expenditure of £200,000 is warranted. We wish success both to Mr. Ruthven Murray and the Urban District Council in their joint endeavours to increase the healthiness of the district of Willesden.

THE PARIS EXHIBITION.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 872, Vol. XXV.)

Before passing on to the other machines on view, a few words as to the general system of supply in the Exhibition may not be out of place. The executive engineers decided in the early stages to give a considerable bonus to those makers of engines and dynamos who would exhibit machines and supply load from them for the Exhibition purposes. They supplemented this with a sum per kilowatt delivered, which in the case of the engines will quite pay the cost of the oil, and even allow a slight margin for liquidating the engine attendants. This latter sum was not sufficient to make the makers very keen in completing their contract, and, due to the bungling on the part of the Exhibition authorities, the building to contain this plant was about the last to be finished. This left very little time for the putting up of the plant, and has driven a large number of exhibitors on to the mains of the various supply companies of Paris. Underneath the Château d'Eau are placed two large switchboards, on which is received the current generated by the various machines in the Exhibition. On the switchboard devoted to direct currents all arrangements have been made for working the machines in parallel, and this is done with more or less success. In the case of the alternating currents, however, owing to difficulties in synchronising, and in certain instances to slight variations in the frequency, no attempt at parallel running has been made. Instead of this, each of the large circuits is brought to one panel of the alternating-current switchboard, on which switches are provided so that it can be quickly thrown on to either of the two large alternators. In this way the risk of breakdown is, to a certain extent, avoided at the expense, of course, of providing a poor load factor for each machine, and a slight flicker in the lights which will be noticed when the load is switched over. As the circuits take a considerable amount of current, the throw over will also be a trial of the governing properties of the various sets. The full description of the distributing system of mains running from the switchboard I propose to defer until a later date, but I wish to get into print quickly my condemnation of the system of fuses adopted by the authorities. These fuses have already caused a fire, and it will not be surprising if numerous other fires take place before the Exhibition closes. The mains convey the direct current on the three-wire system, with 500 volts between the extreme wires near the machine, and 440 volts where the supply is given to the stall-holders. They are placed underneath the floor of the Exhibition, which is of wood, laid on wooden joists. Under the side and main gangways fuse boxes are constructed by the simple process of placing a wood base on the bare soil underneath the floor. These wood bases have clamps to embrace the cables, and there are attached to these clamps lead fuses, which are taken to the branches going to the stall-holders. The three poles of the three-wire system are all mounted on the same base-plate, and are all divided from one another by a thin wooden partition, which is, of course, exceedingly likely to ignite when a fuse goes. Over the whole of the fuses a cover of wood is placed, which will also serve to help to conduct a fire as occasion serves. As these wood cases come close in to the joist in the floor, it will be seen that the electrical engineers advising the Exhibition authorities on the laying-out of their electrical system have great faith in the non-inflammability of wood. The wood covers to the fuse boxes will certainly protect the fuses for a little while against a flow of water from above, but here, again, the work is of such a light description that it cannot be looked upon as a reasonable safeguard from the water rising from the subsoil. Any water escaping from the circulating pipes for the condensers and passing over the soil below the floor would, of course, be fatal to the insulation of these fuse blocks.

View of the Esplanade des Invalides.

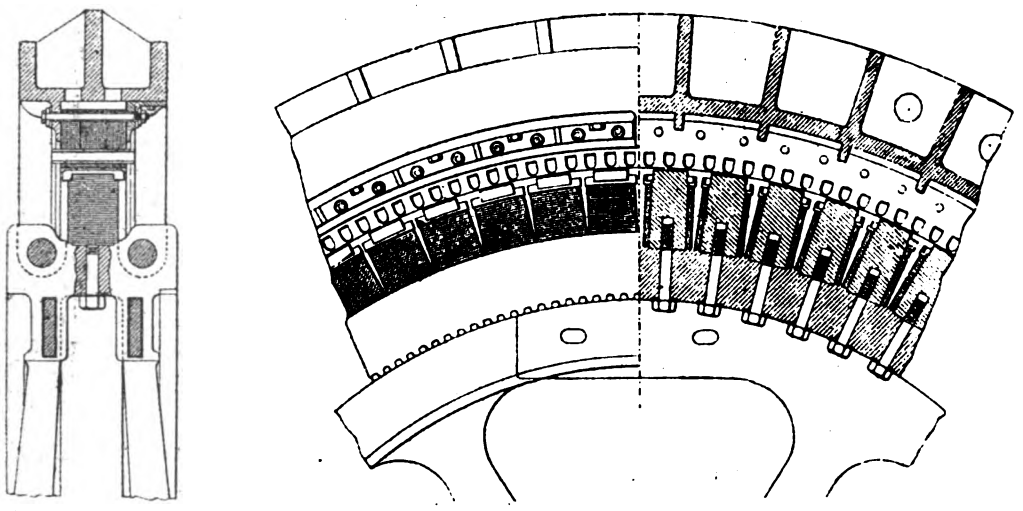
One of the most interesting machines in the Paris Exhibition is to be seen at the stall of Mr. Alexander Grammont This firm exhibit a large alternator of 600 kw., the general design of which can be gathered from the section and elevation (Figs. 1 and 2). The frequency of this machine is 50, and it has 64 poles. The voltage of the machine is 2,400. The armature is wound for three-phase work on the star system, with 1,390 volts in each limb. The following particulars of the machine may be of interest. The total excitation in ampere-turns is 9,610, of which 7,550 are required for the air gap, 180 for the armature iron between the poles, 120 for the armature iron behind the poles, and 1,660 for the field-magnet poles. It is estimated that in the yoke some 98 ampere-turns are required. The number of wires in each hole in the armature core is 70. The armature reaction for cos $\phi = 1$ is 2,020. Some 17½ kw. are required for excitation. The following are the calculations for the efficiency of the machine:

	Cos $\phi = 1$.	Cos $\phi = 0{\cdot}7$.
C^2R losses in the field-magnet coils ...	4,250	11,500
C^2R losses in the armature	6,210	12,700
Hysteresis	14,050	14,050
Mechanical losses	6,000	6,000
Total loss in watts	30,510	44,050
Efficiency per cent.	95	93·2

The most interesting point, however, about the exhibit is the compound exciter, which provides automatically the correct exciting current to give constant voltage at all loads, independent of the power factor which the load may have. This compound exciter was designed by Messrs. Hutin and Leblanc. It consists in principle of an ordinary armature of a continuous-current machine (Fig. 3) which

Digitized by Google

is subjected to the influence of two revolving magnetic fields created by the two systems of iron cores and windings, marked B and C respectively. The winding on the



FIGS. 1 AND 2.—Section and Elevation of the Grammont Alternator.

core B consists of fine wire, and is connected across the terminals of the alternator as a shunt. The winding on the core C is connected in the main circuit from the alternator, thus carrying the current from the alternator. The characteristic feature of the invention is that by the special and ingenious arrangement of the inventors it is possible to receive a continuous current from the machine, although

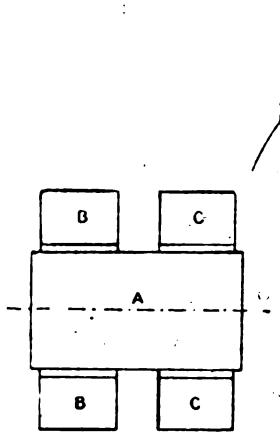


FIG. 3.

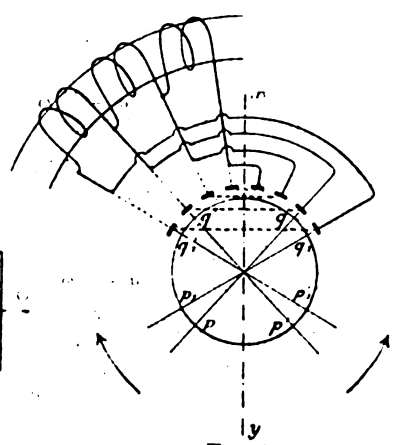


FIG. 4.

the brushes are fixed and the current is induced by a revolving field. In order to complete the description, it is well to describe the machine in detail. The winding on the armature corresponds in every respect to that of an ordinary continuous-current machine which utilises N lines of brushes and has N poles, but from the armature to the commutator all the connections are the reverse of the usual

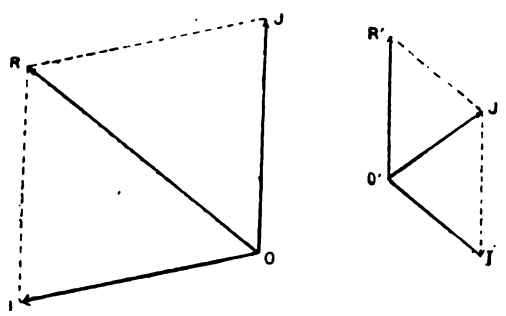


FIG. 5.

ones with N symmetrical poles. Thus in this case the number of sets of brushes need not be equal to the number of lines of poles. One or other of these conditions will suffice, as we shall show further on, to obtain the desired result, but their combination facilitates in practice the construction of the machine. If we call N the number of lines of poles due to the revolving field; K the number of lines of brushes; a the frequency of the alternating current in the field-magnet system; and ω the speed of the armature, we can then ascertain what the necessary conditions are in order to make the current continuous by the aid of fixed brushes.

This will be $$N + K = \frac{a}{\omega},$$

or, $$N - K = \frac{a}{\omega},$$

according to whether the armature turns in the same direction as the field or in an inverse direction. As N and K are determined by the construction, and are invariable, this condition fixes the ratio between the speed of the exciter and that of the alternator. To explain the working of this machine, let us consider in the first place an ordinary bipolar continuous-current dynamo. Its working only depends on the relative movements of the armature with respect to the field magnet. One is able thus to assume that if one gave to the field magnet an angular speed equal to that of the armature, and in the opposite direction, the armature could be stationary if the brushes were attached to the revolving field.

Let us now consider (1) to reverse the direction of rotation, what is it necessary to do with the brushes, with respect to the armature, to obtain a constant current; (2) how to vary the speed of these brushes. Then, after establishing the general formulæ which give the speed of these brushes, we will find out on what conditions we can obtain their being fixed.

I. *Reversing the Direction of Rotation in Connection with the Armature, the Speed of the Brushes remaining constant.*—Let us refer to our former considerations. We have deduced directly from an ordinary dynamo a theoretical dynamo with fixed armature, and with revolving magnets and brushes. We will suppose, for the present, that our machine is bipolar. If the magnets make a revolutions per second, the brushes will have to accomplish during the same time a revolutions round the collector. Let us imagine diagrammatically (see Fig. 4) a bipolar Gramme ring and its commutator. Let us see at a given moment, p^1, q^2, the position of the line of brushes which would correspond to ordinary connections between the armature and the collector. Let us consider any fixed diameter, $x\,y$, with respect to the collector, and we will suppose, as we have said, that the connections are reversed with respect to this diameter. In our diagram the ordinary connections are indicated by broken lines, and the actual connections by full lines. To the position $p^1\,q^1$ will evidently correspond the position $p\,q$, which are symmetrical with respect to $x\,y$. It follows, in consequence, that if $p^1\,q^1$ become $p_1{}^1\,q_1{}^1$, then p and q will come to $p_1\,q_1$ if the wires are displaced through the same angles, but in the inverse direction. For a machine of n lines of poles we evidently obtain the same result by adopting n symmetrical diameters.

II. *Variation of the Brush Speed.*—Let us consider an armature of n poles fixed in position. With a collector of

Digitized by Google

n lines of brushes these will have to revolve in the same direction as the inducing field and with the speed of this

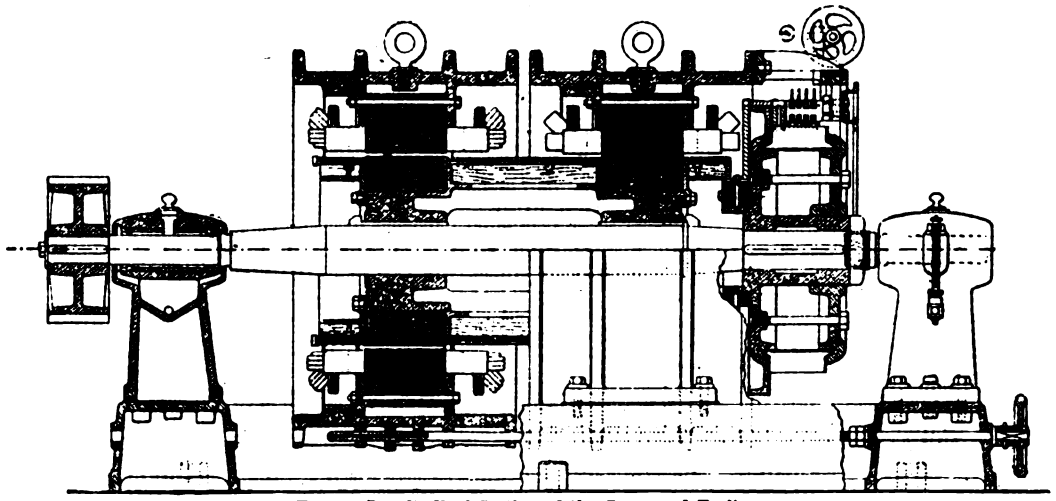


FIG. 6.—Longitudinal Section of the Compound Exciter.

field. But as we admit (theoretically, at least) that the brushes can be independently revolved, we can at will avail ourselves of their speed in modifying the number of

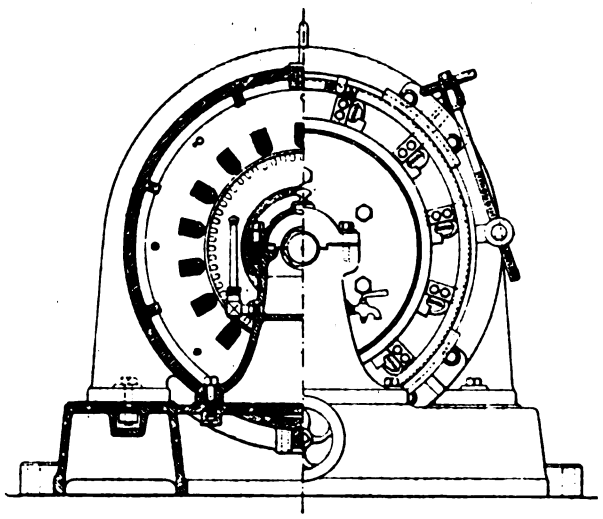


FIG. 7.—Section and End Elevation.

segments of the collector which are in parallel. In allowing only a number n times smaller to remain, it is evident that the speed of the brushes must be n times larger than that of the field, and for k lines of brushes this speed will become equal to that of the field multiplied by the ratio, $\frac{n}{k}$.

The application of these two principles to the compound exciter is as follows: Let us consider, in the first place, one of the two stators which envelope the armature. We will call N the number of its lines of poles, and a the frequency of the exciting current. The speed of the revolving field will evidently be $\frac{a}{N}$. Let us suppose that the armature revolves in the same direction with the speed ω; the relative speed of the field with respect to the armature will be $\frac{a}{N} - \omega$. The multipolar armature will also have N poles. For k lines of brushes to the collector, the speed of these poles will be, as we have shown:

$$\frac{N}{k}\left(\frac{a}{N} - \omega\right),$$

or,

$$\frac{a - N\omega}{k}.$$

The armature being attached to the ordinary commutator by a special reversing connection, the direction of this rotation will be reverse to that of the armature.

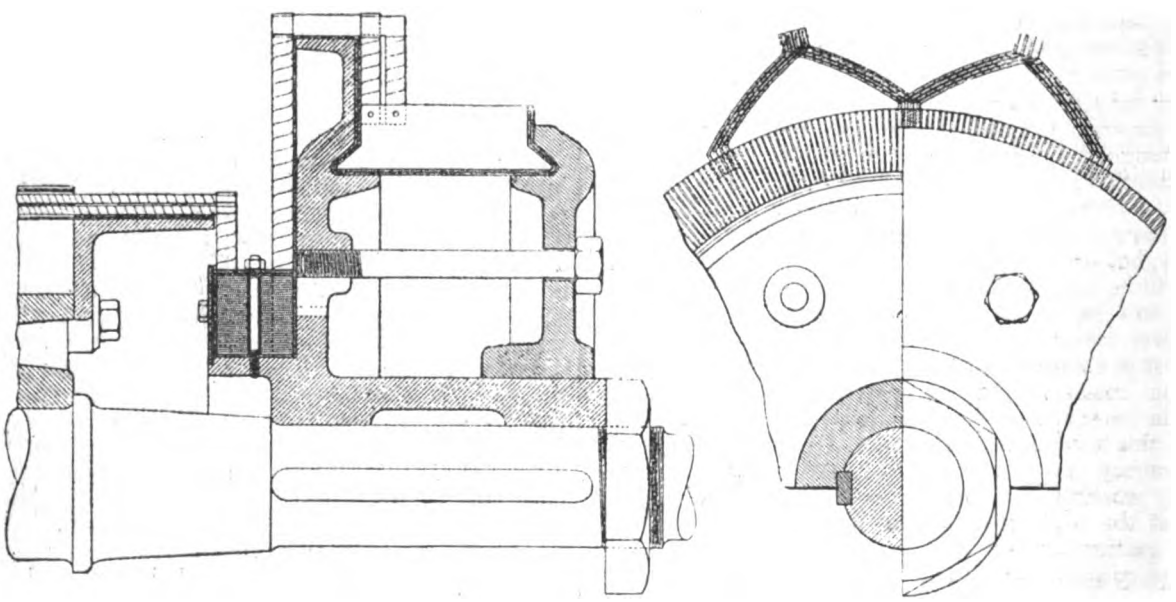
The absolute speed of the brushes in space is therefore

$$\frac{a - N\omega}{k} - \omega.$$

To obtain fixed brushes, one must revert to the first condition—viz.:

$$N + k = \frac{a}{\omega}.$$

We should obtain a different solution to the problem in causing the armature to revolve in a contrary direction to that of the field. The relative speed is then $\frac{a}{N} + \omega$. The brush speed, for k lines of brushes,



FIGS. 8 AND 9.—Details of Commutator and Connections.

Digitized by Google

$$\frac{N}{k}\left(\frac{a}{\omega}+\omega\right), \quad \text{or,} \quad \frac{a+N\omega}{k}$$

in the direction of the field. It is useless in this case to use the special connections, the absolute brush speed being

$$\frac{a+N\omega}{k}-\omega.$$

The condition of their being fixed

$$k-N=\frac{a}{\omega}.$$

The arrangements just described allow us to collect, with fixed brushes, the continuous current induced by a revolving field. We immediately conceive the possibility of arriving at compounding conditions, using, as we have previously said, for the excitation of the exciter, two distinct stators, one of them connected as a shunt to the alternator terminals and the other in series with the armature circuit. We only have now to show how it is possible, by correctly placing the two stators with respect to each other, to produce a compounding current both for varying load and lag. The problem is to produce in the exciter a resulting field always having the two following characteristic properties: first, intensity in proportion to the necessary magnetising current, and, consequently, variable with the different outputs of the alternator, and, secondly, independence of phase difference. The first condition does away with the regulating rheostat for the alternator field, while the second prevents the necessity of varying the lead of the brushes and makes the exciter quite self-regulating. To simplify the reasoning and make it more clear, we will suppose in what follows that the alternator only possesses two poles, and that the same is the case in the exciter. We will suppose, in addition, that this last consists of a fixed armature, and that the brushes revolve with the inducing field. These hypotheses do not in any way diminish the generality of the reasoning. We will represent by O J (Fig. 5) the vector of the alternator field. Then, on the other side, O I represents the armature reaction. From O J and O I we obtain the resulting flux, O R. It is on the value of O R that will depend the potential difference at the terminal. We have, in the shunt-wound stator, a flux, $O^1 R^1$, proportional to O R, and in the series-wound stator a flux, $O^1 I^1$, proportional to O I. It will always be easy in changing the dimensions of the exciter to arrive at the equality of the two ratios $\frac{O^1 R^1}{O R}$ and $\frac{O^1 I^1}{O I}$. To obtain the resultant action in the exciter from a flux proportional to a magnetic field of the alternator (supposed for the present to be excited in an ordinary manner, and regulated from a constant voltage), it will suffice then to use the two stators in the well-known way: thus the angle $R^1 O^1 I^1 = \pi$ – angle R O I.

If we suppose the two axes of the alternator and the exciter placed end to end, and the two directions, O R and $O R^1$, brought into coincidence, $O J^1$ will place itself on O J.

On the other hand, if O R or O I should advance or recede slightly, $O R^1$ and $O I^1$ would immediately conform to these displacements. There is, therefore, not only a proportionality, but also a synchronism between O J and $O J^1$. The result will be that, taking the above arrangement, the line of brushes will remain fixed in space whatever the current and power factor may be. For the compounding to be correct, it is necessary that the armature coefficient of self-induction remains always proportional to the mutual induction coefficient in connection with the magnet. Though this is not absolutely true in practice, the approximate accuracy that we can obtain is amply sufficient for everyday working. It remains to be shown that, as we stated at the beginning of this article, by the use of suitable gearing between the alternator and exciter, we can limit the speed of this latter so as to maintain it in a constant ratio with that of the alternator. It will suffice for that to go over the preceding hypotheses, which theoretically bring the machine to the type of a continuous-current dynamo with revolving magnets and brushes. The mechanical action of the alternator cog-wheel on the pinion of the exciter would make its armature revolve with the speed ω. The electromagnetic action of the stators on the rotor would produce a field revolving with the speed $\frac{a}{N}$. But as we have $\frac{a}{n} > \omega$, this last action preponderates, and the pinion "drives the wheel." The mechanical work thus restored to the alternator axle will evidently be, to the total electrical work wanted, in the ratio of ω to $\frac{a}{N}$.

Details of Construction.—The armature and the field revolving in the same way, the condition to get fixed brushes is, as we have established, $N+k=\frac{a}{\omega}$. We have taken $N=3$, $k=6$, which brings us (with $a=50$) to $\omega=333$. Fig. 6 shows a longitudinal plan, and Fig. 7 a transversal plan of the exciter. Figs. 8 and 9 show the details of construction of the commutator, which are very simple. We think it advisable to insist on the advantages which the compounding of alternators presents, as much from an economical construction standpoint as from the working advantages, principally for polyphase traction. Already many trials have been made in that direction. MM. Hutin and Leblanc's solution, equally simply and elegant, completely resolves this question.

The above details are from an article by Mr. J. L. Routin in *L'Industrie Electrique*, but I inspected the machine personally, and had it explained to me by M. Maurice Leblanc. As no photograph has come to hand I cannot show a general view of the exciter, but it is placed at one end of the alternator shaft, and is driven from it by a gearing with a ratio of 3 to 2.

(To be continued.)

YARMOUTH ELECTRIC LIGHTING ACCOUNTS.

From the accounts of the Great Yarmouth Corporation electricity works just received, it appears that the total expenditure on capital account to March 31, 1900, amounted to £40,264. 10s. 11d.

Dr. Revenue Account.	£	s.	d.
Generation of electricity	2,727	14	7
Distribution of electricity	16	8	1
Public lamps	177	18	6
Rates and taxes	200	0	8
Management expenses	615	2	0
Special charges	77	2	0
	3,814	5	10
Amount carried to net revenue account	2,629	18	6
Balance carried to next account for bad debts	8	15	4
	£6,452	19	8
Cr.	£	s.	d.
Sale of current per meter and under contracts	6,238	9	5
Rental of meters and other apparatus	201	18	3
Sundries	12	12	0
	£6,452	19	8

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—loans received, less repaid	37,745	0	0
Sundry creditors	518	14	5
Interest accrued due	270	0	0
Amount due to treasurer	1,020	13	7
Revenue account—balance	8	15	4
Net revenue account—balance	371	4	11
Surplus account, balance of sinking fund, and value of land unappropriated	4,675	12	1
	£44,610	0	4

Cr. Assets.	£	s.	d.
Capital account—amount expended and value of land appropriated	40,264	10	11
Stores on hand	657	11	8
Sundry debtors for current supplied	2,018	17	5
India 3 per cent. stock	1,669	0	4
	£44,610	0	4

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.			410,959
Quantity sold	Public lamps	81,259	299,179
	By contract	4,200	
	Private consumers by meter	213,720	
Quantity used on works			98,485
Total quantity accounted for			397,664
Quantity not accounted for			13,295
Number of public lamps			77
Total maximum supply demanded (watts)			318,709

Digitized by Google

LIGHT RAILWAYS.

The Commissioners have submitted to the Board of Trade an order for the construction of a light railway in the county of Warwick, in the urban district of Nuneaton and Chilvers Coton, and the rural district of Atherstone.

The order by the Commissioners authorising the construction by the Great North of Scotland Railway Company of the light railway between Fraserburgh and St. Combs has recently been issued as a parliamentary paper.

Sir Courtenay Boyle recently had before him for confirmation the light railways orders granted by the Commissioners for light railways from Colne to Trawden and from Colne to Nelson and Barrowford, when several verbal alterations were made in the clauses.

The Thornhill District Council have decided to lodge an objection with the Board of Trade to the Spen Valley Light Railways (Extensions) Order, so far as it refers to the future purchase of the undertaking in their district.

There are two rival light railway and electric lighting schemes at Carnarvon, and a committee has been empowered to interview any likely promoters of light railways in the neighbourhood.

The Blackburn Town Council have resolved that the Light Railway Commissioners be requested to confer on the Town Council, by means of the Blackburn, Whalley, and Burnley District Light Railways Order, 1900, authority to construct or contract for the construction of any railway or railways within the borough of Blackburn. The Clayton District Council have formulated a number of objections to this proposed light railway.

The Bridlington Rural District Council have given their consent to the proposed light railway between Driffield and Hornsea.

According to the report of the West Riding Law and Parliamentary Committee, the Wales and Laughton light railway is promoted by a private company, who seek powers to construct light railways from the parish of Wales to Laughton-en-le-Morthen. The gauge is 4ft. 8½in.

Subject to the clause referring to gauge being eliminated, the order for the extension of the line of light railways from Snowdon Station to Beddgelert will be confirmed by the Board of Trade.

At the last meeting of the Southgate Urban District Council the Chairman, in commenting upon the decision of the Light Railway Commissioners not to allow the light railway to proceed further than the Orange Tree, instead of allowing it to be carried through to Finchley, said the scheme was one of those specially meant by the Light Railway Act. It was carried from Edmonton to Southgate right through a district without railway accommodation, and if it had been carried on to Finchley it would have been one of the most useful light railways in the county of Middlesex.

The Board of Trade have recently confirmed the undermentioned light railway orders: Bexhill and St. Leonards Light Railway Order, 1900, authorising the construction of a light railway in the county of Sussex, from Bexhill to St. Leonards; Cheltenham and District Light Railway Order, 1900, authorising the construction of a light railway in the county of Gloucester, from Cheltenham to Cleeve Hill; Cheltenham and District Light Railway (Extension) Order, 1900, authorising the construction of a light railway at Cheltenham, in the county of Gloucester; and the Robertsbridge and Pevensey Light Railway Order, 1900, authorising the construction of a light railway in the county of East Sussex, from Robertsbridge to Pevensey.

An application for an order authorising the construction of the Deanhead light railway, which will traverse the parishes of Stainland-with-Old Lindley, Barkisland, Upper Greetland, Greetland, and Elland, has been referred to the Waterworks Committee of the Morley Town Council, with power to get the necessary clauses inserted in the order for the protection of the Corporation's water-mains.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

LIGHT RAILWAY COMMISSION.

List of Applications made to the Light Railway Commissioners in May, 1900, for Orders Authorising Light Railways.

Title.	Promoters.	Engineer.	Mileage.	Motive power.	Gauge.
					ft. in.
Barnsley and District (Extension) No. 2	British Electric Traction Company	S. Sellon	4¼	Electric	3 6
Bath and District	Bath Corporation, Sir J. Sivewright, and Leopold Hirsch	G. Hopkins and Son	13½	Electric	4 8½
Blackburn, Whalley, and Burnley	Auxiliary and Light Railways and Tramways Company	C. Chadwell	14¼	Electric	4 0
Cleobury Mortimer and Ditton Priors	Viscount Boyne and Admiral R. Woodward, C.B.	E. R. Calthorp	12¼	Steam	4 8½
Deanhead	J. Shaw, J. Normanton and Sons, and others	J. H. Rhodes	5¼	Steam	4 8½
Durham and District	British Electric Traction Company	S. Sellon	2¾	Electric	4 8½
Hayling Island	E. Belfield, T. Pollock, and J. P. Bedson	Knowles and Russell	3¼	Electric	4 8½
Hyde and Dukinfield	Hyde and Dukinfield Corporations	J. Mitchell and S. Hague	9¾	Electric	4 8½
Jarrow and South Shields	British Electric Traction Company	S. Sellon	3¼	Electric	4 8½
Kidderminster and Bewdley	Kidderminster and District Electric Lighting and Traction Company	S. Sellon	4½	Electric	3 6
Kingston, Surbiton, and District (Extension)	British Electric Traction Company	S. Sellon	7	Electric	4 8½
Mansfield and District (Extension)	J. Fell, J. Lewis, and W. J. Kershaw	C. H. Gadsby	4½	Electric	3 6
Mid-Anglian (Amending)	B. M. Kilby and C. T. Molyneux-Montgomerie	Jeyes and Godden	44½	Steam	4 8½
Nidd Valley	Power and Traction, Limited	H. Ough and Son	7¼	Steam	2 6
Norwich and Dereham	Hon. A. E. Fellowes, H. Jerningham, and C. Pearse	Jeyes and Godden	16	Steam	4 8½
Sheerness and District	British Electric Traction Company	S. Sellon	2½	Electric	3 6
Southwold (Extension to Kessingland)	Southwold Railway Company	A. C. Pain	9	Steam	4 8½
Staines and Egham	Staines and Egham Light Railway Company	V. B. D. Cooper	3½	Electric	3 6
Wales and Laughton	T. R. Gainsford, C. E. Jeffcock, and A. Wightman	C. E. Rhodes	5¼	Steam	4 8½
Warrington and Northwich (Extension)	A. Anderson and A. Brown	K. H. Scotter	9¼	Electric	4 8½
Warrington and Runcorn	International Electric Traction and Power Syndicate	Bennett and Ward Thomas, Knowles and Russell	8	Electric	4 8½
Pwllheli and Nevin	North Wales and District Light Railway and Electric Power Syndicate	Bennett and Ward-Thomas	6½	Electric	3 0
Rhyl and Prestatyn (Extension)	Rhyl and Prestatyn Light Railway Company	A. Dickinson and Co.	2	Electric	3 6
Swansea and District	Swansea Corporation	Kincaid, Waller, and Co.	8	Electric	4 8½

Digitized by Google

Questions.

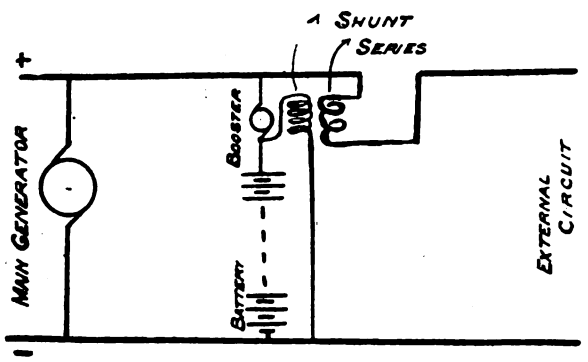
287. Give particulars and explain any arrangement for the abatement of smoke from station chimneys you may have had practical experience with, and state result.—F. R. S.

288. What current density per square inch is it usual to allow in best engineering practice in switch contacts of the following types: (1) laminated contacts constructed of hard-rolled sheet copper; (2) spring contacts in which the contact surfaces are machined, and the only material used is cast brass—*i.e.*, such as those used in the Bates fuse and Brush trigger switch; (3) flat cast-brass machined contacts, which can be held together under considerable pressure by a nut or setscrew. Give sketches.—E. L.

Answers.

Question No. 281.—I have a motor installation working at 100 volts. My engines and generators will only give me 200 e.h.p. The usual power absorbed by the motors is 150 h.p., but at times I shall require 250 h.p. Is it possible to arrange a set of accumulators so as to be charged at light loads, and yet automatically run in parallel with the generators at heavy load? If so, state the arrangements necessary.

Best Answer to No. 281 *(awarded* 10*s.).*—The requirements of the case are met exactly by the ordinary arrangement used in traction stations employing batteries. This arrangement consists in connecting the armature of a special differentially-wound booster in series with the battery across the mains, as shown in the following figure. The object of the booster is to supply the few extra volts necessary to charge the battery when the external circuit is taking less current than the main generators can give, and, on the other hand, when the external circuit requires more current than the normal load of the generators, the booster must give a few volts in the opposite direction and so helping the battery to discharge into the circuit. In order to attain this result quite automatically, the booster field magnets are excited by two distinct windings—a shunt winding connected right across the terminals of the battery, and a series winding carrying the main external current or some definite proportion of it, the rest being shunted past the winding. The two windings oppose one another, the series winding overpowering the shunt to a greater or less extent according to the current in the external circuit.

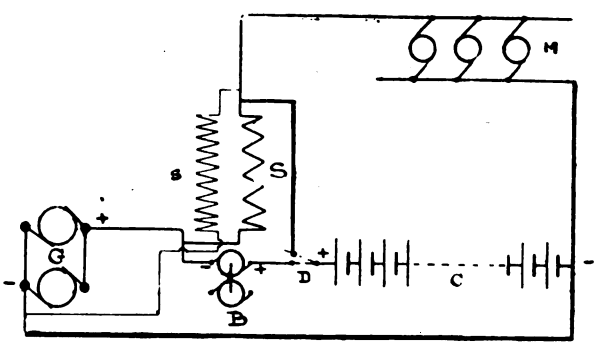


In the case under consideration the circuit voltage is 100, so that the battery should have about 50 cells giving 100 volts on open circuit when fairly fully charged. The voltage required to fully charge these cells will be about 135, and the discharge voltage with the full current of the battery passing will be, say, 85 to 90, allowing for the loss in resistance of battery and connections. The duty of the booster will therefore be: (1) To give 35 volts in a direction tending to charge the battery when the external current is 1,120 amperes—*i.e.*, 150 e.h.p. used in the external circuit. The booster or charging current at this point should be 370 amperes (50 e.h.p.), the two loads together serving to fully load the main generators to 200 e.h.p. (2) To give no volts when the current in the external circuit is 1,500 amperes (200 e.h.p.), the ampere turns given by the series winding on the booster at this current being made exactly equal and opposite to the ampere-turns of the shunt winding when connected across the battery giving 100 volts. (3) To give 10 to 15 volts (in the opposite direction) tending to discharge the battery, when the current in the external circuit reaches 1,870 amperes (250 e.h.p.), the discharge current being 370 amperes.

At intermediate values of the external current the booster voltage would also be intermediate to the above values, thus tending to keep the main generators always working at normal full load (200 e.h.p.), whilst the external load may be anything from from 150 e.h.p. to 250 e.h.p. The capacity of the cells will depend entirely on the relative lengths of time that the external load exceeds and is less than 200 e.h.p. A few trials under ordinary working conditions of load will indicate the correct number of cells to keep in circuit in order that the net result of an average day's work shall be to leave the battery charged to the same extent as at the end as at the beginning of the day. The booster may be driven in any convenient way so long as the speed is fairly steady, though it is usually run by a motor mounted on the same bed-plate.

A booster wound for the above work is naturally more expensive than an ordinary dynamo of the same output, because of the considerably greater amount of field wire necessitated by the differential winding. If the variations in load occur only occasionally during the day and at known times, good results can be obtained with an ordinary shunt-wound booster by means of hand regulation of its exciting current, but such an arrangement is in no way automatic.—Q.

Answer to No. 281 (*awarded* 5*s.*).—Under the conditions specified in the question, a set of accumulators may be arranged in parallel with the generators, so as to charge at light load and to discharge at heavy load. If the generators are shunt-wound and have a sufficiently drooping characteristic it would simply be necessary to connect the battery directly in parallel with the generators, care being, of course, taken that the battery is large enough for its work, and has a low internal resistance. Automatic charge and discharge will then take place according to the load on the generators. It is, however, not permissible to assume these conditions of generator, so that an arrangement, such as that shown in sketch, may be necessary to help the battery to charge and discharge at the proper times. B is a motor-driven compound-wound booster, with the field windings, S *s*, in opposition to each other. When

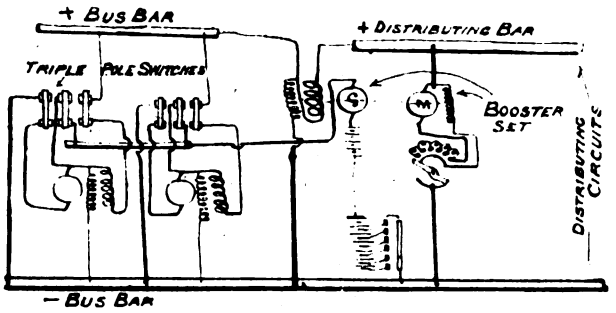


the current in the motor circuit is just equal to the output of the generators, the two windings neutralise one other, so that the booster does no work. Suppose that the motors, M, demand more than the output of generators, the series winding, S, will predominate, and cause the polarity of the booster to be such as to add pressure to the battery circuit, and so help it to discharge. When the current in the motor circuit falls below the output of the generators the shunt winding, *s*, will reverse the polarity of the booster, so that the pressure will be in the right direction for charging the cells. D is a change-over switch for cutting out the booster and paralleling the battery directly across the generator leads, if this should be desired.—P. S. T.

Answer to No. 281 (*awarded* 5*s.*).—Assuming that the generators mentioned in the question are compound wound, the accompanying diagram shows an arrangement which would accomplish the desired end. The generators are connected in the usual way with the equalising bar joined to the middle blade of a triple-pole switch. The apparatus necessary to enable the accumulators to automatically discharge on heavy loads and to be charged on light loads consists of a booster set, the motor part, M, of which is run directly off the mains, while the generator armature,

Digitized by Google

G, is placed in series with the battery. The battery and G are put across the negative and equalising bars. Between the positive generator 'bus bar and the positive distributing 'bus bar is placed the series winding of G, the shunt winding being connected as plainly shown. These two windings are so connected that they oppose one another, and their respective ampere-turns should be so proportioned that when the generators are working at about their normal load there is no field. Should the load now increase, the additional ampere-turns given to the series winding causes a few volts to be generated in the direction of discharge, thus causing the battery to take up all or nearly all the increase. When the load falls below normal, the shunt winding predominates, and voltage is generated in the opposite direction, thus assisting the generators to charge the battery. It will be understood that in the case of an overload, although the current in the series windings of the generators is increased (as arranged in the diagram), and consequently their pressures and output, the E.M.F. generated in the booster should be sufficient to ensure that the battery really does take most of the increase of load. The booster, G, and battery are placed across the equalising—not the positive—bar and the negative bar, for the same reason why compound-wound machines are not run in parallel without the use of an equalising bar, this arrangement being unstable. Should it be noticed during the daily working of the plant that the battery is not being sufficiently charged, the regulating switch can be operated to cut a cell or two out, so that at



normal load a small charging current will be passed; or, in other words, the point of equilibrium will be raised, thus increasing the duration of the periods of charge and decreasing those of discharge.—E. J. Evans.

Question No. 282.—What are the most important considerations to be observed when designing the ordinary condensing plant for a condensing engine in order that a good vacuum may be obtained in the low-pressure cylinder?

Best Answer to No. 282 (*awarded* 10*s.*).—The first consideration is whether the water available for condensing is suitable for after use in the boilers, for on this will depend the type of condenser used. If the condensing water is reasonably pure, a jet condenser may be used; if otherwise, a surface condenser must be employed. The former type is the more efficient, since the water and steam are thoroughly intermixed, and there are no power losses in driving pumps.

The three main points to be fixed in designing a jet condenser are: (*a*) weight of injection water required; (*b*) capacity (volume) of the condenser; (*c*) area of injector orifice.

(*a*) Taking the terminal pressure of the steam in the low-pressure cylinder at 10lb. absolute, each pound of steam contains about 1,140 B.T.U. above that contained by 1lb. of water at 32deg. F. The temperature of the mixture of condensed steam and water in the hot-well will be about 110deg. F. Take the temperature of the injection water at 50deg. F., then every pound of injection water gives up 110 − 50 = 60 B.T.U. But B.T.U. per pound of steam = 1,140 + 32 − 110 = 1,062 B.T.U. ∴ Weight of injection water per pound of steam $= \frac{1,062}{60} = 17{\cdot}7$lb. In practice, in order to ensure safety, about 25lb. to 30lb. water are allowed per pound of steam condensed.

(*b*) The volume of the condenser depends on the volume of the low-pressure cylinder, but different makers have different ratios. An average rule is to make the volume of the condenser half that of the low-pressure cylinder.

(*c*) The size of the jet can be found from the formula $A = \frac{W}{26\,v}$, where A = area of valve in square inches, W = pounds weight of injection water per minute, v = velocity of jet in feet per second (take this at 20ft. per second). In a surface condenser the chief points to be considered are (*a*) area of cooling surface, (*b*) amount of circulating water, (*c*) capacity of circulating pump.

(*d*) *Capacity of Air-Pump.*—(*a*) Let S = area of surface in square feet, W = weight of steam condensed per hour in pounds. Then the area of cooling surface can be got from the empirical formula, $S = \frac{17\,W}{180}$. (*b*) The temperature of the condensed water will probably not be the same as that of the condensing water. The difference may be taken at 35deg. to 40deg. F. Let H = number of heat units in 1lb. of steam above that contained by 1lb. of water at 32deg., T = temperature of condensed steam, t = temperature of circulating water on entering condenser, t_1 = temperature of circulating water on leaving condenser, W = weight of circulating water in pounds required for each pound of steam condensed; then $W = \frac{H + 32 - T}{t_1 - t}$. (*c*) The circulating pump may either be a piston or plunger pump, or a centrifugal pump. In the latter case a small special engine will be required. In the former case the pump can be worked from the main engine if desired. In the latter case the circulating pump must be of such size that the discharge capacity per minute is from $\frac{1}{40}$th to $\frac{1}{60}$th of the volume swept through by the low-pressure piston per minute. In the former case, if D = diameter of circulating pump in inches, L = length of stroke in inches, n = number of strokes per minute, w = total weight (pounds) of circulating water required per minute, then

$$D = 5{\cdot}86\sqrt{\frac{w}{n\,L}}.$$

(*d*) Either a vertical single-acting bucket pump or a horizontal double-acting piston pump is commonly used as an air-pump, the former type being preferable. Assuming that the pistons of the air-pump make the same number of strokes per minute as the piston of the engine, the capacity of the vertical single-acting pump will be: for jet condensing, $\frac{1}{5}$ to $\frac{1}{10}$ low-pressure cylinder capacity; for surface condensing, $\frac{1}{10}$ to $\frac{1}{15}$ low-pressure cylinder capacity. The capacity of the horizontal type will be: for jet condensing, $\frac{1}{8}$ to $\frac{1}{10}$ low-pressure cylinder capacity; for surface condensing, $\frac{1}{15}$ to $\frac{1}{25}$ low-pressure cylinder capacity. The difference between the capacities (*a*) jet condensing and (*b*) surface condensing is due to the fact that in the latter case the pump has to remove the condensed steam and any air that has entered with the steam, while in the former case the condensing water has to be dealt with in addition.

In the surface condenser, the cooling water may be passed either inside or outside the tubes (which should be of solid-drawn brass 16 to 19 B.W.G. thick and about $\frac{3}{4}$in. outside diameter). The former method is the more usual. The tube plates to be of rolled brass, the tubes pitched about $1\frac{1}{2}$in. apart, and secured by means of a gland or soft wood ferrule. The above data and formulæ are given on the authority of Messrs. Low and Bevis, in their "Manual of Machine Drawing and Design."—J. A. S.

Answer to No. 282 (*awarded* 5*s.*).—This question clearly refers to condensers of the ordinary jet or surface type, and it will therefore be advisable to state at the outset that the remarks below refer only to these types. There are so many points of detail, small in themselves, but any of which if badly designed will considerably impair the efficiency of the condenser, that it is somewhat difficult to point to those of most importance. In the writer's opinion the dimensions of the air-pump and the velocity of the bucket have probably the greatest influence upon the efficiency of the plant, and are the factors of first importance. The volume swept out by the bucket should not be less than one-tenth of the volume of the low-pressure cylinder for a jet condenser, and, of course, will be very much less for a surface condenser; also it is not desirable to have a higher bucket velocity than 250ft. per minute. Experience has amply demonstrated that a large diameter

Digitized by Google

and short stroke give a better result than a small diameter and a long stroke for a fixed air-pump volume. This is well illustrated by comparing the vertical type of pump, which undoubtedly produces a better vacuum than the horizontal type. The former, it will be noted, usually has a stroke of about one-third to one-half of the engine stroke, whilst the latter is more usually of the same stroke as the engine, since it is a common practice to work these air-pumps off the tail rod. Further, other conditions being similar, a single-acting pump is more efficient than a double-acting one. It may, therefore, be generally laid down that a short-stroke single-acting pump is the most efficient, and this should be borne in mind when designing, and, where practicable, adopted.

Another matter having an important bearing on the vacuum is the form of the condenser, which should be such that there are no spaces where air may be trapped or lodged, for if so this will greatly vitiate the vacuum. In the case of a surface condenser, the general form should be such that the circulating water will have to travel continuously through the tubes. In the jet condenser, a good mixture of the injection water and the steam to be condensed should be effected. In the surface type, the entering cold circulating water should meet the condensed steam leaving the condenser. The volume of the condenser may vary between fairly wide limits without seriously prejudicing the vacuum, but the usual proportion is from one-third to three-quarters the volume of the condensing cylinder. The injection or circulating pipes should be large enough to admit 30lb. of injection or circulating water per pound of steam used by the engine. The diameter of the injection pipes is governed by the velocity of the injection water, which in turn depends on the height and distance the water is drawn, so that if the supply is some distance from and below the condenser, large pipes are required. The practice of calculating the diameter of the injection pipes by making them some fractional diameter of the condensing cylinder is too empirical, and is to be discouraged. In all cases the head due to the height and vacuum should first be obtained, and then the loss due to friction of the pipes calculated, and this deducted from the above head to arrive at the effective head driving the water into the condenser. When there is a long length of injection pipes, a non-return or check valve is often fitted at the end of the pipes. This valve prevents the pipes entirely emptying themselves when the engine is stopped, and therefore when starting the engine the pump has not to draw so far, consequently the condenser gets its water more quickly and the maximum vacuum in the condenser is earlier obtained.

The area through the bucket, delivery, and foot valves is a detail that requires attention, and these areas should be sufficient. The exhaust pipes from the cylinder to the condenser should be large enough and as short as practicable to limit the drop between the condenser and the engine. In this connection it is desirable to note that a short exhaust pipe is attained in a tandem engine by putting the low-pressure cylinder at the back when an air-pump working off the tail rod is adopted, and at the front when the pump is worked from the cross-head, and therefore probably a vertical one.

Careful attention to the following details will also add much to the efficiency. The air-pump, parallel motion, slides, bearings, etc., should be of good proportions, so that they will not readily get out of alignment, otherwise there will be undue wear of the barrel or bucket with consequent loss of efficiency. The air-pump bucket is best made plain with water grooves, and not fitted with rings or springs, for this simple arrangement has been found by experience to give good results, and the liability to breakdown is very much reduced.—E. Y. T.

Answer to No. 282 (*awarded* 5*s.*).—As far as the condensing plant is concerned, a good vacuum in the low-pressure cylinder of the engine depends primarily upon three conditions: (1) length and condition of exhaust pipe connecting cylinder to condenser; (2) complete and speedy condensation of exhaust steam; (3) efficiency of the air pump.

(1) Under this heading little need be said except that, other things being equal, a condenser close to the cylinder and connected to it by a pipe, having as few joints as possible, will give better results than one placed some distance away.

(2) This is a matter of water supply, and in the case of a surface condenser a question of the number, arrangement, and tightness of the tube.

(3) With conditions (1) and (2) perfectly fulfilled, good results cannot be obtained without an efficient air-pump.

In order to make clear what to avoid in designing an air-pump, it may be instructive to compare two types of pump that have come under the writer's notice (see Fig. 1). This pump under most favourable conditions never maintained 23in. of vacuum. It will be seen that the water which has run in from the condenser traps the air back, much as sewer gas is kept in a drain. Air from the condenser has to find its way as best it can through the water and valves. In order to ensure quick closing on the part of the valves, the lift is small, consequently the inlets are much obstructed. The air, instead of passing freely through, tends to become intimately mixed with the water. The clearance above and below the bucket is considerable. If the pump were dealing with "solid" water this would be of no great moment, but with water containing a good deal of air the case is very different. Let us follow the bucket through a cycle of operations, beginning with the bucket in position shown. The "aerated" water over the foot valves has been compressed until the bucket valves have opened and

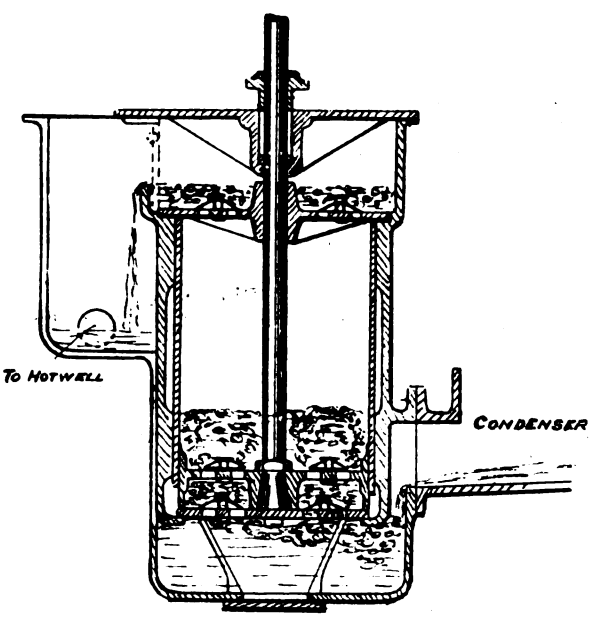


Fig. 1.

allowed all but the water in the clearance spaces to pass through. The bucket begins to move upward, and the air in the clearance spaces expands, filling up the space in the barrel below the bucket, which ought to be available for a fresh supply, and causing a certain amount of back pressure against the foot valves, which do not open until pressure in condenser is sufficient to overcome this back pressure. A similar state of affairs obtains between the bucket and the head valves. The air in the clearance water is compressed to something greater than atmospheric pressure to enable the pump to discharge into hot-well. This air re-expands during the down stroke, uselessly filling up the barrel, and causing a certain amount of back pressure against the bucket valves, which indirectly makes greater compression between bucket and foot valves necessary. More air is thus imprisoned to re-expand on the up-stroke, causing slightly greater back pressure against the foot valves. This increased back pressure delays the discharge from the condenser, as the supply of exhaust steam is constant, the pressure in the condenser naturally rises.

Fig. 2 shows another form of air-pump, from which some of the foregoing objections are absent. The condensed water and air have a free passage into the pump barrel through the ports shown midway along the cylinder. No bucket valves are needed, as the piston acts as a valve in blanking the ports when passing over them. The

Digitized by Google

clearance spaces between the piston and valve plates are as small as practicable. The amount of air a pump will throw depends upon the pressure at which air can flow into the barrel. It is, therefore, important that to maintain a good vacuum there should be no obstructions which can act as reducing valves between the low-pressure cylinder, the condenser, and the pump barrel. The object aimed at in an air-pump is to keep the pressure in the pump barrel as nearly as possible equal to that due simply to the temperature of the exhaust. This end is defeated by allowing large clearance spaces, as the compressed air so stored

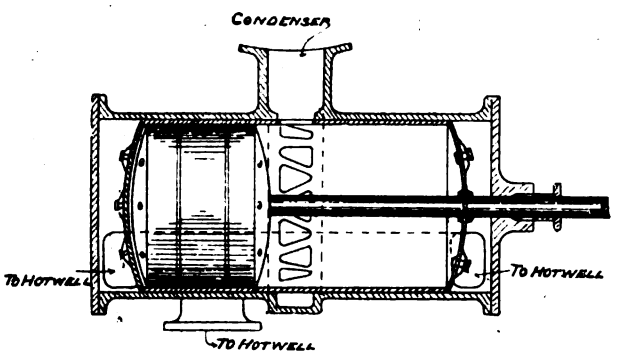


FIG. 2.

takes up space in the barrel, and, as already mentioned, creates a certain amount of back pressure which must be added to that against which the low-pressure cylinder has to exhaust. On similar grounds, it is also important that the pump should not have to discharge against any head of water caused by placing the hot-well on a higher level than the discharge valves.—P. S. T.

LEGAL INTELLIGENCE.

HYDE CORPORATION v. THE OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY COMPANY.

In the Court of Appeal, on Thursday last week, the hearing of the case of the Mayor and Corporation of Hyde *v.* the Oldham, Ashton, and Hyde Electric Tramway Company, Limited, and others, was concluded. It was an appeal against the decision of Mr. Justice Grantham, given some 12 months ago, granting the plaintiffs an injunction, restraining the defendants from laying wires called feeders under the footways in Hyde, for the purpose of working tramways which the defendants had constructed. Mr. Justice Grantham also awarded the plaintiffs £100 damages. Mr. Cripps, Q.C., instructed by Mr. Sydney Morse, London, represented the appellants, and Mr. McMorran, Q.C., and Mr. Sutton, instructed by Messrs. T. and A. Brownson, solicitors, Hyde, represented the respondents, the Hyde Corporation. After a somewhat lengthy hearing, the appeal was dismissed, with costs, subject to a variation of the injunction made by Mr. Justice Grantham.

COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL POWER STORAGE.

Directors: John Irving Courtenay, Esq. (chairman and managing director); Sir Daniel Cooper, Bart., G.C.M.G.; Frederick Green, Esq.; Sir James Pender, Bart., M.P. Chief engineer: H. W. Butler. Secretary: David Smith.

The directors, in their report for the year ended May 31, 1900, state that the profit for the year is £5,309. 4s. 3d., and the balance brought forward from last year £554. 12s. 11d., together amounting to £5,863. 17s. 2d. Of this, £243. 1s. 1d. has been carried to reserve fund and £1,000 to contingent fund, and the directors recommend the payment of a dividend of 5 per cent. on the ordinary share capital, which will absorb a further £4,362. 8s. 5d., leaving £258. 7s. 8d. to be carried forward. The Company's buildings, plant, tools, etc., have been maintained in thorough repair and condition at a cost of £2,394. 10s. 2d., which sum has been provided out of revenue. The directors are glad to state that the demand for the E P.S. batteries increases year by year, and the recent extension of the works is being fully utilised. The orders on hand are larger in amount than at any previous time, and include several for tramway and power stations, the special type manufactured by the Company for this purpose having met with the entire approval of engineers. The development of the business has necessitated the introduction of further working capital, and a call of £1 per share has been made during the year on 3,132 ordinary shares on which only £3 per share had been previously paid. The directors regret to announce the death of Mr. Frank King, lately a director, and for many years manager of the Company. Mr. King had been in failing health for some considerable time, and his death in August last removed one of the pioneers of the storage battery industry. The retiring director is Mr. Frederick Green, who offers himself for re-election. The auditors, Messrs. James Meston and Co., chartered accountants, also offer themselves for re-election.

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Share capital authorised—20,100 shares of £5 each	100,500	0	0
Shares issued—			
66 founders' shares of £5 each, fully paid	330	0	0
15,460 ordinary shares of £5 each, fully paid	77,300	0	0
3,132 ditto of £5 each, £4 called	12,528	0	0
18,658	90,158	0	0
Deduct calls in arrear	50	0	0
	90,108	0	0
Debentures issued—284 debentures of £100 each...	28,400	0	0
Sundry creditors	13,873	8	1
Reserve fund—amount at credit as per last balance-sheet, £9,756. 18s. 11d.; added this year, £243. 1s. 1d.....	10,000	0	0
Contingent fund—amount at credit as per last balance-sheet, £2,000; added this year, £1,000	3,000	0	0
Profit and loss account—balance at credit May 31, 1899, after paying dividend at 5 per cent., £554. 12s. 11d.; add profit for year, £5,309. 4s. 3d.; less amount carried to reserve fund, £243. 1s. 1d.; and amount carried to contingent fund, £1,000	4,620	16	1
	£150,002	4	2

Cr. Assets.	£	s.	d.
Patents, goodwill, etc.....	87,685	0	0
Building, plant, tools, fixtures, etc., £10,473. 13s. 8d.; less depreciation written off, £748. 2s. 9d.	9,725	9	11
Stock on hand at cost or under.....	22,882	19	2
Sundry debtors (less reserve for discounts and doubtful debts)	18,250	1	2
Bills receivable	408	14	1
Debentures and shares in other undertakings	740	15	0
Cash at bankers and in hand	10,309	4	10
	£150,002	4	2

EDMUNDSON'S ELECTRICITY.

The third ordinary general meeting of this Corporation was held on Friday last at the offices, Broad Sanctuary-chambers, Westminster, S.W., Mr. John R. Wigham, J.P., presiding.

The **Chairman** said the report was satisfactory. The profit for the year ended March 31 last amounted to £17,260, showing an increase of £6,000. During the period under review the capital had been increased by the issue of 9,400 ordinary shares, making the total capital £200,000, the full amount authorised. There had also been a further small issue of debentures, raising their total amount to £75,000. Among the assets was the large item of £121,000, under the heading of "sundry debtors and advances to subsidiary companies." The advances to subsidiary companies, which formed a large proportion of this item, represented money spent in connection with their various companies, in exchange for which they were entitled to get shares or debentures. Since the date of the balance-sheet this item had been considerably reduced by the transfer to the Company of many of these shares and debentures. The investments, standing at £111,000, had been taken at actual cost price, their par value being much larger. The Board recommended a dividend of 6 per cent. on the ordinary shares and the same rate on the deferred shares. They proposed to write £5,000 off the goodwill and to carry forward £4,152. The progress of the Company's stations during the past year had been greater in nearly every case than had been expected. The rapid increase in the use of the electric energy for all purposes had necessitated large extensions, and most of their work during the past 12 months had been devoted to such extensions. The Board had, however, secured powers for several other important towns which were then being confirmed in Parliament. Amongst these were Grantham, Stamford, Twickenham, Bishop Auckland, Weybridge, and Redruth. In addition, the directors had practically secured a concession for an electric tramway between Redruth and Camborne, which it was proposed to work in connection with the Company's Redruth central electric station. A considerable number of private installations for country houses, etc., had been carried out during the year, and others were in course of construction. As in last year, additional capital was required to meet the Company's extending business, and the directors proposed that the capital should be increased from £200,000 to £400,000, and they intended to at once issue £100,000 as 6 per cent. preference capital, reserving the remainder for issue when required. The Board thought it was in the interest of ordinary shareholders that preference shares should be issued instead of increasing the ordinary share capital. He then moved the adoption of the report and the payment of the dividends therein recommended.

Mr. W. R. Davies seconded the motion, and, after a short discussion, it was unanimously agreed to.

The **Chairman** next proposed: "That the directors be and they are hereby authorised to issue the remaining 20,000 new

Digitized by Google

shares, or such part thereof as they shall think fit, either as preference shares, ranking in all respects *pari passu* with the 6 per cent. preference shares above mentioned, or as ordinary shares of the Corporation."

Mr. Davies seconded the resolution, which was agreed to *nem. con.*

The resolutions for the increase of the capital were afterwards submitted to separate meetings of the ordinary and deferred shareholders, and adopted.

CITY OF LONDON ELECTRIC LIGHTING.

An extraordinary general meeting of this Company was held at Winchester House, E.C., on Wednesday last, when a resolution authorising the directors to borrow any sums not exceeding in the whole £400,000 in excess of the amount of the debenture stock of the Company outstanding, and the premium payable thereon on redemption, was confirmed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bermondsey.—The Vestry invite tenders for the erection of a generating station in Neckinger, Spa-road. Tenders by 26th inst.

Croydon.—The Council invite tenders for the erection of car sheds at the Thornton Heath and Brighton-road depôts. Tenders by July 18.

Sheffield.—The Corporation invite tenders for 12 months' supply of transformers. Tenders by 21st inst. Details in our advertisement columns.

Beckenham.—The Urban District Council invite tenders for Section G, free wiring contract. Tenders by July 16. Details in our advertisement columns.

Paris.—Tenders are invited for 11 lots of telegraph apparatus. Tenders, addressed to Post and Telegraph Department, 103, Rue Grenelle, Paris, by 24th inst.

Manchester.—The Tramways Committee invite tenders for the electrical equipment of 150 cars. Tenders by 21st inst. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for the manufacture and delivery of 10 30 kw. transformers. Tenders by 24th inst. Details in our advertisement columns.

Darlington.—The Corporation invite tenders for the supply and delivery of arc lamp posts and brackets. Tenders by 28th inst. Details in our advertisement columns.

Southend-on-Sea.—Tenders are invited for the supply and delivery of about 1,180 tons of steel girder rails and about 46 tons of steel fishplates. Tenders by July 25.

Birkenhead.—The Corporation invite tenders for constructing and erecting a new car shed in connection with the electric tramways in Laird-street, Birkenhead. Tenders by July 24.

Rugby.—The Urban District Council invite tenders for taking a lease of their powers under the Rugby Electric Light Order, 1898. Tenders by Aug. 1. Details in our advertisement columns.

Algemesi (Valencia, Spain).—The Municipal Authorities will receive tenders for the installation and working of the electric lighting by July 21. Specifications may be inspected at this office.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of lighting cables, tramway feeders, and street lighting. Tenders by Aug. 13. Details in our advertisement columns.

Rome.—Tenders are invited by the Marine Department for electric lamps for the lighting of ships and arsenals. Particulars are to be obtained from and tenders addressed to the above Authority by 17th inst.

Kingston-upon-Hull.—The Corporation invite tenders for the electric lighting installation and fittings for the Springhead pumping station, near Hull. Tenders by 23rd inst. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply and fixing of coal-conveying plant at the electric supply station, Dunning-street, Sunderland. Tenders by 27th inst. Details in our advertisement columns.

Algemesi (Spain).—Tenders are invited for an installation of public and private electric lighting. Specifications are to be obtained from and tenders addressed to the Municipal Authorities of the above place before July 21.

Wimbledon.—The Urban District Council invite tenders for supplying and fixing telephones intercommunicating between the various buildings forming the isolation hospital. Tenders by 18th inst. Details in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for the supply and erection of five high-tension continuous-current rotary transformers, with switch gear and accessories. Tenders by 26th inst. Details in our advertisement columns.

Aston Manor.—The Urban District Council invite tenders for steam dynamo, motors, switchboard, pipework, storage battery, pumps, arc lamps and posts, travelling crane, and wiring. Tenders by 24th inst. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the overhead equipment for the tramways in the borough, exclusive of the steel poles, but inclusive of their erection. Tenders by July 16. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for the supply and erection of boilers and auxiliaries, steam generators and switchboard and cranes, feeders and distributors, line equipments, trucks and car equipments. Tenders by July 25. Details in our advertisement columns.

Islington.—The Electric Lighting Committee invite tenders for relaying York and other stone and providing new York and other stone where necessary over the conduits and mains, as required, during the three years next. Tenders by 25th inst. Full details in our advertisement columns.

Hapton.—Tenders are invited for the lighting of Hapton township with electricity from Sept. 1, 1900, to April 30, 1901. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, 16, Hammond-terrace, Padiham, by 31st inst. Full particulars on application.

Liverpool.—The Select Vestry invite tenders for an installation of about 100 lights in connection with the Parish Offices, Brownlow-hill. Specification may be seen at the office of Mr. H. J. Hagger, vestry clerk, Parish Offices, with whom tenders (sealed and endorsed) must be left not later than 19th inst.

Blackpool.—The Corporation invite tenders for the following works in connection with tramways extension: (Section A) trolley poles; (B) cables and trolley wires; (C) boosters and switchboards; (D) storage battery. Tenders will be received for any one or more sections, but not for part of a section. Tenders by July 23.

Madrid.—The Spanish Government invite tenders, not later than Aug. 18, for the concession of a system of electric tramway lines in Barcelona. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Russia.—Tenders are invited by the Russian Government not later than the 28th prox. for the telephone service of Warsaw, St. Petersburg, Moscow, Odessa, and Riga. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Grays.—The Urban District Council invite tenders for the supply, delivery, and erection of the following work in connection with the electric lighting of the district: (Section A) two Lancashire boilers and pipework; (B) two 100 kw. steam dynamos, with boosters and balancer; (C) fuel economiser; (D) switchboard; (E) battery; (F) travelling crane; (G) mains and street lamp fittings. Tenders by Aug. 9.

RESULTS OF TENDERS.

St. Pancras.—The Guardians have accepted the tender of A. Sweet, at £13. 5s., for electrical firebells at St. Anne's Home.

Luton.—The Council have accepted the tender of Messrs. T. and E. Neville for the erection of electricity works, at £4,881.

Cheltenham.—The Town Council have accepted the tender of Messrs. Collins and Godfrey, at £1,873, for building extensions at the electric light works.

St. Pancras.—The Vestry have accepted the tender of the Western Electric Company, at £2,618, for laying additional mains in Tottenham Court-road and Euston-road.

Bermondsey.—The Vestry have accepted the tender of Messrs. W. T. Glover and Co. for the supply and laying of mains, conduits, junction boxes, etc., at £8,134. 7s. 9d.

Grimsby.—The following tenders have been accepted: Messrs. Chamberlain and Hookham, of Birmingham, for electrical meters, and Messrs. Mackenzie Bros., Edinburgh, for 60 arc lamps.

Newington.—The tender of the British Insulated Wire Company, at £9,026, has been accepted for the supply and laying of insulated electric mains, etc., in certain agreed side streets.

Stoke-upon-Trent.—The Guardians have accepted the tender of Messrs. R. Dawson and Co., Limited, Stalybridge, at £470, for the electric wiring of the new cottage homes at Penkhull, including overhead cables.

Longton.—The Town Council have accepted the following tenders: T. S. Bromage, chimney shaft and boiler-house for new electric light works; R. Goodwin, Longton, new workshops and stores for electric light works.

Leeds.—The Tramways Committe have accepted the following tenders for raising and extending the Hunslet car-sheds: I. Gould and Co., Limited, at £3,929. 14s., for all trades except ironwork; Clayton, Son, and Co., at £1,130. 16s. 6d. (subject to approval of Council), for ironwork.

London County Council.—The following tenders have been received for the lighting of the Farmfield Reformatory: Oil-engine—Bilbie, Hobson, and Co. (Hornsby-Akroyd engine), £257 (accepted); Priestman Bros., £312. 5s.; Crossley Bros., £324. Wiring, etc.—Tamplin and Macovskie, wood casing £309. 14s. 6d. (accepted), steel tubing £360; Strode and Co., £349 and £373; Concentric and General Contract Company, £360 and £440; F. A. Glover and Co., £407 and £450; Wood, £484 and £530; E. P. Rickson, £678 and 700. Dynamo—Parker and Co., 700 revolutions per minute £165 unfixed, 900 revolutions £143 unfixed; Electrical Construction Company, 620 revolutions, £139 fixed (accepted); Silvertown Company, 600 revolutions, £130 unfixed, £136 fixed; Siemens Bros., 720 revolutions, £182. Battery—Chloride Company, 25 amperes £159, 70 amperes short £183, 60 amperes long £327; Electrical Power Storage Company, £144, £158 (accepted), and £278. Cables—British Insulated Wire Company, £174 per mile (accepted).

Digitized by Google

BUSINESS NOTES.

TRACTION.

Camborne and Redruth Tramway Bill.—The preamble of this Bill has been proved.

Eccles.—The Council have decided to advertise for a consulting electrical engineer, to advise generally on the electrical equipment of the tramways.

Nelson.—The Council have decided to give notice to the Burnley and District Tramways Company for the purchase of so much of the tramways as are in the borough.

Swansea.—It is reported that the first week's running of the electric tramcars has been a great success. No less than 95,000 passengers have been carried, and this without a single mishap.

Hull.—During the past 12 months the electric trams have carried 9,902,104 passengers, the total receipts for the year being £42,258. 15s. 4d. The net profit on the trams for nine months ending March 31 last was £9,990. 14s. 4d.

Wolverhampton.—The Tramway Committee are asking for permission to purchase several plots of land on the Newhampton-road in order to widen it for tramway purposes, and to employ an assistant borough surveyor to devote his time to tramway work.

Kirkcaldy.—Considerable purchases of property will be necessary in connection with the Kirkcaldy tramway scheme. The tramway will commence from the west end of Linktown and terminate at Gallatown. Prof. Kennedy has the building of the cars already under consideration.

Newport.—The Council have authorised the Tramways Committee to accept tenders for rails and fishplates, and agreed to a strengthening of the committee by the addition of Alderman Moses, Mr. G. H. Llewellyn, and another member of the Electricity Committee to assist in the decision as to the system of electric traction for the Corporation-road route.

Dewsbury.—The General Purposes Committee's last report states that they had supported the British Electric Traction Company in their endeavour to preserve the free use of the intended tramway from Cleckheaton through Dewsbury to Ravensthorpe; also that they were seeking an interview with Messrs. E. Fox and Sons respecting their proposal for the opening out of Watergate, on the bank of the Calder, as a wide public road.

Rawmarsh.—A requisition on behalf of the Sheffield and South Yorkshire Navigation Company for leave to withdraw their opposition to the Urban District Council's Tramways Bill has been deposited in the Private Bill Office of the House of Commons. The Bill is now unopposed, and has been referred to the consideration of the committee on unopposed measures in the Commons. It has already been passed by the House of Lords.

Newcastle.—At the last meeting of the Town Council a letter was read from the secretary to the Potteries Electric Traction Company, Limited, who wrote in reply to a communication from the Council asking that the tramway system might be continued from Newcastle to Trent Vale, on the Trentham-road, that the matter had been receiving the consideration of his Board for some time and was down again for discussion at the next Board meeting.

Stockton Heath.—The Council have passed the following resolution: "That it is desirable that a representation be made to the Warrington Corporation with the view of getting their tramway system, subject to satisfactory terms and conditions, extended to Stockton Heath, and that a committee of the Council, together with any representative ratepayer or ratepayers, be appointed to wait upon the town clerk of Warrington and confer with him on the subject."

Wakefield.—At the recent enquiry held by the Light Railway Commissioners it was pointed out that a serious obstacle to the carrying out of the proposed tramways scheme for Wakefield was the narrowness of the old bridge (belonging to the county) which spans the Calder at the bottom of Kirkgate. The Commissioners suggested that a new footbridge should be erected alongside it for the use of the public, and that the County Council, the Corporation, and the promoters of the scheme should divide the cost.

Liverpool.—The recommendation of the Tramways Committee, "That a society, to be called the Liverpool Corporation Tramways Benefit Society, be established in accordance with rules now submitted, and that an addition be made to the wages of every employé in the tramways service who joins the society equivalent to 33⅓ per cent. of the amount of such employé's subscription to the society, and that such addition be paid to the treasurer of the society during the pleasure of the Council," will again come before the City Council next week.

Salford.—The General Purposes Committee on Wednesday confirmed the recommendation of the Tramways Sub-Committee to discontinue negotiations with the Manchester Carriage and Tramways Company for the working of the trams in Salford, Swinton, Pendlebury, and Eccles after April 27 next, and also that the Corporation work the tramways after that date by horse traction until such time as the arrangements are completed for the electrical working was considered. They further agreed to advertise for tenders for the equipment to carry on the present system.

Ayr.—An arrangement has been approved of whereby the electric power for the tramways is to be given from the present generating station in Mill-street at the cost of production—that is, at the rate of about 1d. per unit, the price at which it is expected the current may be produced a year hence. Mr. A. J. Fuller, the electrical engineer, has submitted the following comparative statement, showing a steady reduction in the cost of producing the current: 1897—output, 120,000 units, cost 3·61d.; 1898—161,000 units, cost 2·8d.; 1899—297,000 units, cost 2·03d.; 1900—433,000 units, cost 1·7d.

Moss Side.—The District Council have asked the Manchester Carriage and Tramway Company to discontinue the jumping of the cars at the junction of Raby-street and Princess-road, and remonstrated on the collection of cars and the behaviour of carmen at the end of Princess-road. It has been ordered that Askham's spring points be fixed at the corner of Moss-lane East and Raby-street, and that a new cast-iron point be fixed on the tramway in Moss-lane West, and that any repairs deemed urgently necessary to the lines in Moss-lane West, Alexander-road, and Yarburgh-street be forthwith executed.

Derby.—The receipts of the Corporation tramways during the four weeks ended June 23, 1800, amounted to £1,409. 3s. 10d., being an increase of £151. 16s. 2d. as compared with the corresponding period last year. The Tramways Committee have had under their consideration the joint reports of the borough surveyor and electrical engineer relative to the proposed tramway extensions. The committee are of opinion that the tramway system should be extended, and that electric traction should be adopted. The Council have authorised the committee to prepare a scheme of electric tramways, and submit the same to the Council for approval.

Bradford.—The minutes of the Tramways Committee show that the engineer having reported on the estimated cost of extending the electricity cables from the top of Whetley-hill along Toller-lane and Duckworth-lane to Ladye Royde Hall and Daisy Bank and neighbourhood, and as to the probable annual revenue to be derived from customers on such extension, the committee had resolved that the engineer be authorised to lay down such extension, and also to extend the electricity cables from Duckworth-lane along Pearson-lane to its junction with Allerton-lane, thence along Allerton-lane to Four Lane Ends, and thence along Thornton-road to the junction of such road with Whetley-lane, to couple up with the existing cable at that point.

Reading.—The Town Council have passed the following resolutions: (1) "That as soon as possible after the Reading Corporation (Tramways) Act, 1900, shall have received the Royal assent the town clerk do obtain prints thereof and forward a copy to each member of the Council; and that the Tramways Committee do thereupon consider and report to the Council as to the steps to be taken for carrying into execution the powers which will be conferred upon the Corporation by the Act." (2) "That if the Court of First Instance should give a decision adverse to the Corporation in the pending action by the Reading Tramways Company, Limited, all requisite steps be taken on behalf of the Corporation for entering and prosecuting an appeal against such decision."

Darlington.—At a meeting of the Darlington Town Council on Tuesday it was resolved that the Light Railway Commissioners be informed that if the company are not prepared to carry out the whole scheme of light railways in its entirety, as proposed by the company and supported by the Corporation at the public enquiry before the Light Railway Commissioners held in August last, with the modifications thereto which have been subsequently agreed to by the Corporation, and which are referred to in the report, the Council will consider the expediency of making an application for a new order at an early date. It was also agreed that the tramway company should forfeit a sum of £5 to the Corporation for every day after the expiration of the period for completing the tramways until such lines be completed, if the company carry out the work.

Dundee.—On Tuesday considerable commotion was occasioned, says the *Glasgow Herald*, by the report that it had been found impossible to bring north the new electric cars which have been manufactured in England for Dundee. The cars were railed several days ago, but after completing part of the journey the train which they were being conveyed in was stopped, it having been learned in the interval that the cars, while able to pass under the English railway bridges on account of their span being sufficiently high, would be likely to collide with the bridges on the North British Railway system, over which it had been arranged they should pass. It is stated that the bodies of the cars may have to be taken off the bogies and rebuilt on their arrival at Dundee. Meanwhile it is understood they are standing at one of the junctions on the Midland Railway.

Birmingham.—The report of the Judicial Sub-Committee, adopted on Tuesday, stated that the three months' trial which was agreed to be given to the new loop line in the Old-square expired on Monday, July 2. In his report the chief constable stated that special attention had been given to the Old-square during this period, and it had been found that two cars could be loaded at the same time without causing obstruction, thus preventing a great deal of congestion of tramcars and passengers which constantly occurred under the old condition. The cars kept much better time, and altogether the new arrangement had proved highly satisfactory. The sub-committee recommended that the Public Works Committee be now asked to take up the old metals and repave the Old-square in accordance with the arrangements made with the Aston Tramway Company.

Isle of Man Tramways.—The petition of a creditor of the Isle of Man tramways to have a liquidator appointed and the company wound up compulsorily was to have come by adjournment before Sir James Gell on Tuesday. The directors had, since the appointment of an interim receiver a month ago, approached many of the largest creditors, with, they thought, satisfactory results. About £150,000 was required to meet the most pressing claims, and they had reason to hope that if the shareholders could be induced to

Digitized by Google

subscribe £50,000 more the balance could have been found, and the company saved from compulsory liquidation. The *Financial Times* states that on the 11th inst. the petition for the compulsory winding up of the Isle of Man Tramways and Electric Power Company, Limited, came on for hearing in the Manx Chancery Court. The order was not further objected to by the new directors, who had been unable to make arrangements to place the company on a satisfactory financial position. Mr. W. H. Walker was appointed liquidator. The directors suggested that Mr. Edward Martin should be appointed with him, but it was pointed out that Mr. Walker would later on be acting as receiver for the debenture holders on a separate undertaking, and Mr. Martin's name was withdrawn.

Glasgow.—The tramway accounts were approved by the Corporation last week. The Chairman, in presenting the same, said the revenue for the year was £469,000, being an increase over the previous year of £30,000. The working expenses of horse traction had been 8 81d., as against 6·26d. for electric traction. In other words electric traction had cost 2½d. per car mile less. Then the receipts from the electric traction cars had been 14d. per car mile, while from horse traction they had only been 11·30d. per car mile, or 2½d. in favour of electric traction. If the cost of the working of the whole system by electric traction was in the same ratio as the small part they were working now, and he was convinced that it would be less, it meant a saving on the present mileage of £115,000 per annum, less the additional sinking fund on capital. On the other hand, if they could assume, as he thought they fairly might assume, that the passengers would also increase to such an extent as would give them an increase of 2½d. per mile, that meant an increase of £230,000 per annum, less the amount spent on working expenses. The more they had considered the question the more thoroughly were they convinced that when electric traction was in operation all over the city it would be an undoubted success. They had borrowed during the year £345,000, and they had a good deal more to borrow.

Folkestone.—The Tramway Special Committee of the Corporation have resolved that the routes previously approved be adhered to, with the exception that there be substituted for proposed route No. 6 (Bouverie-road East, Bouverie-road West to Grimstone-avenue, Grimstone avenue to Shorncliffe-road) a line from the town hall westward along Sandgate-road to the boundary of the urban district at the top of Sandgate-hill. The town clerk has been authorised to inform the clerk of the Cheriton Urban District Council of the steps now being taken by the sub-committee, and to approach the Urban District Council of Sandgate and the South-Eastern Railway Company upon the subject of connecting up the proposed Folkestone system of tramways at the top of Sandgate-hill with the existing tramway of the South-Eastern Railway Company in Sandgate. It was also resolved that the sub-committee is of opinion that the system for supplying current for working the tramways should be other than the overhead system, and that the routes adopted be amended by including that portion of Dover-road between a point opposite Bellevue-street and Rendezvous street, and also so much of Foord-road as lies between the junction therewith of Grace-hill and Tontine-street, and that the proposal to lay tramways along Kent-road and Bradstone-road be not carried out. The services of a consulting engineer are to be obtained to assist this sub-committee, in conjunction with the borough engineer, by advising as to the probable cost of the proposed scheme of tramways. The General Purposes Committee recently resolved that the Tramways Special Sub-Committee be requested to take into consideration the question of negotiating with Lord Radnor for the laying of tramways along the Lower Sandgate-road to the boundary between the urban districts of Folkestone and Sandgate, and forming there a junction with the tramway of the South-Eastern Railway Company.

Govan.—The following arrangement has been arrived at with regard to the conversion of the tramways: (1) the lines belonging to the burgh of Govan to be converted for overhead electric traction so as to be worked as one system with the Glasgow tramways; (2) the lease of the Govan lines to the Corporation to be extended for 21 years after the termination of the existing lease—viz., to 1935; (3) the conditions of the existing lease to remain in force, except as modified by the new agreement; (4) the Corporation of Glasgow to carry out the work of converting the lines (including the renewal of the permanent way, the laying of ducts and cables, the erection of overhead work, etc.), finding the capital therefor, which they would reduce by a sinking fund of their own, and to undertake to maintain the whole lines, cables, and overhead construction, and leave them in good working order at the termination of the extended lease, but the lines and all overhead electrical construction in the streets to be and remain the property of the Govan Commissioners during the whole period of the extended lease; (5) the Corporation to continue to pay interest and sinking fund upon the capital sum expended by the Commissioners under the existing lease till the termination of the extended lease; (6) the Corporation to pay all owners' assessments on the Govan lines as from the date when these are worked by electricity; (7) the Corporation to have power to sublet or to alter the existing tramway depôt in Govan, and not to be under obligation to restore the existing buildings at the end of the lease, provided they leave buildings equal in value to those now on the ground, but the other obligations as to payment of feu-duty, etc., not to be affected; (8) the Corporation to agree that the arrangement made in December last with the engineers and boilermakers as to the height of trolley wires should be applicable to Govan, or, at the option of the Commissioners, that the side-pole construction should be adopted in Govan-road between Linthouse and Cessnock, so as to leave one side of the road open; (9) all fares, tolls, and charges levied by the Corporation within Govan to be at the same rate as those charged generally within the city; (10) the Corporation to give a satisfactory through service of cars from Govan to the city.

LIGHTING AND GENERAL.

Lancaster.—The profit of the electricity department for the year is £420. 18s.

Neath.—It is proposed that the Council apply for an electric lighting provisional order.

Batley.—The Town Council have obtained sanction to a loan of £22 231 for electrical works.

Darlington.—The Town Council have decided to advertise for an electric lighting engineer.

Accrington.—A circular, with form of application, for the supply of electricity, has been issued.

Buxton.—Mr. Leeming, of Blackburn, has been appointed assistant engineer to Mr. Calvert.

Long Eaton.—Mr. Crowther, of Wallasey, has been appointed consulting electrical engineer to the Council.

Broughty Ferry.—The scheme for the electric lighting of Broughty Ferry will not at present be proceeded with.

Inverness.—In consequence of a petition from ratepayers the Council have agreed to abandon the electric lighting scheme.

New Malden.—The Surrey County Electric Lighting Company intend to apply for an order to supply the district with electricity.

Warwick.—The British Electric Traction Company intend to apply for a provisional order for lighting the town with electricity.

Leamington.—The Corporation's offer to buy the Midland Electric Light Company's undertaking for £17,000 has been refused.

Gloucester.—The Electric Light Works Committee will receive applications for a borough electrical engineer at a salary of £250 per annum.

London Gazette.—The estate of J. E. Stott, Huddersfield (trading as James E. Stott and Co.), has been released from trusteeship.

Richmond (Yorks).—The North British Electric Light Company intend to apply for a provisional order to supply Richmond with electric light.

Chesterfield.—In view of the large demand for private lighting it has been decided to postpone the question of street-lighting with arc lamps.

Aston Manor.—The Urban District Council have accepted Mr. G. H. Jack's estimate of £1,791 for the electric lighting of the Witton Hospital.

Harwood.—A syndicate intends to apply for an order to supply electricity within the urban districts of Rishton, Great Harwood, and Clayton-le-Moors.

Limerick.—Mr. Cowen held an enquiry on Wednesday into the application of the Corporation for sanction to a loan of £20,000 for electric lighting purposes.

Blairgowrie.—A committee is considering the intended application of the North British Electrical Supply Company to supply electricity within the district.

Woodford.—The County Electricity Supply Company intend to apply for a provisional order to supply electricity in Woodford, Wanstead, and Buckhurst Hill.

Nantwich.—The Council's Electric Lighting Bill for a provisional order having received the Royal assent, the surveyor is preparing a map showing the lighting area.

Smoke Nuisance.—On Monday at Blackpool the town clerk was fined 10s., or 14 days, for allowing thick smoke to issue from the Corporation electricity works.

Pudsey.—The District Council have decided to oppose the Northern Counties' Electric Supply Company's proposal to supply electricity in the Pudsey district.

Bradford.—Further progress has been made with the proposed acquirement of a loan of money for the instalment of the electric light in the Bradford Workhouse.

Peterhead.—The National Telephone Company have agreed to the stipulations laid down by the Council in regard to the erection of a line of poles on the South-road.

Salford.—The resolution with regard to the constitution of the Electric Lighting Committee, mentioned in our last issue, was defeated last week by 29 votes to 12.

Wolverhampton.—The Lighting Committee are about to ask the Council to agree to a reduction of their charges for the supply of electricity for lighting and energy.

Crewe.—The question of borrowing £10,000 for electric lighting extensions has been referred back, with a recommendation that the extension scheme be not proceeded with.

St. Andrews.—A special committee has been appointed to consider the intended application of the North British Electricity Supply Company to supply electricity within the burgh.

Warrington.—The building strike is delaying building operations at the electric lighting station. It is therefore not likely that the works will be completed as early as anticipated.

Tonbridge.—The Electric Lighting Committee have recommended that Mr. Hammond's report on electrical supply should be printed, but the matter has been deferred for a month.

Consett.—The Northern Counties' Electricity Supply Company intend to apply for an order for the district. Some members of the Council are in favour of obtaining an order themselves.

Digitized by Google

Whitechapel.—The District Board have decided to spend a further £44,670 in the supply of electricity in the district.

Matlock Bath.—The Urban District Council have decided to oppose the North British Electric Company's application for a provisional order to supply power in Matlock Bath district.

Partnership.—Mr. John M. Henderson has assumed his son, Mr. John M. Henderson, jun., as a partner. The business will be carried on in future under the style of John M. Henderson and Co.

Croydon.—The salaries of the officials in the electricity department have been raised all round, that of the borough electrical engineer to £450, with annual increments, till £600 per annum is reached.

Eastern Extension, Australasia, and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended March 31 of 2s. 6d. per share, tax free, payable on the 14th inst.

Crieff.—The North British Electricity Supply Company intend to apply for a provisional order for power to supply electrical energy for public purposes within the area of the Crieff local authority.

Helensburgh.—The Burgh Commission intend to oppose the proposed application of the North British Electricity Supply Company for power to supply energy within the jurisdiction of the local authority.

Derby.—The sum of £850 has been granted by the Town Council for laying electric lighting mains to the infectious diseases hospital, and application is to be made for sanction to the borrowing of that amount.

Bromley.—The Council have confirmed a notice by the Foots Cray Parish Council under the Act of 1882 as to the scheme for the electric lighting of Foots Cray, lower borough of Chislehurst, Sidcup, and part of Bexley.

Globe Telegraph and Trust Co.—The directors announce a dividend of 4s. 6d. per share on the ordinary shares, making, with the previous distributions, a total dividend for the year of 5¼ per cent., carrying forward about £950.

Kelso.—At a meeting of the Burgh Commissioners on Tuesday it was stated that if the price of lighting the gas lamps were raised a resolution would be brought forward that the Commissioners adopt a scheme of electric lighting.

Berkhamsted.—The North British Electricity Supply Company intend to apply in December for powers in the district under the jurisdiction of the Council. The question will come before the Urban District Council next month.

London County Council.—At the usual weekly meeting of the Council on Tuesday it was agreed to lend the Fulham Vestry £50,519, the Islington Vestry £8 579, and the Shoreditch Vestry £21,905 for electric lighting purposes.

Newington.—The salary of Mr. Blaikie, resident engineer, has been increased by £50 per annum, on the understanding that Mr. Blaikie remains in the service of the Vestry and their successors for a period of two years at this salary.

Camborne.—The North British Electric Light Supply Company, whose headquarters are at North Shields, intend to apply for a provisional order authorising them to supply electric light for public and private purposes for the urban district of Camborne.

Pontefract.—The North British Electricity Supply Company intend to apply for a provisional order to supply electrical energy to the borough. The clerk has been instructed to report as to the steps to be taken by the Council to give such supply themselves.

Largs.—The North British Electric Supply Company, South Shields, intend to apply for a provisional order authorising them to supply electrical energy to the burgh. The Commissioners have resolved to ask for further particulars before taking any action.

Sowerby Bridge.—The North British Electricity Supply Association intend to apply for a provisional order for supplying electrity within the area of the District Council, who have during the present session of Parliament received a provisional order for the some purpore.

Chiswick.—The Chiswick electrical lighting company are prepared to wire the new town hall free of charge, the installation to remain the property of the company for 10 years; the charge for current to be at the rate of 6d. per unit. The wiring of the building will cost £500.

Direct United States Cable Co.—The directors announce a final dividend of 3s. per share and a bonus of 2s. per share, payable 31st inst., making, with interim dividends, 3½ per cent. for the year ended 30th ult., and £10,000 is placed to reserve fund account and about £3,700 carried forward.

Gomersal.—The North British Electricity Supply Company and the Northern Counties Electricity Supply Company intend to apply for provisional orders authorising them to supply electrical energy in the Council's district. The matter will shortly be brought before the Council for consideration.

Spalding.—The United Electric Light and Traction Company, Limited, have served a notice on the Urban District Council of their intention to apply to the Board of Trade for a provisional order authorising them to supply electricity for public and private purposes within the area of the Council.

Cupar-Fife.—The Lunacy Board have adopted the report of Bailie Mackenzie, Edinburgh, which states that the estimated cost of the introduction of the electric lighting system at the asylum at Springfield was £3,050. Estimates for the introduction of electric lighting into the asylum are to be obtained.

Browett, Lindley, and Co.—We learn that Messrs. Browett, Lindley, and Co., of Patricroft, Manchester, have recently opened a London office at 6, Old Queen-street, Westminster, S.W., under the supervision of Mr. Thos Browett. The general correspondence will still be carried on from the works in Manchester.

Lytham and St. Annes.—The Council have decided that inasmuch as the St. Annes Land Company refused to allow the Council to retain the portion of land intended for the site of the electricity station, the whole plot be given up. Electric lighting mains are to be laid along Victoria-road and Fairhaven-road.

Crompton and Co., Limited.—The directors will recommend at the approaching general meeting a dividend at the rate of 9 per cent. per annum for the half-year, free of income tax, making with the interim dividend paid in January last 7½ per cent. for the year. A sum of £12,000 will be added to the reserve fund.

Appointments Vacant.—The Corporation of Darlington invite applications for the appointment of borough electrical engineer.—The Ilford Urban District Council are prepared to receive applications for the appointment of a clerk of works for their electric light station and cable-laying. Full particulars will be found in our advertisement columns.

Northampton Institute.—The engineering day courses in mechanical, electrical, and horological engineering will be started on Monday, Oct. 1, 1900. Entrance examination on Wednesday and Thursday, Sept. 26 and 27. Particulars of the courses can be obtained on application at the office of the institute, or to the principal, Dr. R. Mullineux Walmsley.

Perth.—In connection with the application of the National Telephone Company, Limited, for permission to erect poles and wires along the road from Bridge of Earn to Freeland and Invermay, the Standing Sub Committee has granted the permission on the conditions embodied in the existing agreement between the District Committee and the company. The company has also been granted permission to erect telephone poles and wires along the highways leading from Cherrybank to Dupplin on the same conditions.

Stranraer.—The Town Council on Monday evening had under consideration a notice from the North British Electricity Supply Company, South Shields, of intention to apply for a provisional order whereby it was proposed to supply electrical energy for public or private purposes within the burgh. Satisfaction was expressed at the intimation, and more especially in view of the recent announcement of the Stranraer Gas Company raising the price of gas from 4s. 7d. to 5s. per 1,000ft. The communication was remitted to the Lighting Committee.

Fire.—With regard to the fire which occurred at the British Insulated Wire Company's works at Prescot late on Tuesday, we are informed that the occurrence was of a comparatively trivial nature. A drum of cable in the drying oven caught fire and was quickly extinguished by the firm's own fire brigade. The damage done to the buildings was almost negligible, but a good many drums of cable in course of manufacture were spoiled by smoke and water. The whole factory was working as usual on Wednesday, and no inconvenience will be caused to customers, except those for whom the damaged cables were being built, and in this case it will only mean a few days' delay.

Bath.—The Electric Lighting Committee have resolved that local wiring contractors be requested to have their business premises or private houses wired and connected to the mains. Any wiring contractor so connected who engaged a canvasser to be employed for canvassing for electric lighting to be allowed a commission of 1s. for every 16-c p. lamp wired, according to the Corporation regulations, by such contractor, and connected by the authority in private houses during each quarter. A committee has been asked to consider the possibility of the Corporation putting in fittings on the understanding that they should be paid for at so much per quarter, or a certain sum added per unit consumed.

Stock Exchange.—The Stock Exchange Committee have ordered to be quoted in the official list Edison and Swan United Electric Light Company, Limited, provisional certificates for £100,000 5 per cent. second debenture stock. Applications have been made to the committee to appoint a special settling day in, and to grant a quotation to, the Axminster and Lyme Regis Light Railway Company, shares of £10 each; Babcock and Wilcox, Limited, ordinary shares of £1 each and preference shares of £1 each; and the Metropolitan Electric Supply Company, Limited, further issue of £125,000 3½ per cent. mortgage debenture stock. The committee have further been asked to allow the British Aluminium Company, Limited, 20,000 7 per cent. cumulative preference shares of £10 each, fully paid, Nos. 1 to 20,000 (renewed application), to be quoted in the official list.

Birmingham.—At a meeting of the Electric Supply Committee on Wednesday a report was received from the engineer with reference to the recent interruption in the electric service in the centre of the city. The delay was caused, it was stated, by a defect which was inseparable from the system upon which some of the older mains were laid, and it is with a view to preventing a recurrence of the inconvenience that these mains are being relaid upon an improved principle. It was also announced that the Lord Mayor, acting with the informal concurrence of the committee, had purchased the site of the old General Hospital for the purposes of the department. The action of the Lord Mayor was approved. In making the purchase the committee had in view the growth of the electric supply undertaking, and the possible needs of a central station in connection with the local tram systems.

Digitized by Google

Llanelly.—The contract for the electric installation at the Old Castle Works has been let to Messrs. J. C. Howell, Limited, electrical engineers, Llanelly. The plant to be laid down will be of the most modern type, and will be complete in about a month's time. The installation will include 12 arcs and about 300 incandescent lamps.

New Issue.—The United River Plate Telephone Company are making an issue of 23 361 5 per cent. cumulative preference shares of £5 each, at par. The prospectus states that the growth of the company's business calls for extended alterations in its plant at Buenos Ayres, for which purpose the present increase of capital is chiefly required.

Lewes.—At a recent special meeting of the Town Council it was reported that the whole matter of the transfer of the electric lighting order had been dealt with; the costs—£550—paid over by the company, and the deeds and agreements duly completed. Great satisfaction was expressed at the conclusion of this long and troublesome transaction.

Stroud.—The United Electric Light and Traction Company, Limited, intend to apply to the Board of Trade on or before Dec. 21 next for a provisional order authorising the supply of electricity for public and private purposes in this district. The Lighting Committee are discussing the action the Urban District Council should take in the matter.

Bournemouth.—The Guardians are in favour of establishing electric lighting in the workhouse upon the lines of a report received from Mr. George R. Peers of Manchester. The estimate is £1,610, and they have decided to refer the matter to the House Committee. In the meantime Mr. Peers has been asked upon what terms he would prepare plans and specifications.

Bermondsey.—The Vestry have resolved to apply to the London County Council for a loan of £4,500 for the purchase of the Hanover Arms beerhouse, which stands on a part of the site in the Neckinger required for the generating station, and to apply to the County Council for a loan of £21,000 to defray the cost of erecting a dust destructor and a chimney shaft, and also of laying mains.

Thornhill.—The Northern Counties Electricity Supply Company, Newcastle-on-Tyne, intend to apply to the Board of Trade for a provisional order to supply electricity in the Council's area. The Council have asked the company to submit, in writing, a draft of the proposed measure which they sought to have passed, and then meet the Council at Thornhill at their next monthly meeting.

Wakefield.—Mr. H. Percy Boulnois has held an enquiry into the application of the City Council for sanction to borrow £25,000 for electric lighting purposes. Mr. Blackmore (city electrical engineer) explained that it was intended to duplicate the mains in various parts of the city, and to lay down additional plant capable of supplying 25,000 8-c.p. lamps, and 50 arc lamps for street-lighting.

Eastern Telegraph Co.—The directors announce that the accounts show, after payment of the interim dividend of £1. 5s. per cent. on the ordinary stock to Dec. 31, a balance available sufficient to pay a final dividend of £1. 5s. per cent. and a bonus of £2 per cent., both tax free, on the ordinary stock, payable on the 19th inst., making a total distribution of 7 per cent. for the year ended March 31.

Bradford.—It is suggested that the Corporation should extend the electric lighting cables (at an estimated cost of £2,300) to Daisy Hill for the supply of electricity to Mr. Illingworth's residence, and to other property in the district. At the special meeting to be held on July 17 a resolution will be proposed to empower the Electricity Committee to borrow £140,000 for electric station plant and mains extensions.

Banbury.—The Banbury and District Electric Supply Company, Limited—a company which has been formed by the Electrical Distribution Company, Limited, for the working of the order applied for for the borough—intend to apply for a provisional order in the coming session. This is only a precaution in case of any interference with the passing of the Confirmation Bill now before Parliament.

Stockton.—Mr. Ford (gas manager) has been requested to submit to the Town Council an estimate of the cost of extending several electric light mains, and to ascertain the probable number of new customers. The Rural District Council is to be approached with a view of obtaining their permission to lay the electric light main in the districts of Norton and Hartburn should the inhabitants of those townships make application for a supply of electricity.

Falkirk.—Notices have been received both from Edmundson's Electricity Corporation, Limited, and the United Electric Light and Traction Company, Limited, of intention to apply for a provisional order authorising the supply of electricity for public and private purposes within the Council's area. The Council have decided to oppose any application for a provisional order, and to remit the matter to the Lighting Committee for further consideration.

City of London.—A Select Committee of the House of Lords, presided over by Earl Rosse, have proved the preamble of the Bill promoted by the Charing Cross and Strand Electricity Supply Corporation to establish a generating station at West Ham to enable them to supply electricity to the City of London. The Bill has already passed the House of Commons. The Lords' amendment to the City of London Electric Lighting Company's Bill have been agreed to.

Rochdale.—The Electric Lighting Sub-Committee have agreed to lay the requisite cable to supply electric light to the new Board school at Heybrook, provided the School Board would agree to take the supply for at least three years. The committee hope to start the new electricity works in the course of perhaps a couple of months, and when the works have been handed over to the Corporation in working order a separate electricity committee will probably be formed.

Castle Donington.—It is proposed by one of the largest electrical engineering firms in the country to utilise the water power at King's Mills, Castle Donington, in the construction of an electrical plant, by means of which it is intended to supply Castle Donington and the neighbouring towns with the electric light. It is estimated that a force of 500 h.p. is being wasted at the mills, and that once the necessary plant is installed the cost of maintaining the works will be comparatively small.

Skipton.—Notice has been received by the Urban District Council from two companies that they proposed seeking powers in the ensuing session of Parliament for the supply of electric lighting in Skipton. The Council has now decided, in accordance with a promise made to the ratepayers during the recent gasworks controversy, that the time has arrived when a Bill should be promoted in Parliament empowering the Council to manufacture and supply electricity within the township.

Rugby.—At the last meeting of the Urban District Council, a letter was read from the Northern Counties Electricity Supply Company with regard to an electric supply for Rugby, suggesting that representatives of the Council should meet members of the company and exchange views with them. The Clerk said he had replied referring the company to the advertisements the Council had inserted in certain papers, stating that the Council were prepared to receive tenders for leasing their powers.

Blackburn.—At last week's meeting of the Town Council the Parliamentary Committee resolved that, in view of powers being obtained by the Corporation by the Bill to be promoted in the next session of Parliament for the extension of the area of supply for electricity purposes, it be an instruction to the town clerk to serve formal notice upon the local authorities of the following districts—namely, Livesey, Witton, Wilpshire, Pleasington, and Rishton—of the intention of the Corporation to apply for such powers in accordance with the provisions of the Electric Lighting Act, 1882.

Trowbridge.—Mr. D. Stevenson has been asked to inspect the town and prepare a report giving information as to the system of lighting most suitable, to report on suggested sites, the first cost of work, probable cost of maintenance and income, the most suitable area to commence with, and the question of refuse destruction. Edmundson's Electricity Corporation, Limited, have given the formal statutory notice on behalf of the Urban Electric Supply Company, Limited, that they intend to apply to the Board of Trade for a provisional order for electric lighting in the urban district of Trowbridge, for confirmation in the parliamentary session of 1901.

Cardiff.—At a recent meeting of the Electrical and Lighting Committee of the Cardiff Corporation, Mr. H. J. Burstall, the expert appointed in connection with the recent action, the Corporation *v.* Ferranti, to inspect the engine (300 kw. Ferranti alternator), reported that the alternator at the electricity works had been finished and adjusted to his entire satisfaction, the engine and the whole of the work decided to be done under the terms of settlement having been carried out. The engine was ready to be taken over by the Corporation. Mr. Appelbee, the resident engineer, said the engine worked well and satisfactorily, and could be taken over now. The committee thereupon decided to do so.

Hastings.—The Town Council have agreed to the extension of several mains at a total cost of £1,232. 9s. 7d., which is to be raised by loan. To effect a saving in the electric light works, it has been resolved to discontinue the Waterworks-road station and to remove a part of the plant to the East-street station. The remainder of the plant is to be disposed of. The balance-sheet in connection with the electricity department for the year ended Dec. 31 last was presented at last week's Council meeting. In moving its adoption, Councillor Dr. Alfrey said, although they paid rather a large sum for works, he was glad to say they had £200 or £300 to the good, notwithstanding that they had reduced the price, while coal had advanced in price.

Sheffield.—The city surveyor has reported to the Electric Light Committee that he has now taken out and removed the whole of the concrete foundation for the new alternator at the electric light works, and has found the work to be of a worse character than he had anticipated, and that consequently the action of the committee in ordering the work to be taken out and removed has been justified by subsequent events. Mr. S. E. Fedden is to be appointed chief engineer and manager of the electric supply department, and to be solely responsible to the committee for the same. The wiring and fittings department and trading department and factory will remain under the commercial manager, who is to be the head of the clerical staff, under the direction of the chief engineer and manager.

Walsall.—The electric mains are to be extended from the generating station along the Pleck road as far as Bescot, and two transformers provided, at a total estimated cost of £5,178. A communication having been received from the Local Government Board stating that they proposed to defer sanctioning the loan of £15,000 until the sites for the proposed transformer stations have been decided upon, the Electric Lighting Committee have urged them to sanction the loan immediately, as it was impossible for the Corporation to fix at this date the situation of the transformer stations, and have pointed out that the site depends upon the

Digitized by Google

demand there is for the current, and that the delay in carrying out the new works is likely to seriously interfere with the Corporation complying with their statutory obligation to supply current.

Brighton.—At a recent meeting of the Town Council it was stated, with regard to the demand for arc lamps, that the committee received continual applications from various districts for small sections to be lighted with the arc lamps, and they were all given the same reply—viz., that it was not deemed advisable to grant the request at present. The present system of incandescent lights was so satisfactory that the committee did not consider it expedient yet to make any change. Upon an enquiry why the committee were accepting a tender for the supply of incandescent lamps at 1s. 3¾d. per lamp, when they had tenders at 6d. and 9d., it was explained that the lamps were subjected to certain tests, and it was found that the more expensive lamps gave the required results more economically than the cheap makes, and were beyond question the cheapest.

Walton-on-Naze.—The electric light has made great progress during the last two years. Messrs. G. E. Taylor and Co., of Lombard House, George-yard, E.C., electrical engineers, were the contractors for the electric work recently done at the pavilion, as also for the further preparation for electric lighting and cooking at the Café Chantant. A number of 16-c.p. and 32-c.p. lamps are fixed on the stage and the auditorium. At each side of the stage provision has been made for use in the wings for one plug of 200 c.p. for stage effects. All the offices are lighted by electricity, as also the staircase. The lighting of the outside includes two lamps at each end of 16 c.p. each. At each of the four corners are three-light brackets for 32-c.p. lamps, a total of 384 c.p. for the illumination of these corners. The system of wiring is lead-covered twin wire, which is arranged so that there shall not be joints in any circuit. All the brackets, which are of pretty design, are of copper. The consulting engineer has been Mr. G. L. Addenbrooke, and Mr. H. Dawkins, the representative of the contractors, has had charge of the whole of the contract and works.

Beckenham.—The Electric Lighting Committee's report, adopted at the last meeting of the Urban District Council, contained the following items: "A letter from the Local Government Board sanctioning a loan of £7,000, repayable in 10 years, for the wiring of houses was submitted. Instructions were given to the engineer to prepare a form of specification and tender. A telegram was submitted from the British Insulated Wire Company, Limited, agreeing to the scheme of free wiring set out in the Council's memorandum of April 25, 1900. The clerk was directed to prepare a supplementary contract embodying the free-wiring arrangement and other matters. The officers were instructed to draft a form of circular to enable the contractors to proceed with the canvassing of householders. The committee recommend that in connection with the loan for free wiring, Mr. Reginald P. Wilson, consulting electrical engineer, be retained to supervise and be responsible for the proper execution of the wiring, and that he, in conjunction with the surveyor, be instructed to prepare the necessary specifications, and obtain tenders for the wiring. The engineer was instructed to prepare specifications and invite tenders for transformer stations."

New Companies.—The following new companies have been registered: Premier Electric Lamp Company, Limited, with a capital of £100,000 in £1 shares, the object being to acquire the business of the old company of the same name and extend the same, and to carry on the general business of an electric light and power company, etc.—South Lancashire Electric Supply Company, Limited, with a capital of £10,000 in £1 shares, the object being to carry on in South Lancashire or elsewhere the business of electricians and suppliers of electricity for the purposes of light, heat, motive power, and otherwise.—Lewisham and District Electric Supply Company, Limited, with a capital of £10,000 in £1 shares, the object being to carry on at Lewisham, S.E., and elsewhere the business of an electric light company in all its branches.—Improved Electric Glow Lamp Company, Limited, with a capital of £40,000 in £1 shares, the object being to carry on the business of electrical engineers, etc.—Dow Portable Electric Light and Power Syndicate, Limited, with a capital of £40,000 in £1 shares, the object being to adopt an agreement with a company of the same name for the acquisition of certain inventions relating to galvanic batteries, and to carry on the business of electrical engineers, suppliers of electricity, etc.

Dalkeith.—In connection with the scheme adopted, subject to the revision of details, for the electric lighting of Dalkeith by a London firm of engineers, the three Commissioners who at the last meeting voted against the matter being carried further for the present, have obtained a report by Mr. W. A. Bryson, electrical engineer, Leith. The three Commissioners referred to mention that the town of Dalkeith has streets which extend altogether to about six miles, exclusive of courts and closes. They are at present lighted by 300 ordinary and 20 incandescent gas lamps, and the average cost for gas for the past five years has been £210, and, in addition, the maintenance and expense of lighting has cost £106 per annum. The price charged by the Dalkeith Gaslight Company, Limited, to the Commissioners for the purposes named is 3s. 7d. per 1,000 cubic feet. The cost for electricity is to be 3d. per unit, and to include all charges. Mr. Bryson, as a result of careful examination, states that, while arc-lamp lighting would be suitable for the main streets, in the narrow ones, which are numerous, much of the light would be wasted. Incandescent electric lighting may be used, but it has a less penetrating power than gas. He calculates that if the Commissioners were to extend the system of incandescent gas lighting of 60 c.p., the cost would be found considerably less than electric lighting. A possible estimate for the consumption of gas by 225 lamps lighted till 11 p.m., and 50 burning all night, might be put at £440, this allowing for lighting and maintenance. If the streets were to be lighted throughout by means of incandescent electric lamps of 32 c.p., the cost at 3d. per unit, based on the same hours in use as the gas, would, he states, be £637. The Commissioners are to have a communication before them at the next meeting from the engineers as to the obtaining of the provisional order.

Manchester.—The electricity department of the Manchester Corporation, which includes Manchester, Withington, Moss Side, and Levenshulme, have issued the annual financial statement for the year ended March 31 last. The report of its working is signed by Mr. Alderman Lloyd Higginbottom. The committee state that the total quantity of electricity measured and accounted for amounted to 6,468,405 units, an increase of 24 per cent. over the previous year. The consumers numbered 3,240, an increase of 670. Additional mains were laid to the extent of 47 miles 530 yards, making the total length laid 110 miles 45 yards. Revenue derived from sales of current, etc. (which works out at 3·20d. per unit accounted for), amounted to £86,297. 18s. 4d., and the working expenditure to £49,905. 11s. 6d., showing a gross profit of £36,392. 6s. 10d. From this sum is deducted an amount of £27,199. 15s. 5d. on account of interest on mortgage debt, etc., and sinking fund, and a net profit is shown of £9,192. 11s. 5d. This surplus, together with the balance of £2,000 brought from last year's account and £572. 6s. 5d. interest on reserve fund investment, making a total of £11,764. 17s. 10d., has been appropriated in the following manner: paid to city fund in aid of rates, £10,000; placed to reserve fund, £1,764. 17s. 10d. The following statement exhibits the financial position of the undertaking at March 31: total capital expenditure, £641,821. 18s.; mortgage debt, £556,278. 9s.; amount of mortgages redeemed to date by action of sinking fund, £49,232. 11s.; balance at credit of renewals suspense account, £335. 4s. 5d.; ditto reserve fund, £13,360. 15s. 2d. Owing to the necessity for renewing a considerable length of mains which had proved defective, the charge upon revenue account for repairs and renewals of mains this year amounted to £7,453. 10s. 6d., as against £1,495. 12s. 6d. last year. In addition to this, the sum of £12,459. 10s. 6d. had been taken from the renewals suspense account to cover similar expenditure. The committee regretted that the accident which happened to the machinery at Dickinson-street station in September last did considerable damage. The amount withdrawn from the reserve fund on account of the breakdown was £7,069. 18s. 1d. The committee are putting forward the equipment of Bloom-street station in order to meet the increasing demand for the supply of electrical energy, and to be ready to supply the current necessary for working the tramcars. At the Polygon, Ardwick, satisfactory progress is being made, it is stated, with the erection of buildings for workshops and cable stores, and it is expected they will be ready for occupation before the end of the present year. Plans have been approved for the equipment of a part of Stuart-street generating station. Considerable progress has been made during the past year with the laying of electric mains in the districts of Withington, Moss Side, and Levenshulme. The supply of current has been available in portions of Moss Side since December last, and in Withington since February last. The committee add that on Sept. 30 last the price of electric energy to long-hour consumers was reduced from 1½d. to 1¼d. per unit, and a similar reduction was made in the price of current supplied for motor purposes. The foregoing represents, they state, a concession to the consumers of £2,873. 8s. 6d. in six months.

Sunderland.—The report of Mr. J. F. C. Snell, the borough electrical engineer, on the electric light undertaking, states that during the past year there has been an increase in the number of lamps connected and in the amount of electricity consumed, as well as a notable advance in the annual profit. On March 31 last year there were 25,617 lamps connected, and this had grown by the March of this year to 35,024 lamps, an increase of 36 per cent. The number of units sold had leaped from 472,343 for 1899 to 640,079 for the later period, representing an increase of 35 per cent. The gross profits on the undertaking were £4,047. 6s. 4d., and after meeting the sinking fund and interest, which cost £3,580. 10s. 9d., there was a net profit of £466. 15s. 7d. left. This compares with a gross profit for the previous year of £2,865. 17s. 9d., and a net profit of £364. 11s. 3d. The report states that the profits were equal to 5½ per cent. on the average capital outlay for the year. The enormous rise in the price of coal made an increase of over 50 per cent. in that item alone, but for which there would have been a clear profit of over £1,100. The report continues: "The actual capital outlay on the undertaking to March 31 last is as follows: buildings, £10,329; machinery, £38,983; mains and services, etc., £29,706; professional services and incidentals, £1,894; public arc lamps, £2,000—total, £82,912, representing £74 per kilowatt installed. The average of all other municipal stations, as extracted from the Board of Trade returns, 1900, is £84. Extensions are now proceeding at Dunning-street, which, when completed, will use up the whole of that site, increasing the kilowatts installed to 1,980, or 3,600 i.h.p., which will bring up the capital outlay to the amount sanctioned—namely, £111,100, or £56 per kilowatt installed." The report states that seven section pillars have been fixed, whereby the risk of breakdowns of the mains is very much reduced and faults will be more quickly localised. Mr. Snell emphasises the necessity for immediate extension of the works, and says: "Four 120-i.h.p. steam dynamos for lighting and traction, with surface condensers, and four Galloway boilers with economisers, mechanical stokers, and induced-draught fans, and a tramway switchboard, are now being fixed. A new site has been negotiated for on which the new (and future principal) Hylton-road station will be erected. This site is well

Digitized by Google

placed as regards centrality, coaling arrangements, and ample room for extension, as at least 15,000 h.p. can be placed there. It will be necessary to at once lay down a certain portion of this plant to cope with the increasing demands for current. The limit of supply from Dunning-street is 55,000 8-c.p. lamps (including the plant for tramways), and already, adding lamps applied for to those connected to the station, there is a total of 46,000, emphasising this immediate necessity for further addition. The department is now supplying power for all kinds of industrial purposes, graving-dock pumps, dock cranes, large workshop tools of all descriptions, mortar mills, joiners' tools, stable machinery, elevators, printing machinery, sewing machines, coffee mills, and other machinery, even revolving hairbrushes." As to the cost per unit, it is satisfactory to note that Sunderland is seventh on the list of similar undertakings, and only ·57d. per unit more than the lowest—Edinburgh, the price being 2·90d., compared with Sunderland's 3·58d. per unit. Mr. Snell states that there is an efficiency of 85·78 per cent. at the station, and the machinery is in the highest condition. Mr. Snell bears warm testimony to the excellent services of the staff.

Bury.—The annual report for the year ending March 31, 1900, of Mr. S. J. Watson, borough electrical engineer, states that the total number of consumers connected with the electricity works on March 31 last was 198, with 14,733 8-c.p. lamps, as against 144 consumers, with 10,275 lamps at the end of March, 1899. The number of units sold during the year ending March 31 was 213,395, as against 115,853 for the previous year, and 64,462 for the year ending March 31, 1898. "A satisfactory improvement," says the report, "is shown by the load factor, which for the past year works out at 12½ per cent., thus indicating that the maximum load was used for three hours per day, as compared with 9 per cent., or 2 hours 12 minutes, for the previous year, and 8 per cent., or 1 hour 56 minutes, for the year ending March, 1898. This improvement is partly due to the extended use of the arc lamps for street-lighting, and partly to the maximum demand tariff, which encourages the long-hour consumer. Without the public lighting the value would be 11 per cent., or 2 hours 36 minutes per day." Some important extensions at the works have been made during the year, including the putting in of a Lancashire boiler, 30ft. by 7ft., made by Mr. Wm. Lord, of Bury, a 360-b.h.p. engine, direct coupled to a 250-kw. dynamo, to run at a speed of 370 to 400 revolutions per minute, and a balancer and booster set. The number of cells has been increased from 130 to 260. An agreement for the maintenance of these cells for three years has also been arranged. The present capacity of the plant, after making an allowance for spares, is 7,300 8-c.p. lamps alight at once. This is equal to nearly 15,000 8-c.p. lamps connected to the mains, as only 50 per cent. of the lamps connected are usually used at once. When the second large generating set is delivered the capacity will be increased to 14,600 8 c.p. lamps alight at once, or nearly 30,000 8-c.p. lamps connected to the mains. During the past year 2,270 yards of cables have been laid in the streets, and the total length of cables laid to date equals 9 miles 376 yards. There are now 31 arc lamps erected in the main streets, 13 additional lamps having been set to work during the past year. It has also been decided to erect two more in Manchester-road, by the fountain at Buckley Wells. The analysis of cost for the past year gives the following figures: generating costs, £1,595, equal to 1·79d. per unit; interest and sinking fund, £1,803, equal to 2·03d. per unit; total cost, £3,398, equal to 3·82d. per unit; profit, £184, equal to ·21d. per unit; revenue, £3,582, equal to 4·03d. per unit. Last year there was a deficit of £336, and the previous year of £579. The cost of carbons and attendance to public lamps have this year been deducted from the revenue received for public lighting, as Mr. Watson considers it misleading to express the same as a cost of generation or source of revenue in any way depending on the units sold for all purposes. An additional expenditure of £135 has been necessary on account of the advance in price of fuel, the average price paid during the past 12 months being 9s. 6½d. per ton, as compared with 6s. 11d. per ton for the previous year. The question of making any immediate reduction in the charges will require careful consideration, having in view the cost of renewing some of the vulcanised rubber-insulated cables, which have to be met by revenue. Mr. Watson has, therefore, prepared estimates to see whether any reduction can safely be made without causing a deficit at the end of the year, and recommended that the present tariff be maintained to Dec. 31 next, and if the progress made by that date were sufficiently satisfactory a reduction may be made to date from Jan. 1, 1901. Such an alteration would only reduce the revenue for the year by about £75, and there should still be a margin on the profit side to meet any unforeseen expenditure.

PROVISIONAL PATENTS, 1900.

JULY 2.

11897. Improvements in trolleys for overhead electrically-driven tramcars. James Townsley Pearson, St. James's Hall, Burnley.

11907. An improved block or mounting for electrical, gas, and like fittings. John Bolton, 287, Lillie-road, Fulham, London.

11914. Improvements in the manufacture of electrodes for secondary batteries. James Charles Richardson, 19, Claremont-square, London.

11917. Improved method of and means for signalling, chiefly designed for submarine purposes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Gray Telephone Company, United States.) (Complete specification.)

11929. Improvements in or relating to production of type by means of electric current. Frank Charles Frederick Knaak and James Smalley Campbell, 11, Pall-mall, London.

11933. Improvements relating to the regulation of electric motors. Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11937. Improvements in telephone systems. Frans Birger Stafsing and Carl Egnér, 322, High Holborn, London.

11941. Improvements in electric motors and regulating appliances for turret turning, gun training, and analogous purposes. William Harding Scott, 47, Lincoln's-inn-fields, London.

11944. Switching arrangement for Nernst and vacuum incandescence lamps. Victor Fallon Feeny, 66, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

JULY 3.

11965. Improvements in electric receivers and electric clocks. Archibald Barr, William Stroud, and Ludwig Becker, 154, St. Vincent-street, Glasgow.

11970. Improvements in or relating to the construction of electric switches and contact makers used for electric tramways and the like. John Milnes, 4, St. Ann's-square, Manchester.

11991. Improvements in rheostats for electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John L. Hall, United States.) (Complete specification.)

11997. An improvement in accumulators or secondary batteries. Richard Rodrian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

12002. Improvement for providing an automatic lock for the purpose of securing electric and other lamps in lampholders, electric and other shades in holders, and locking couplings of a like nature. Eric Philip Barfield, 8, Grosvenor-gardens, Muswell-hill, London.

12003. Improvements relating to dynamo-electric mine exploders or apparatus for firing explosives. Jasper Wetter, 37, Essex-street, Strand, London. (Louis Charles Gomant, France.) (Complete specification.)

12016. Improvements relating to electrically-propelled motor vehicles. Thomas Jefferson Ryan, 18, Buckingham-street, Strand, London. (Complete specification.)

12018. Improvements relating to electric propulsion for motor vehicles. Thomas Jefferson Ryan, 18, Buckingham-street, Strand, London. (Complete specification.)

JULY 4.

12054. The electric lighting of motor-driven vehicles. Percival Harry Frost Smith, 10, Basinghall-street, London.

12074. An improvement in static voltmeters. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.)

12086. Improvements in electrical storage or secondary batteries. Arthur William Baxter and Charles Baxter, 53, West-hill, St. Leonards, Sussex.

12089. Improvements in dynamo-electric machinery. Charles Edward Grove, The Thames Ironworks, Orchard-yard, Blackwall, Middlesex.

12100. Improvements in or relating to electrical tramways and the like. Edward Bennett Viles, 322, High Holborn, London.

12111. Improvements in electrical jacquards and dobbies. Jan Szczepanik and Ludwig Kleinberg, 46, Lincoln's-inn-fields, London. (Complete specification.)

JULY 5.

12115. Improvement in apparatus for magnetically separating iron or steel borings, filings, and the like from brass or other non-magnetic substances. Benjamin Young, Leek-street, Birmingham.

12128. A device for shielding fallen wires from overhead electrical conductors. George Sockett Holmes, 10, St. Georges's-crescent, Liverpool.

12152. Improved method for the practical application of lead secondary batteries. Carl Heim, 63, High Holborn, London. (Complete specification.)

12160. Improvements in the manufacture of filaments for electric incandescence lamps. Victor Thomas, 53, Chancery-lane, London.

12170. Electric meter. Paul Mandowski, 40, Chancery-lane, London. (Complete specification.)

12175. Improvements in electrical relays. The Thomson-Davis Telephone System, Limited, and Arthur Thomas Milnor Thomson, 22, Southampton-buildings, Chancery-lane, London.

12177. Improvements in the holders of electrical incandescent or glow lamps. William Walker, jun., 7, Staple-inn, London.

Digitized by Google

12179. Improvements in or connected with electrical tramways or railways. Hugo Hirst, 47, Lincoln's-inn-fields, London.

JULY 6.

12249. Improvements relating to thermo-electric cells. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. Louis Siegfried Langville, United States.) (Complete specification.)

12256. Improvements in and relating to electric arc lamps. Curt Arthur Max Bärner, 322, High Holborn, London. (Complete specification.)

12267. Improvements in electric accumulator. Vladimir de Robinsky, 4, South-street, Finsbury, London.

JULY 7.

12276. Improvements in hooks or clips for gas and water pipes, electric wire conduits, picture rods, and the like. Cope, Allman, and Co., Limited, and William Allman, Icknield-square, Birmingham.

12296. Improved turbine fan or air propeller driven electrically or by mechanical power. Bridgman Russell, 42, Berwick-street, Oxford-street, London.

12315. Improvements relating to electrical signalling and communicating apparatus. Gregor Blanck, Joseph William Hudson, and William James Downs, 322, High Holborn, London.

12321. An improved collector for electrical machines and the like. Fritz Kaeferle, 6, Lord street, Liverpool. (Complete specification.)

12331. Improvements in blocks for electric conduits. Eugen Schellbach, 45, Southampton-buildings, Chancery-lane, London.

12338. Improvements in dynamometers and/or brakes. John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on July 23.

1899.

9436. Electric telegraphic apparatus. Cantono. (Date applied for under International Convention, Jan. 12, 1899.)

9437. Electric telegraphic apparatus. Cantono. (Date applied for under International Convention, April 13, 1899.)

13733. Electric traction on a read-contact or like system. Thompson and Walker.

13939. Magneto-electric and dynamo-electric generators. Frank Bryan and Abel Henry Bayley.

15744. Electric regulating switches. Lucas.

15907. Terminals of electric batteries and the like. Wright.

16285. Plugs for telephone switchboards. Pearmain.

16444. Method of receiving telegraph signals as displayed or photographed by magnetically-deflected cathode rays. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

16949. Telephone speaking tube and like receivers. Cutmore.

19064. Electric trolley standards. Little and Ireland.

1900.

3268. Interrupters for electric circuits. Lecarme and Lecarme.

5688. Bonding for iron or steel electrical conductors. Thomson. (Brown.)

9968. Magnetic separators. Imray. (Mechernicher Bergwerks-Aktien Verein.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	July 7	699	668	+ 31	3,559	3,155
Birmingham Tramways Co.	,, 7	4,649	4,334	+ 315	114,841	108,085
Blackburn Corp'rat'n	,, 7	486	427	+ 59	10,063	11 535
Blackpool Corporatn.	,, 5	822	587	+ 235	8,140	6,382
Blackpool-Fleetwood	,, 7	801	1,048	- 247	801	1,048
Bradford City Trams	—	—	—	—	—	—
Bristol Tramways Co.	,, 6	3,221	3 153	+ 68	—	—
City & South London	,, 8	1,447	1,037	+ 410	1,447	1,037
Cork E. T. and L. Co.	,, 5	526	439	+ 87	8.931	10,073
Dover Tramways ...	,, 7	235	219	+ 16	4 737	4,451
Dublin U.T., elec cars	,, 6	3,107	1,063	+2,044	—	—
Dublin S.D. Electric	,, 6	847	877	- 30	—	—
Halifax Corporation	,, 1	900	670	+ 230	9,615	6,786
Hull Corporat'n E.S.	,, 7	1,212	—	—	16,659a	—
Liverpool Corporat'n	June 30b	7,740	7,352	+ 388	188,741	165,862
Liverpool Overhead	July 8	1,687	1,539	+ 148	—	—
Sheffield Corporation	,, 8	2,417	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. b Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	½-¾
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6-6½
—— 5 per cent. Mortgage Debentures	100	—	98-102
British Electric Works, Ordinary, 50,001-95,000	1	—	½-¾
—— 6 per cent. Cum. Pref., 1-50,000	1	—	12/16-15/16
—— 4½ per cent. First Mortgage Debentures	100	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2½
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-14½
—— 5 per cent. Pref.	5	—	5½-5¾
Crompton and Co.	3	—	3¼ 4
—— 5 per cent. Debentures	—	—	98-101
Ellison and Swan United, Ordinary	3	—	2-2½
—— 5 per cent. Debentures	5	—	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	—	91-93
Electric Construction	2	—	2-2½
—— 7 per cent. Cumulative Pref.	2	..	2-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	104-107
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-14½
—— 4½ per cent. Preference	5	—	5½-5¾
—— 4½ per cent. Debentures	100	—	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-23
—— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	12	—	28-30
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6½-7½
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-6
Chelsea Electricity Supply	5	—	6-7
—— 4½ per cent. Debentures	100	—	107-110
City of London, Ordinary	10	..	8½-9½
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	103-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	—	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	10-10½
London Electric, Ordinary	3	..	1-1½
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-100
Metropolitan, Ordinary	10	..	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1-1⅛
—— £5 Shares	5	..	7½-7¾
—— £4½ Shares, New	4½	..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5-6
River Plate Electric Light and Traction, Deb.	100	—	76-80
Royal Electrical Company of Montreal	$100	..	165-180
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-90
South London, Ordinary	3	..	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	12½-14½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	—	11½ 13½
Electric Railways.—			
Central London, Ordinary	10	—	9½-10
—— Pref. Half-Shares	5	..	4½-5
—— ,, ,, deferred	5	..	4½-5
City and South London, Consolidated Ordinary	100	..	64-66
—— Ordinary	10	—	6-7
—— 4 per cent. Debenture Stock	100	—	123-128
—— 5 per cent. Pref. Stock '91	100	—	140-145
—— ,, ,, ,, '96	100	..	133-137
Liverpool Overhead, 5 per cent. Pref.	—	—	12½-13½
Waterloo and City, Ordinary	100	..	97-100
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	17½-18½
Brisbane Tramway	100	..	102-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary, 1-30,000	10	—	14-15
—— 60,001-75,000	10	—	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	122-126
—— ,, ,, ,, 1900	100	—	120-122
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	102-105
Isle of Man Electric Power, 1-95,000	1	..	1-1 3/16
—— 6 per cent. Preference, 100,001-170,000	1	..	3/16-¼
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. Pref.	5	..	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
Telephones.—			
National Telephone, Ordinary	5	—	4½-5½
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	12-14
—— 5 per cent. Non. Cum. Third Pref	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	97-100
Oriental Telephone and Electric Company	1	—	½-1½

Digitized by Google

NOTES.

Institution of Junior Engineers.—On Friday next, June 27, the members of the above institution propose to visit the generating station and depôt of the Central London Railway at Shepherd's Bush. The time fixed for the inspection is 6.30.

Society of Chemical Industry.—This society has been holding its meetings in London this week at the Royal Institution. Prof. Chandler is president this year, and delivered a most excellent address. Amongst the places of interest which the society visited was the Shoreditch refuse destructor.

Congress on Physics.—We will remind our readers that the International Congress on Physics is to take place in Paris next month. The meetings will commence on Aug. 6 and continue till the 11th. Sixty interesting papers have already been put down for discussion, so that members of the congress are expected to work hard. The very short interval between the closing of this congress and the meeting of that on electrical subjects will enable both to be attended without inconvenience.

Overhead Wires.—The Cork Electric Lighting Company has asked the permission of the Corporation to a proposal to supply electric light in the outlying districts of Cork by means of overhead wires. The city engineer reports practically in favour of the proposal, but more details are to be given to the Corporation before the matter is decided. The company's reason is that the lower capital charge enables light to be supplied more cheaply. This seems to us to be a valid consideration in certain scattered districts.

Personal.—We are pleased to note that Mr. Thomas Carter has been appointed demonstrator and assistant professor in electrical engineering in the Heriot-Watt Technical College, Edinburgh. Mr. Carter is an old student of this college, and since leaving it has obtained extensive practical training. This he has recently supplemented by a systematic study of electrical engineering in Germany and Switzerland. It is encouraging to note that the Heriot-Watt recognise the advantage of practical experience.

Society of Model Engineers.—The fourth monthly meeting of the Liverpool branch of the Society of Model Engineers was held at the Balfour Institute on July 4, when a very fine collection of models was on view, and Mr. Hastings gave an interesting description of the engine for his new model torpedo-boat. The next meeting will be held in the recreation-room at the Balfour Institute, Smithdown-road, Liverpool, on Aug. 1 at 7.45 p.m., when another exhibition of models will take place, and there will be a general discussion on any difficulties experienced by members in connection with their work.

Wireless Telegraphy.—General Greeley is the authority for the statement that the Signal Corps have established wireless telegraphy stations, and are now successfully operating a system of wireless telegraphy between Alcatraz Island, San Francisco, and Fort Mason. It has been impossible previously to obtain cable communication between these two points owing to the interruption from shipping. It is also stated that a similar system is to be used to bridge the Magellan Straits in order that communication may be obtained between the mainland of the Chilian republic and the outlying island.

American Tramways.—The data respecting the growth of American tramways is so largely quoted that we shall be glad when the English lines will afford statistics of a similar nature, in order that the signs of progress in electric traction need not always be supplemented with American figures. We are told by one of the American authorities that at the end of last year there were about 19,000 miles of street railways in the States under 870 distinct managements. The total capital of these companies amounts to no less than £360,000,000. We believe that the shares in these undertakings are, as a rule, worth more than their par value.

Combined Lighting and Traction.—The officials of the Evanstone Electric Street Railway of Chicago have decided that the combination of electric lighting and electric traction in the one street is to be deprecated. Owing to their cars leaving the tracks so frequently, these officials have held an expert examination into the cause, and have decided that it is due to the large number of insects killed by the electric lamps beside the track. We should require to see that bank balance of the company, and also a certificate, under penalty, as to the veracity of its officials, before we tried to believe the explanation in question.

A Cable to China.—We understand from a Reuter's telegram that the Powers are considering the laying of a new cable between the present seat of disturbance or base of operations in China and some points such as Shanghai, Port Arthur, or Yokohama, through which more speedy communication could be had with Europe. According to the present tentative arrangements the expense of the undertaking will be borne jointly by the Powers. It is probable that the United States will be able to lay the cable in the shortest time, owing to the fact that a cable which is intended for inter-island communication in the Philippines could be diverted to China.

The Joint Paris Conference.—The following is the subject on which discussion is to take place at the joint meetings of the Institutions of Electrical Engineers of this country and America—*i.e*, "The relative advantages of alternate and continuous current for a general supply of electricity, especially with regard to interference with other interests." We understand it is specially desired to discuss how far interference with other undertakings, rather than ordinary commercial and industrial conditions, will come to be a determining factor in the selection between continuous and alternating currents. The joint meeting will be held on Aug. 16 in the American Pavilion in the Exhibition.

St. Johns, Newfoundland.—We gather from the *Scientific American* that a new electric railway has been opened in St. Johns, Newfoundland. There are seven miles of track and 20 cars. As the traffic increases the line will be extended to the suburbs. The current is generated nine miles from St. Johns. There is a chain of four lakes, and from the outlet of the last runs a flume which is built along a steep hillside for 3,300ft. until it disappears in a tunnel cut 350ft. through a bluff of solid rock. At the end of the tunnel was erected a huge sluice box of timber, to the bottom of which is fixed a steel tube 6ft. in diameter. Through this the water flows 185ft. to the power-house. The capacity of the plant is 1,600 h.p., but the flume is of sufficient capacity to drive another plant of the same size.

North-East Coast Institution.—We have received parts V. and VI. of vol. LVI. of the *Transactions* of the above institution, which contain, among other things, the paper by Mr. Borrowman on "Some Considerations affecting the Training of Young Engineers." In this the author expresses the regret that the old apprenticeship system has died out. He urges the combination of theoretical training with that practical experience which alone is given to

Digitized by Google

apprentices nowadays, and points out that special experience in one department is now more essential than an all-round smattering of many subjects. Mr. Borrowman's paper is worthy of most careful study. The discussion also is of great value. On the whole we gather that the speakers advocated a certain amount of practical training preceding the theoretical.

The American Association of Science.—The above association for the advancement of science, which is run somewhat on the same lines as our British Association for the same object, had a most successful meeting in New York the last week in June. The arrangement of the meeting so early in the year was in order that it might not clash with the various congresses which are being held in this country and in Paris. A certain amount of heat was added to the meeting by the determination of one speaker to introduce politics into the discussion. This gentleman, as a scientific man, objected to the United States Government spending 30 millions for the killing off of the Filipinos. We wonder if this gentleman, after the dreadful news which has arrived from China this week, would object to an expenditure of a similar amount towards the wiping of Pekin off the face of the earth.

The Pacific Cable.—The question of the Pacific cable was again brought up in the House of Commons on Thursday week, when Sir Edward Sassoon enquired as to how the matter was progressing. Mr. Chamberlain, in reply, gave the satisfactory information that the various Governments interested had accepted the recommendations of the Pacific Cable Committee, and that tenders for the laying of the cable would be called for forthwith. With this information one may reasonably hope that at no very far distant date an all-British cable communication between Great Britain and her Colonies will be an established fact. We are sorry to note, however, that Mr. Chamberlain could give no definite information as to the reduction of the telegraphic rates to India. This reduction is urgently needed, and it is hardly fair that while the rate to Australia is 4s. per word, it should be the same to India, which is only half the distance.

Power Bills.—On Monday last the House of Commons agreed to the third reading of the County of Durham Electric Power Supply Bill, the Lancashire Electric Power Bill, and the South Wales Electric Power Distribution Bill. The only opposition raised was by Mr. Galloway, of Manchester, who did not think that Standing Orders should be suspended in order to get the Bills through in a hurry. His argument seemed to be that because the committee had taken nine weeks over the Bills, they should be talked out of existence in the House, or finally, perhaps, reach the House of Lords too late for the present session. It was a great pity that Mr. Caraway had not come into contact with the terminals of a Wilmshurst machine before making his speech, as he would then have learnt that electricity is rather apt to be in a hurry. The Jarrow and Hebburn Electricity Supply Bill and the Hastings Tramway Bill were read for a third time in the House of Lords on Monday last.

Rival Illuminants.—We have often stated in our columns that when electricity is substituted for gas in works and buildings generally a saving in the cost of lighting is usually found at the end of the year. Our friends having to do with the gas industry naturally refuse to see this, and it is only when proof comes from an independent source that the truth is really brought home to them. Such an instance as this we noticed recently in connection with St. Luke's Vestry wharf. In this case the Wharf Committee reported that they had considered the question of the cost, etc., of the electric lighting at the wharf premises. The superintendent in his report estimated that the sum of £40 had been saved during the year by only the partial use of electricity. The committee in consideration of this recommended the Vestry to substitute electric light entirely for gas, and to arrange for a connection with the County of London and Brush Provincial Company's mains for use when the supply of electrical energy by the Vestry's plant was not available. This recommendation, as would naturally be expected, was carried.

Insulating Gloves.—A competition amongst inventors of protecting insulating gloves for electricians is being arranged by the Association des Industriels de France contre les Accidents du Travail, 3, rue de Lutèce, Paris. A prize of 1,000fr. (£40) may be adjudged by the special commission to the inventor of the best glove, or be divided amongst the competitors according to the merits of their invention. These gloves must ensure a sufficient protection to the hand and forearm, be strong, and not only resist electric pressure, but also any accidental perforations which might be caused, for instance, by copper wires sticking out; they must be easy to put on to any size of hand and allow the workman the free use of his fingers for executing his work. To qualify, two pairs of gloves and a descriptive note must reach the president before Dec. 31 of the present year. The gloves and descriptions will remain the property of the association, who reserve the right of publishing any of these latter. The idea is worthy of support, as nothing is more dangerous in a high-tension station than a glove of rubber when perforated.

Municipal and County Engineers.—Mr. C. H. Lowe, the surveyor of the Hampstead Vestry, is the new president of the above association. In his presidential address delivered yesterday he gave a most interesting *résumé* of the probable changes which would be introduced in the routine of metropolitan engineers by the Local Government Act of 1899. Another topic which occurred in the presidential address was that of electric lighting. After referring to the good work done in Hampstead in the municipalisation of the electric light, Mr. Lowe proceeded to discuss the question of the control of such undertakings. He did not agree that the engineer or surveyor to a council should have a quasi-control over the management of this department, owing to the vast amount of ordinary duty, which is quite enough to occupy one man's time. Mr. Lowe considered that such a department, requiring as it does a most perfect knowledge in all its branches, should be administered by an electrical engineer entirely independent of the municipal engineer. Mr. Lowe then expressed the hope that during his tenure of office Mr. Cottam, electrical engineer to the Hampstead Vestry, could favour the association with an account of the undertaking and an opportunity of inspecting the station.

Loss of Life by Lightning.—We gather from analysis by Mr. A. J. Henry in the monthly *Weather Review* of America, interesting details as to the loss of life by lightning during the year 1899. In the United States during that year 562 persons were killed outright and 820 received severe shocks. Mr. Henry has ascertained that 45 per cent. of the fatalities occurred in the open, 34 per cent. occurred in houses, and only 11 per cent. under trees. Fully a dozen persons were killed in the act of stripping clothes which had been hanging out to dry on a wire line. Further news respecting the treatment of persons who have been struck by lightning comes from Surgeon-Major Cahen, of the French army, who reports having witnessed during a storm an officer and his horse both struck by lightning. The horse died on the spot, the officer, who seemed

Digitized by Google

to all appearances to have shared the same fate, was subjected to artificial respiration simultaneously with rhythmic tractions of the tongue. After a few minutes he began to breathe, and at the end of half an hour he was out of danger. M. Cahen says that if assistance had not been rendered at once to the officer, respiration would not have been speedily re-established, and he would have been asphyxiated. He is of opinion that in most cases a fatal issue is caused by want of immediate succour.

To Electrical Students.—A circular letter has this week been addressed to the students of the Institution of Electrical Engineers informing them that the Council of the Institution proposes to grant £5 to each of 20 selected students to assist them to visit the electrical exhibits in the Paris Exhibition. Intending candidates must fill up and return an application form (issued with the circular) before 10 a.m. on Saturday, July 28. In the selection the Council will give preference, other things being equal, to those who, being still students of the Institution, have either, or both, read papers before the students' section, or been members of the committee of that section. The conditions of the grant are as follows: (1) The selected student shall spend at least six days in Paris, the visit to commence not earlier than Aug. 27. (2) He shall write an essay or a paper on the exhibits in a special section allotted to him, and shall send the paper to the secretary of the Institution before Nov. 15, 1800. (3) The paper submitted shall, like all other papers presented to the Institution, become the property of the institution; if approved by the Council it may be read at a meeting of the students' section, and, if so read, will be eligible for the usual Institution premiums offered for such papers. We consider the above a most excellent idea, and trust that there will be a keen competition for the honour of reporting the progress shown by the exhibits.

London United Tramways.—Mr. J. Clifton Robinson, the managing director of the above tramway company, has scored another victory. Thus, the House of Lords Committee presided over by the Earl of Rosse passed on Monday last the preamble of his Bill without reservation of any kind, and the whole of the extensive scheme in the West of London, embracing the important extensions to Heston, Isleworth, Twickenham, Teddington, Hampton, and Hampton Wick, will at once be proceeded with. The present lines are already equipped, and will shortly be opened for traffic. The only opposition was that of the Middlesex County Council and a few frontagers in the Richmond-road. The Middlesex County Council *locus* was limited again, as was the case before Sir U. Kay Shuttleworth's committee in the Commons, and the frontagers on the Richmond-road failed entirely to prove a case. It seems that the Middlesex County Council persevered in their opposition because they considered that they should be the tramway authority for the whole county. In this attempt to imitate the London County Council they have not been successful, which is, we think, to the advantage of the inhabitants of their district. We offer our congratulations to Mr. J. Clifton Robinson, who, like an Irishman, will soon be spoiling for more councils to fight.

Our American Guests.—Following close on the visit by American Civil Engineers to this country, comes the news that the members of the American Institute of Electrical Engineers, who will shortly start for the Paris congress, have decided to spend a few days in London on their way. Our Institution has accordingly arranged to extend hospitality to these American engineers. The programme as at present settled includes the following items: On Sunday, Aug. 12, a trip will be made on the Thames on electric launches. A luncheon will be given to the American guests at one of the riverside hotels. The next day a dinner will be given in London, and on both Monday and Tuesday, 13th and 14th prox., visits to works in and around London will be organised. It is hoped that ladies will be brought by members to the river trip, and also to the dinner. This innovation, as far as the dinner is concerned, is greatly to be commended. The price of the dinner tickets will be 25s., including wine, while the river trip will not cost more than two guineas. The actual cost depends on the numbers who are taking part, and also on the fact that the Americans will be the guests of those who attend. The Council of the Institution expresses the hope that a large number of members and ladies will meet to give the Americans a true British welcome. Members should send their names quickly to Mr. W. G. McMillan.

Electric Discharge in Gases.—The following is an abstract of a paper by Mr. W. Wien which appeared in the *Physische Zeitschrift*. The abstract is taken from *Science Abstracts*, and reads as follows: "The electric discharge in gases takes place partly by means of material particles which, moving with great velocities, are accelerated at first positively, then, by impacts against other particles, negatively. These conditions must give rise to a radiation of electromagnetic energy. The present investigation was undertaken to see whether this energy could be measured by the difference between the electric energy supplied to vacuum tubes and the heat produced in the tubes. The E.M.F. at the electrodes and the current were measured by volt and ampere meters, and the heat produced was measured by a Bunsen calorimeter. The following table, in which some of the results are reproduced, shows that within the limits of experimental error the electrical and heat energy are equal:

E.M.F. volts.	Current amperes $\times 10^6$.	Calories $\times 10^3$ calculated.	Calories $\times 10^3$ observed.
368	1,085	95·4	94·9
535	1,152	147	149
562	5,682	763	771
682	4,394	716	713
838	2,026	406	411
932	1,731	385	393
1,650	310	122	125

Zones in Wireless Telegraphy.—At a recent meeting of the Paris Academy of Science, M. D. Tommasi read a paper describing an appliance to prevent the interception and interruption of messages to which wireless telegraphy is exposed. The apparatus is based on the principle that the distance to which electrical waves can be transmitted varies as the distance between the two metallic spheres of the oscillator. It will therefore result, that in reasonably varying the interval which separates the two spheres—that is to say, in diminishing the length of the oscillatory spark—it will be possible to regulate pretty accurately the distance that the electrical waves will be able to travel to reach the receiving post of the line. This apparatus principally consists in combining the transmitter of the aerial line, called A, by a second transmitter, B, of which the manipulator, put in motion in any fashion, sends at random long and short messages which get mixed up with those of transmitter A, its oscillator being regulated so that the zone of action of the rays emitted by transmitter B extend to a distance slightly inferior to that which the oscillator of transmitter A has been regulated. In these conditions the electrical waves emitted by transmitters A and B, mix up one with another in such a way that any receiving apparatus placed in the zone of action of transmitter B can only receive a confusion of dots and dashes, from which it will be completely impossible to determine upon the

Digitized by Google

message sent by transmitter A. It will, therefore, only be possible to receive the messages from transmitter A out of the zone of action of transmitter B. The security will be all the larger that the zone of action of transmitter B will be placed nearer to that of transmitter A.

The Chadwick Trust.—In the *Journal* of the Society of Arts for the 13th inst. will be found a full report on the work done by the trustees in connection with the above trust, which is interesting reading, as in it the rules connected with the working of the same are fully given. We notice that amongst other useful purposes to which the funds left by Mr. Chadwick have been applied, is the appointing of an assistant professor or demonstrator to the professor of municipal engineering at the University College, London. Exceedingly valuable classes are now given on the above subject, and the extra assistance provided by this trust enables much more complete organisation to be established. After detailing other work done under the Chadwick Trust, mention is made of the Chadwick scholarship of £100, which is awarded for three consecutive years, subject to certain regulations. The first of these scholarships has been given to Mr. W. P. Gorvain, who also received the Chadwick medal. During the year he holds the scholarship Mr. Gorvain will spend his time in the works of Messrs. Hawthorne, Davy, and Co., of Leeds. The trustees have also awarded a gold medal and £100 in money to Staff-Sergeant O. W. Andrews, M.B., R.N., for work done in promoting the health of the men in the navy. In the scheme a further provision is made for giving medals to those local authorities who make the greatest strides in sanitary science.

The Electric Arc.—We notice in *Science Abstracts* for June an abstract of a paper contributed by Mr. L. Arons to the *Annalen der Physik und Chemie.* The abstract reads as follows: "For the study of the electric arc as influenced by the nature of the surrounding gas, metallic electrodes are to be preferred to carbon electrodes, as their composition is better defined and they do not give out the great quantities of strange gases which render experiments in different gases worthless in the case of carbon electrodes. The gases experimented with were nitrogen and hydrogen. In nitrogen, arcs were obtained between aluminium, cadmium, copper, iron, magnesium, platinum, and brass electrodes. Tin melted at once, and between silver electrodes no arc could be made to play in an atmosphere of nitrogen. This fact is all the more remarkable as silver yields a particularly brilliant arc in air. It is evidently connected with the difference of chemical affinity between the metal and the gas in the two cases. The author found that nitrides are formed of all the other metals, but not of silver. Aluminium electrodes are covered with a greyish-black crust, whose chemical properties identify it with the nitride discovered by Mallet. Brass electrodes acquire a copper colour, owing to the greater consumption of zinc. Copper and aluminium, which in nitrogen give very beautiful arcs, give practically none in hydrogen. Platinum, silver, iron, and lead require very strong currents. The best hydrogen arcs are obtained with cadmium, zinc, and magnesium."

Electric Lighting Orders. — In the House of Commons on Thursday week, Mr. Lough questioned Mr. Ritchie, the President of the Board of Trade, as to the reason why the Board of Trade insisted on all transfers of electric lighting orders to companies being in a standard form, and refused to allow variations required by local conditions, and also on what grounds they refused to allow the insertion of agreed provisions for the reduction of the maximum price either for public or private lighting, and whether he would consider the desirability of relaxing these departmental rules. In answering these questions for Mr. Ritchie, Mr. Hanbury said that the Board of Trade did not consider that deeds of transfer under electric lighting orders should contain any provisions other than those which were consequential on the substitution of a company for a local authority as undertakers. To go beyond this was to provide under the colour of a mere deed of transfer for matters which really required the approval of Parliament. Transferees were placed in exactly the same position with regard to price as they would have been had they obtained an order originally. The price for a public supply was left to agreement, or, failing agreement, to arbitration. The price for a private supply was not specifically fixed, but was left as in the order, subject to a maximum which might be revised periodically by the Board of Trade on the representation of the local authority. He could see no reason for altering the existing practice of the Department.

Electric Traction in Berlin.—In a contribution to a German railway journal on the question of electric traction for the Berlin local and suburban railways, Mr. Schubert advocates the greatest possible distribution of traffic. With ordinary locomotives he thinks this impossible, but with electric traction he considers that 180 trains could be dispatched per hour in each direction, as against the 12 per hour at present running. The service is apparently much of the same kind as that which we mentioned in a recent issue as being given on the Swansea and Mumbles railway, where trains with several carriages run at infrequent intervals, and are then almost empty. In the case of Berlin Mr. Schubert thinks that in place of the nearly empty trains of eight or ten carriages, with accommodation for 1,450 passengers, which run during the periods of minimum traffic, a single car affording accommodation for 75 passengers might be dispatched. Electric traction would further render the present railway capable of dealing with a daily average of 253,000 passengers, the present capacity in passengers carried being only 143,000 per diem. As to conversion, also, this might be easily accomplished. For the whole of the local and suburban lines 300 cars would be necessary, while the total cost of the equipment of the lines for electric traction would be about £450,000. He questions, however, whether it would not be advisable under the existing condition of things to entirely separate the local traffic from that of the suburban circular railway, and for the present introduce electric traction on to the inner lines only.

Accumulator Cars.—Mr. M. R. Zechlin in an article in the *Centralblätt fuer Accumulatoren und Elementenkunde* speaks of the possibility of improving accumulator cars. This, he thinks, can be done in two directions: first, by decreasing the weight of the cars; and, secondly, in the use of ball bearings. By reducing the weight, he states, the tractive resistance would also be diminished, as well as the effect produced by inequalities of the road surfaces on the structure of the cars and accumulators. This economy in weight might be obtained by the judicious employment of tubular construction without detriment to the strength and rigidity of the cars, and by paying greater attention to the dimensions required for a given strength. The weight of the car itself is, Mr. Zechlin points out, of vital importance, as a surplus weight in accumulators of from 20 to 50 per cent. of the total has to be carried. This surplus weight, however, ensures the necessary adhesion of the car wheels, and therefore the endeavour of the designer should be to produce a car which, together with its complement of accumulators, is of just sufficient weight to secure the requisite adhesion under given conditions with a proper distribution of the weight. Most of the accumulator cars constructed up to the present leave much to be desired in

Digitized by Google

the direction indicated. There is apparently little room for the further improvement of the driving motors and control of the same. Neither does there seem any immediate prospect of considerable economy being effected in the weight of accumulators. A further means of improvement also, says Mr. Zechlin, consists in increasing the diameter of the bearing wheels, whereby the tractive resistance of the car may be reduced and other advantages obtained. This does not, however, apply to all forms of motor-propelled vehicles.

The North-Western Electrical Association.—The summer convention of the North-Western Electrical Association of America was held this year at the Grand View Hotel, Waupaca, at the end of last month. President Norcross delivered an address, of which we feel bound to give the following extracts in order to show that in America they make orators of their electrical engineers. Speaking of the beauty of the district he said: "We have wandered over the hills and through the dales, and have been fascinated by the varied scenery; we have breathed the pure atmosphere, have quenched our thirst from the clear water of these gem-like lakes, until we are renewed by the zeal, vigour, and spirit of eternal youth. I have no doubt but that the Indian brave wooed his dusky bride in the sweet leafy retreats about these lovely lakes, and I am equally certain that his imperial successor, the white man, in these same cool, shady, enticing bowers has found courage to woo and win a fairer, sweeter maiden. It seems to me that the god of day wears a brighter smile of gladness as he brings a fresh morning to this enchanted valley, and I can easily believe that his departure over these western hills is accompanied by a benediction and a promise. Standing in the presence of so many beautiful and wonderful objects of Nature's handiwork, we may truthfully unite with the poet in saying:

> Know ye the land of the cedar and vine,
> Where the flowers ever blossom, the beams ever shine,
> Where the tints of the earth and the hues of the sky,
> In colour, though varied, in beauty may vie."

After this burst of eloquence it makes us long to be with the North-Western at their next summer meeting. In welcoming the members, the City Attorney said he had never seen such a set of jolly men in all his life, or so many fat men. The lean years of electrical engineers are evidently a thing of the past in America.

Electrolysis of Fused Salts.—The following is an abstract of a paper contributed by Mr. A. Helfenstein to the *Zeitschrift fuer anorganische Chemie*. The abstract appears in the *Journal* of the Chemical Society, and reads as follows: "The author has electrolysed the chlorides of lead, zinc, tin, cadmium, and silver, and lead bromide and iodide, and has studied the influence of varying conditions on the current yield. Neither in a V-tube, nor in any simple apparatus which allows direct contact of the anode and cathode liquids, can a decomposition be effected equal to that required by Faraday's law. Rise of temperature, decrease of current strength, decrease of the distance between the electrodes, and prolongation of the electrolysis have the effect of diminishing the current yield; in the case of lead iodide, however, the yield increases for a certain interval, 600deg. to 800deg., with rise of temperature, probably owing to the formation of periodide. The chief cause of the imperfect yields obtained is the solubility of the metal in its fused halogen compounds, and a consequent diffusion to the anode and to the surface of the electrolyte, where the metal is oxidised or goes off as vapour. Special experiments, in which a regulus of the metal was kept in contact with its fused halogen compound, showed that the solubility and rate of diffusion increase with rise of temperature. The diffusion of the halogen from the anode, although of less account than the diffusion of the metal from the cathode, is also responsible for a diminution of the yield; this influence of the halogen increases from chlorine to iodine. An approximately theoretical yield is obtained when the disturbing factors enumerated above are removed. The anode and cathode are separated from each other, either by being enclosed in tubes with lateral openings, or by the interposition of a diaphragm. As is to be expected, the enclosing of the cathode is much more essential than the enclosing of the anode. Further, the electrolyte is allowed to solidify on the surface, so as to prevent diffusion of metallic vapour into the atmosphere, and the temperature is kept as low as possible—just above the melting point of the salt. With these precautions, a yield is obtained which is independent of temperature, current strength, and duration of the experiment."

A New Mercury Interrupter.—We notice in the *Electrical Review* of New York a description by Mr. E. W. Caldwell of a new mercury interrupter, which he thinks has advantages over other mercury or liquid interrupters. It differs from most mercury interrupters in that the break is made between two surfaces of mercury instead of between a terminal of mercury and another of platinum or other metal; the air is completely excluded from the contact points, and, consequently, no oxidisation of the metal occurs on breaking; the break is made below the surface of the liquid, where the metal is clean, instead of at the surface, where the imperfectly conducting oxides and other impurities collect. In its simplest form the interrupter consists of a small soft rubber tube about a foot long, closed at each end with a steel plug, and filled with clean mercury, which makes contact with the two steel plugs. This tube is held in a vertical position, and the primary circuit of the induction coil is completed through the mercury column. When the middle of the tube is squeezed between the thumb and fingers, the mercury column is separated into two portions and the circuit is broken with astonishing suddenness and without any visible spark. This apparatus, though it will work well for a short time, is naturally only an experimental affair, and the rubber tube eventually becomes much deteriorated from chemical combination of its sulphur with the mercury. In another variety of the interrupter the separation of the two portions of mercury between which the circuit is broken is effected by a sort of poppet valve made of an insulating material. This valve can be operated automatically by an electromagnet in series with the primary circuit. Yet another form of the instrument, and one which is capable of giving very rapid interruptions, consists of a glass outer vessel containing an inner tube of insulating material. The inner tube is closed at the bottom by a flat plug, which is perforated with a small orifice. A disc of insulating material, perforated with a number of holes near its circumference, is arranged to revolve in close proximity to the lower end of the insulating tube, so as to open and close the orifice in the plug at the bottom. The outer vessel and the inner tube are partially filled with mercury, and electrodes of steel are placed in both. These electrodes are connected in series with the primary induction coil circuit, and when the disc is revolved it rapidly makes and breaks connection between the portions of mercury in the insulating tube and the outer vessel, and thus interrupts the current supply of the coil. The sharpness of the break produced by these mercury interrupters is said to be astonishing, and they work well with a much smaller condenser than is required by the ordinary vibrating or rotary break.

Digitized by Google

GLOUCESTER ELECTRICITY WORKS.

It is always interesting when an old town is progressive enough to walk in the van of modern progress to see how it has in years gone by carried on its municipal work. We this week record the opening of the electric light station at Gloucester, the latest development of the town's activity. So far back as in the ninth year of Edward III. the town was anxious about the paving of its streets, and was granted toll for seven years for this purpose. The toll was renewed for five years by Henry IV., and in the reign of Edward IV. an Act was passed to compel the inhabitants to pave the streets, and a year subsequently by charter the Corporation was empowered to do this work. Whether the obtaining of a pure water supply comes before or after the paving of the streets, we find that at Gloucester, as in so many other places, the obtaining of water was due to the forethought and the energy of the clergy. It was in 1438 that the Grey Friars granted that water might be brought from Robin Hood Hill for the use of the city. It was brought by an aqueduct at the centre of the street crossings. Lenaud says: "The beauty of the town lies in two crossing streets, and at the place of the middle meeting is an aqueduct incallated." This aqueduct remained till the reign of George II., when it was taken down, because, being situated in the centre of the four principal streets, it greatly interrupted the passage of carriages. Thus it will be seen that this city has had a long and interesting municipal career.

The electric light plant, which was officially viewed by the Mayor and Corporation yesterday and declared opened, is an example of the modern municipal enterprise of the citizens of Gloucester. The history of the electric light question in Gloucester dates from June, 1889, when four companies gave notice of their intention to apply to the Board of Trade for provisional orders authorising them to supply electricity within the district of the city of Gloucester. A report was then prepared explaining the various courses open to the Council, and it was decided not to consent to the application of any company, but to obtain further information, and consider whether or not the Council should itself apply for such a provisional order. Notices were given by three companies in 1890, by one company in 1891, and by two companies in 1894, but no further proceedings were taken by any of the companies. In 1895 one company again gave notice, and proposals were made by the City of Gloucester Tramways Company, Limited, for a combined scheme for electric lighting and traction. A deputation from the Corporation visited Bristol and inspected the electric lighting installation of the Corporation and the electric traction installation and the tramways of the Bristol Tramways Company. On Nov. 12, 1895, the Corporation decided not to consent to the application of any company, and resolved, with one dissentient, to apply for a provisional order authorising the Corporation to supply electricity for public and private purposes within the city, and the application was granted by the Gloucester Corporation Electric Supply Order, 1896, confirmed by the Electric Lighting Orders Confirmation (No. 1) Act, 1896. In February, 1897, a special committee was appointed to consider what steps should be taken under the order, and, on the recommendation of the committee, the Council in April, 1897, decided to exercise the powers given by the order, and began to look after a suitable site for the works. In June, 1897, the Council consulted Mr. Robert Hammond, M.I.C.E., and instructed him to prepare a preliminary report dealing generally with the question of

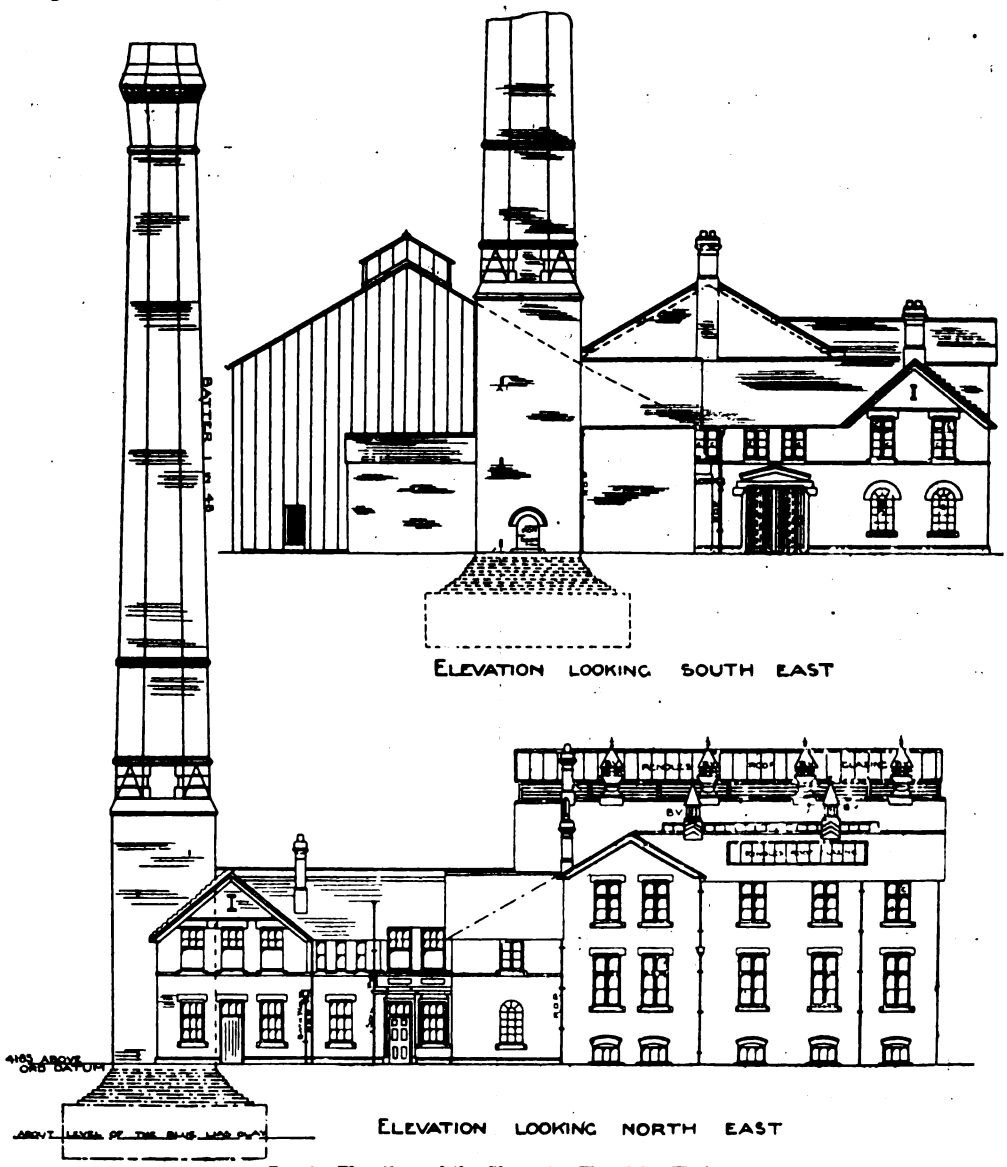


FIG. 1.—Elevations of the Gloucester Electricity Works.

Digitized by Google

electricity supply for lighting and other purposes, and with the question of providing a refuse destructor. In August, 1897, after considering Mr. Hammond's report, the Council unanimously decided to establish electricity supply works, with a refuse destructor in connection therewith, and engaged Mr. Hammond to prepare a scheme on the lines suggested in his report, and afterwards to prepare plans and specifications for and superintend the carrying out of the work. A sub-committee (accompanied by Mr. Hammond) visited the works at Cheltenham, Newport, Reading, St. Pancras, Islington, Leyton, Tunbridge Wells, Brighton, Shoreditch, St. James, Manchester, and Leeds. The sub-committee were thus enabled to verify much of the information given in Mr. Hammond's report; but they gave special attention to a number of points which the report left open for consideration—such as site, character of engines and plant, terms of supply, etc., and to financial and other matters, a knowledge of which might be useful in settling the details of the Gloucester scheme. The sub-committee thus obtained much valuable information, which was summarised in a report presented to the Council in October, 1897. Although the question of electricity supply was under consideration for a long time before the Corporation obtained and proceeded to carry out the powers given by the order of 1896, the time was not wasted, as it enabled the Corporation to ascertain and profit by the experience of other boroughs, and led to unanimous adoption of a really comprehensive scheme, which has met with the general approval of the citizens. At first much difficulty was experienced in finding a suitable site, but the question was happily solved by the Corporation purchasing the Bearland Estate and adjoining properties as an investment for corporate funds, and obtaining the sanction of the Local Government Board to use a portion of the property as a site for the electricity works. A most excellent site has thus been acquired in a central position, easy of access, and near to the river, canal, and dock branch railway. The Corporation have had an excellent adviser in Mr. Robert Hammond, and have been very fortunate in being able to let the whole of the works to contractors of the highest standing, although generally accepting the lowest tenders.

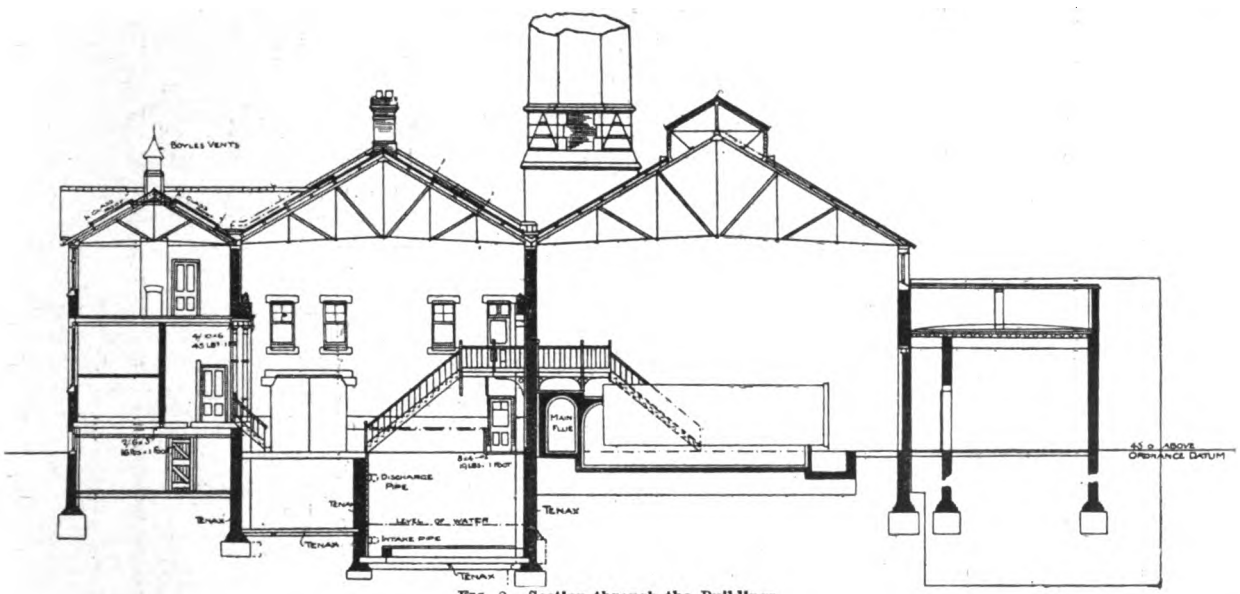


FIG. 2.—Section through the Buildings.

BUILDINGS.

The site of the generating works in the south-west part of the city has a pleasing historical interest. Situated within the south-west corner of the old Roman wall, it must have been, in times long gone by, the scene of many exciting incidents. The old wall from the South Gate passes through Kimbrose, down Commercial-road, turning through the yard of the electricity works, into and up Barbican-alley, and thence across the Bearland to the West Gate. Originally it was surrounded by a ditch and a rampart of earthwork, the rampart at this spot being of natural formation. On the ground now occupied by the Commercial Rooms was raised "an artificial mound towering high over all," the base of this probably extending over part of the site now occupied by the electricity works. This mound was the look-out of the ancient Britons, and from its summit a most extensive view across the river and vale and to the surrounding hills could be obtained. This mound, or "barbican," was in existence at the time of the siege of Gloucester in 1643, and was, no doubt, also utilised by the citizens as a "watch place" to observe the movements of the king's army, which then encompassed the city. Bearing in mind the historical associations of the site, it is interesting to find that during the work of excavation for the foundation of the chimney stack several large stones belonging to the old Roman wall was found. To place this discovery on record one of the stones has been re-worked, and the following inscription cut into it: "While excavating for the foundation of the chimney stack in May, 1899, this stone, which formed part of the old Roman wall of the city, was met with at 15ft. below the ground," and it has been built into the wall running opposite the front entrance to the works. Many small pieces of pottery, some few coins, and other things were also found; but a still more interesting discovery was made in the south-east part of the site, when digging the trenches for the foundation of the north-east wall of the switch and test rooms, the end of a large pit about 9ft. wide and 8ft. deep from top to bottom being come across. The walls of this pit were formed with very large oak beams, varying from 9in. to 15in. square, placed closely one on top of the other, making it perfectly solid, and on the outside clay puddling appears to have been put. The pit was perfectly full of animal bones of all descriptions, and in addition to this was found Roman snail shells, oyster shells, etc. Above the pit, and on the south-west corner of it, was a portion of a stone column, 12in. in diameter, which may probably have been part of a small temple once existing there. It is thought very probably that the pit before referred to may have been for the reception of the bodies of animals after being sacrificed upon an altar which stood near. Electricity works do not naturally lend themselves to elaborate architectural adornment, and it will be seen from Figs. 1 and 2 that no attempt has been made at unnecessary ornamentation, but the architect has, nevertheless, produced a structure which does credit to his profession. The whole of the building work has been carried out by the local firm of Messrs. John Gurney and Sons. The buildings are constructed of brick, with Bisley stone dressing, and in planning them care had to be taken to allow ample room for future extensions, and to plot them in such a way that the refuse destructor, for which contracts have been let, should form part of the same building. The natural formation of the site admirably adapts itself to what is required for the destructor. The buildings, which were designed by Mr. Harry A. Dancey, of Gloucester, consists of a lofty engine-room and boiler-house and a well-arranged suite of offices. The engine-room (Fig. 3) is 54ft. by 37ft. and 28ft. high.

Digitized by Google

The interior walls are executed in buff bricks, with a dado of brown glazed bricks, finished with a moulded capping. In the north-west corner of the engine-room is the condenser pit, the floor of which is 12ft. below the engine-room level. Running along the south side of the engine-room is the switch-room, and running behind this is the test-room. The level of these two rooms is 4ft. higher than the floor of the engine-room. This enables the switch board attendant to obtain a good view of all the machinery. The boiler-house runs parallel to the engine-room, and is of slightly larger dimensions. It provides space for four boilers, and also contains the pump-house and economiser. The chimney stack is 150ft. high, with an internal diameter which is nowhere less than 6ft. From the top of the stack a magnificent view may be obtained, and on the completion of the work the opportunity was taken to photograph the grand old cathedral.

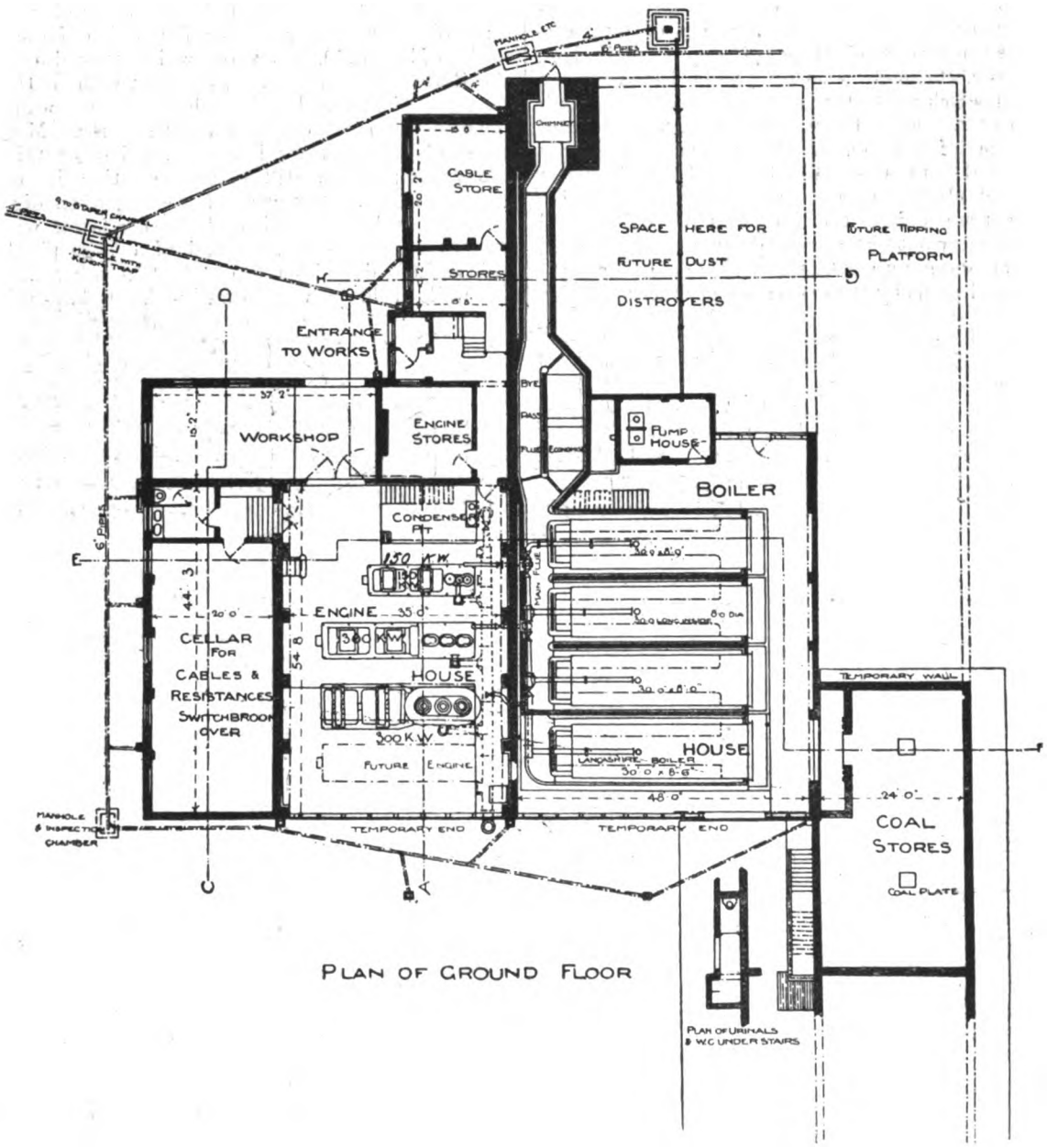


Fig. 3.—Plan of the Gloucester Electricity Works.

Steam Generating Plant.

The boiler-house (Fig. 4) contains three Lancashire boilers by Messrs. Yates and Thom, of Blackburn. Each boiler is 30ft. long by 8ft. in diameter. They are made of steel throughout, and are constructed for a working pressure of 160lb. per square inch. The shells are composed of seven rings, each made from one plate $\frac{13}{16}$in. thick. The boilers are fitted with Proctor's mechanical stokers. The dampers in the side flues are worked from the front end of the boilers, the balance weights being arranged to work in guides, which are graduated to show the opening in inches and feet. Water is fed into the boilers by a compound double-acting ram pump, made by Messrs. Evans, of Wolverhampton, with an injector as stand-by, and the feed water can be passed directly into the boilers, or, alternately, through a feed heater and a Green's economiser containing 96 tubes. A Bruce Peebles 5-kw. shunt-wound motor placed outside the pump-house drives the shafting for the mechanical stokers and the scrapers for the economiser. The main steam and feed pipes are of lap-welded steel, and the whole of the pipework was entrusted to Messrs. Ashton, Frost, and Co., Limited, Blackburn. The steam and feed pipes are all of lap-welded steel, having special thick flanges welded on and drilled for bolt holes. The exhaust pipes are all of cast iron, flanges faced, and the holes drilled and harboured for nuts. The feed pipes are all of steel, galvanised inside and out. The pipes have a special automatic provision for exhausting the atmosphere in event of anything going wrong with the condenser, and are generally arranged in an up-to-date manner.

Engine House Plant.

The generating plant at present at work consists of two combined sets. The larger set (Fig. 5) is composed of a triple-expansion engine, with one high and two intermediate cylinders placed above three low-pressure cylinders, working on cranks set 120deg. apart. The engine runs at a speed of 350 revolutions per minute, and is designed to give 500 i.h.p. with 160lb. steam pressure. To this engine are coupled two Silvertown dynamos, the two being capable of giving an output of 300 kw. at any pressure between 440 and 500 volts. The dynamos are of the single horseshoe

Digitized by Google

type, with drum bar armatures and shunt-wound magnets. The smaller engine is a two-crank compound engine, pressure from 220 to 250 volts, these machines being of the same type as those of the larger set. The engines,

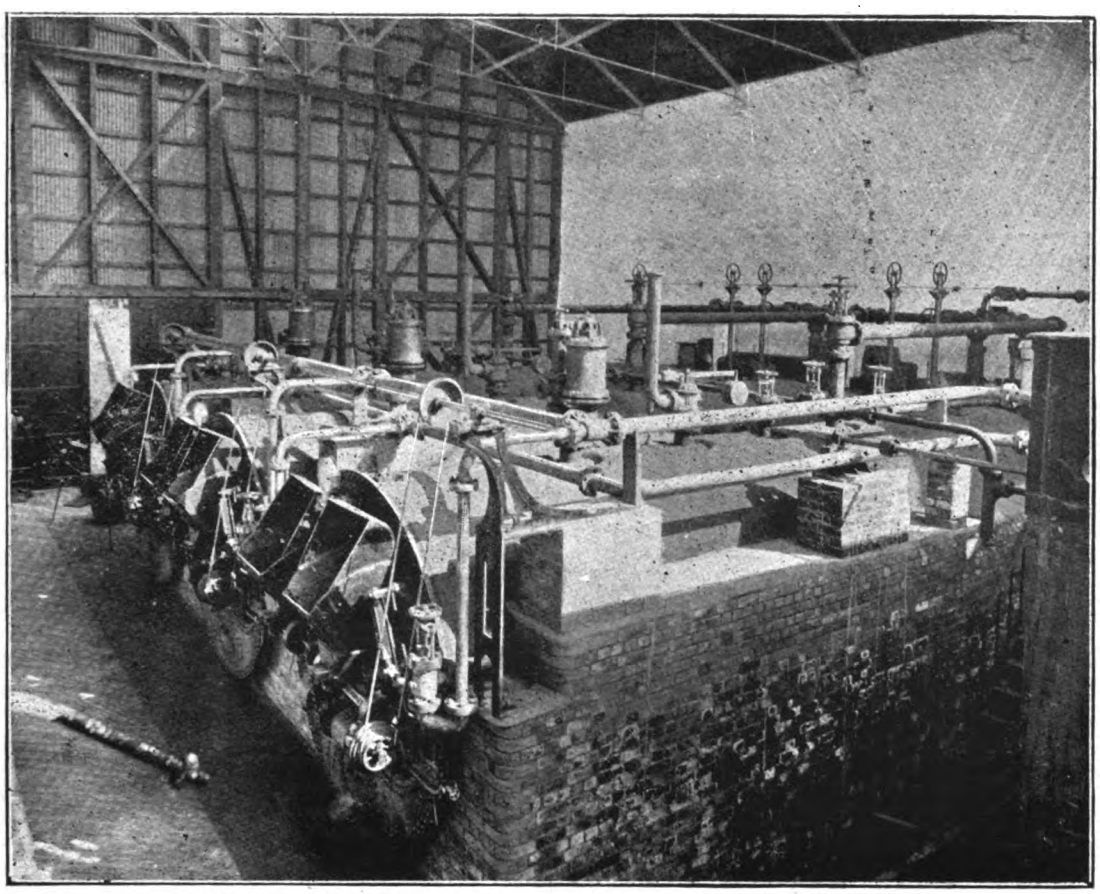


FIG 4.—View of the Gloucester Boilers, showing Mechanical Stokers.

with one high and one low pressure cylinder, working on cranks set 180deg. apart, the steam being distributed by a single piston slide valve of special design placed between them. The engine runs at a speed of 380 revolutions per minute, and will give 250 i.h.p. with 130lb. of steam. The engine drives two Silvertown dynamos, each having a capacity of 75 kw. at any which were made by Messrs. Belliss and Morcom, Limited, of Birmingham, are fitted with their patent system of forced lubrication. In this system a small pump, worked off the main shaft, supplies oil under pressure to a series of pipes, which convey the oil to each bearing, and ensure every working part being thoroughly lubricated. By this means the engines are enabled to

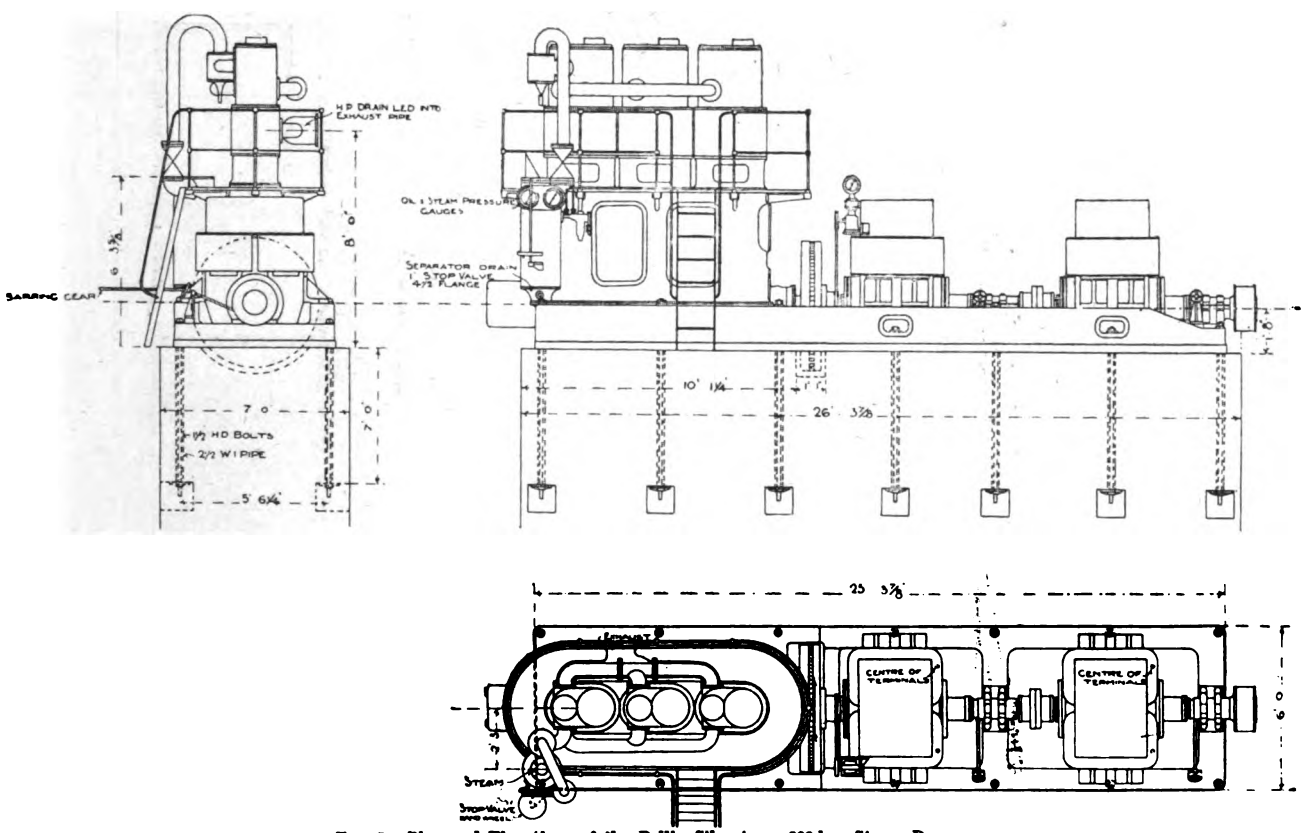


FIG. 5.—Plan and Elevations of the Belliss-Silvertown 300-kw. Steam Dynamos.

Digitized by Google

make uninterrupted runs for long periods without any undue consumption of oil. The design, truth of workmanship, and accuracy of adjustment of the plant are of the highest class, and permit of the engines running

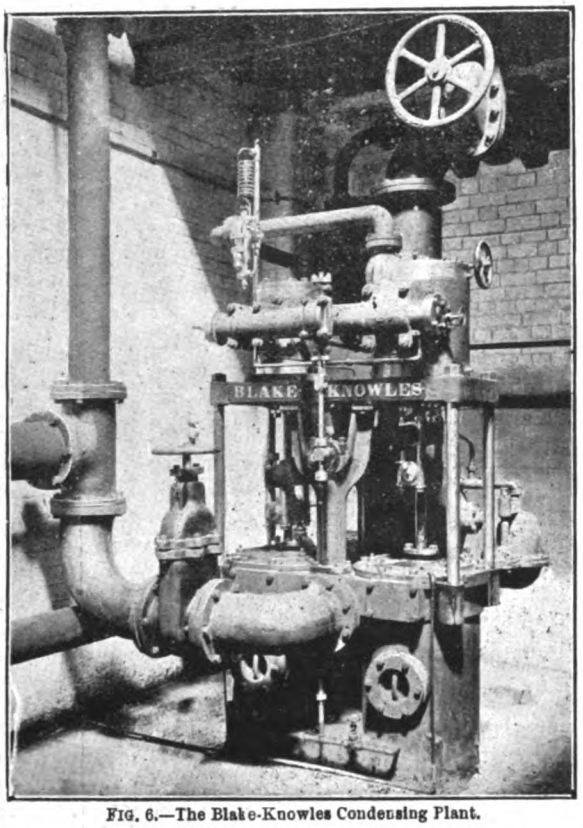


FIG. 6.—The Blake-Knowles Condensing Plant.

quietly and without trouble at the high speed at which they work. A 15-kw. booster is placed in the engine-room, and provides the necessary additional pressure for charging the battery. It consists of two single horseshoe under-type machines, coupled together and mounted on the same bed-plate. One machine runs as a motor, and obtains current from the 'bus bars at 220 to 250 volts. It drives the other machine, which is a generator, and is designed to give a current of 100 amperes at any pressure from 20 to 150 volts when running at a speed of about 780 revolutions. In the condenser pit the Blake and Knowles Steam Pump Company have erected two of their jet condensing plants (Fig. 6) Each of these is capable of dealing easily with 10,000lb. of steam per hour, and of maintaining a vacuum of 26in. under all normal conditions of atmospheric pressure. An overhead travelling crane spans the engine-room. It was made by Messrs. Spencer, of Hollinwood, and will lift a weight of 10 tons. Fig. 7 shows a general view of the engine-room as at present equipped.

THE SWITCHBOARD.

The switchboard, which can be seen in plan in Fig. 3, stands on a gallery on one side of the engine-room. It consists of nine enamelled slate slabs fixed in a wrought-iron frame, which rests on a plinth of glazed bricks. The slates are insulated from the iron frame by ebonite bushes and washers, and the uprights of the framework are hidden by a polished beading, which gives a very neat appearance to the board. The switchboard is divided into three parts: the positive on the right, the booster and battery switches and instruments being in the centre, and the negative on the left. The general view of this switchboard as included in the first contract is given in Fig. 8, but Fig. 9 will be of more interest to our engineering readers as giving the diagram of connections used. These can be readily followed, but we would call special attention to the accumulator switches and to the connections whereby a single boosting dynamo allows of the whole of the accumulators being charged while the accumulators are still on the lighting circuit. In order to do this, the regulating cells are arranged at the earth end of the two batteries. When it is required to charge the accumulators, the discharge switch contact is moved back until the number of cells across either side of the three-wire system is so few that they can be charged at the then voltage of supply. The series of regulating cells cut out of the circuit is then charged by the single dynamo provided for that purpose. The charging contact can be varied in such a way that the end cells when fully charged can be cut out. The path of this charging current from the booster is as follows: From the positive brush to the battery-charging switch of the positive battery, hence through the cells to the discharge contact. From this it passes to the battery-discharge contact on the negative battery, through the end cells of that to the charging

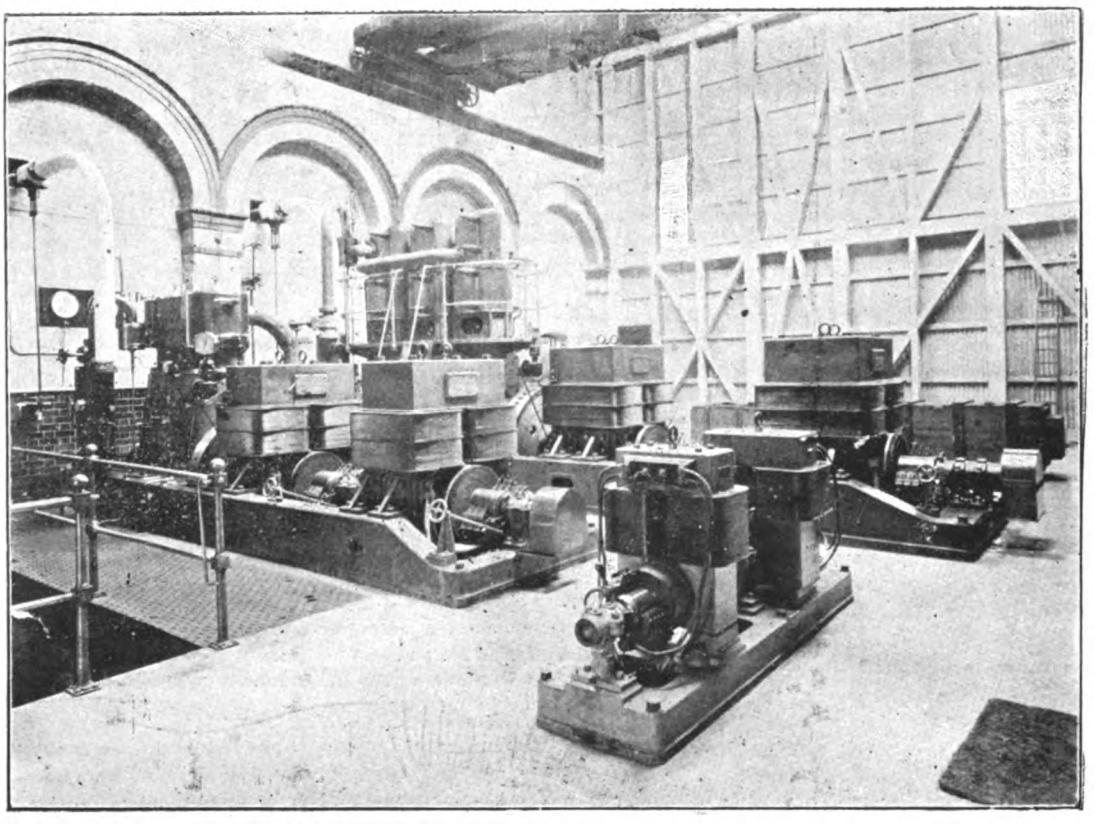


FIG. 7.—View of the Engine-Room at the Gloucester Electricity Works.

Digitized by Google

contact, and back to the booster. These regulating switches would seem, from the front view (Fig. 8), to be of circular form, but these circular series of contacts are only dummies. beneath the handwheel in synchronism with the accumulator regulating switch. In this way troubles from back lash are avoided. In addition to the above, provision is also made that

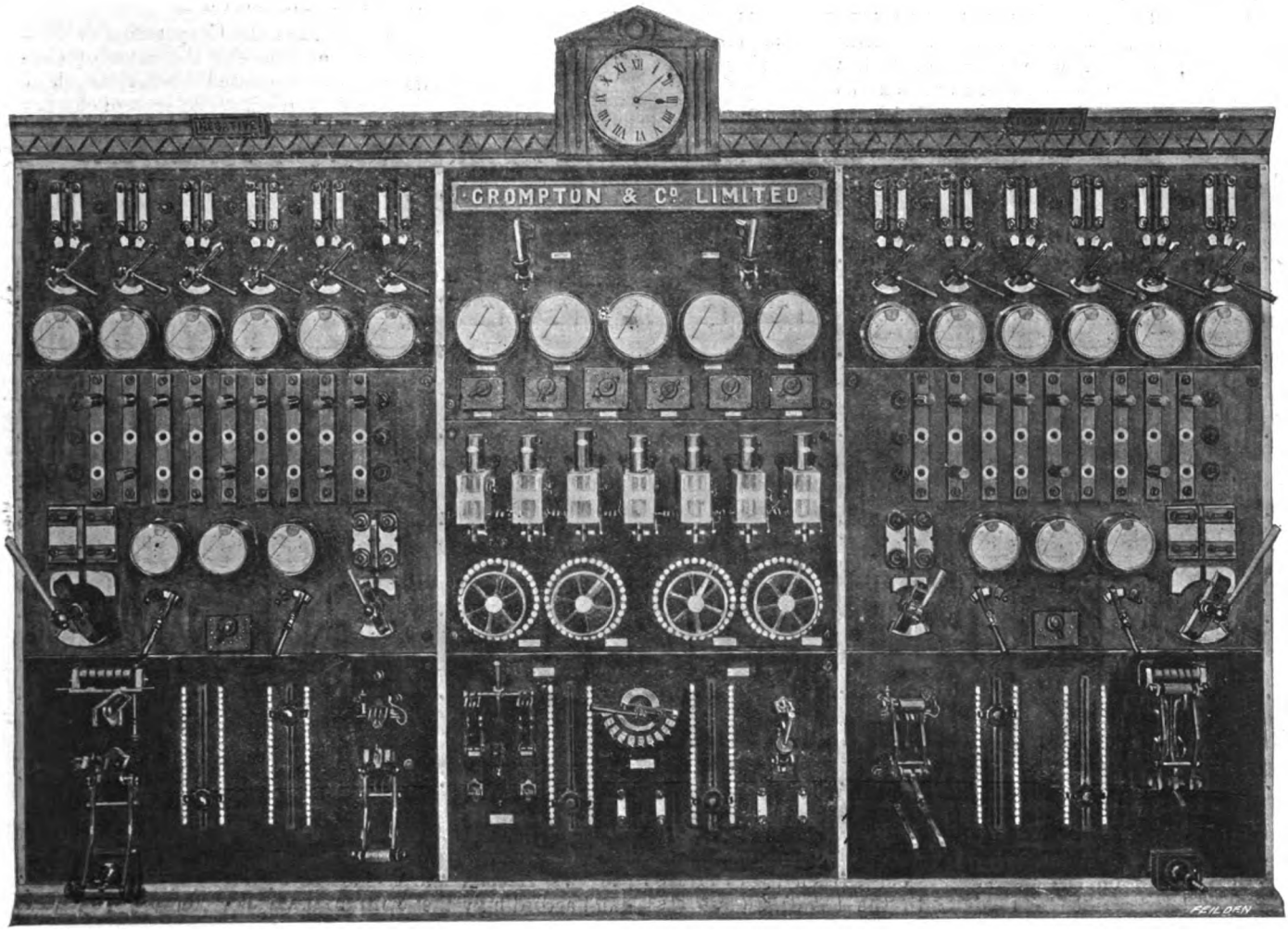


FIG. 8.—Front View of the Gloucester Switchboard.

The switch gear is placed in the accumulator-room, and the handles on the board work by means of bevelled gearing vertical rods, which move the real switch contacts above by the regulating cells cannot be reversed due to the discharge switch being moved ahead of the charging switch. Alarm contacts are provided on the accumulator regulators, which

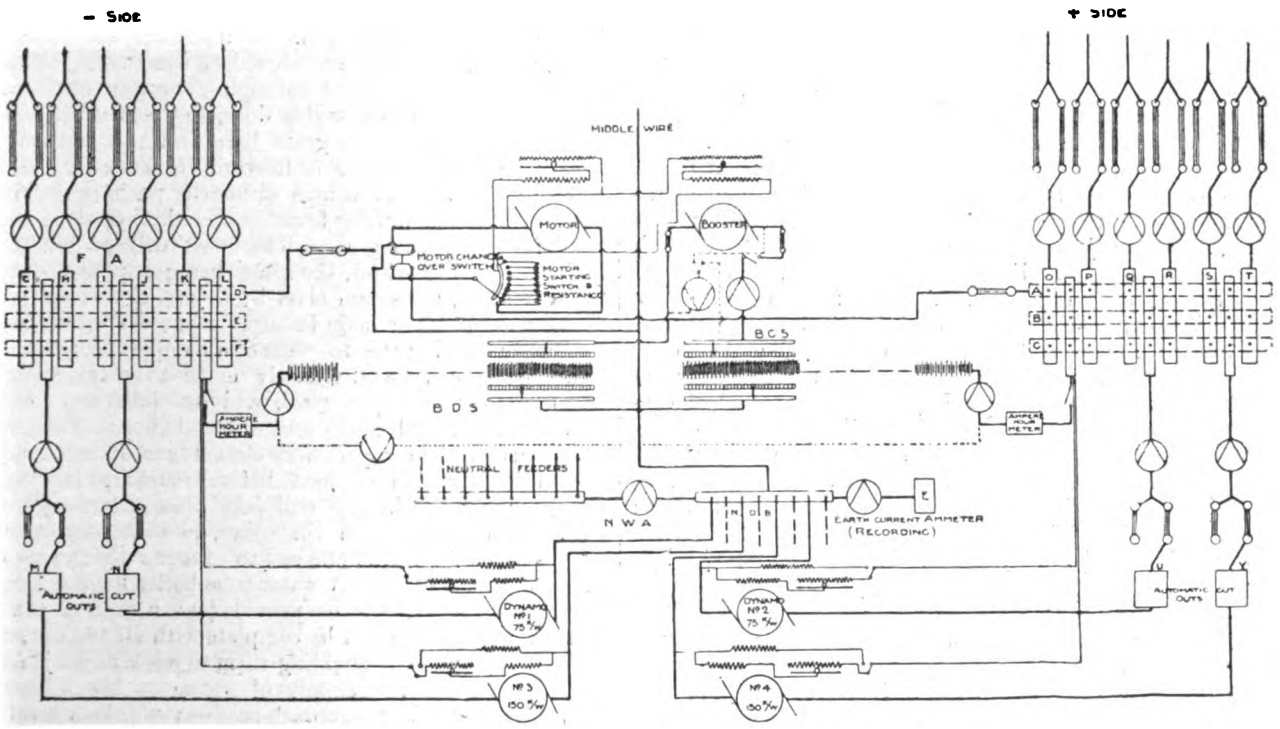


FIG. 9.—Diagram of Switchboard Connections.
B D S, battery discharge switch; B C S, battery charging switch; N W A, neutral wire ammeter.

means of worm gear. In this way a large movement of the handwheel corresponds to one contact, and a suitable reduction gear behind the switchboard keeps the indicator complete the circuit of an alarm bell if an attendant should try to do this. Another good feature in the switchboard is the insertion of slate ledges between each of the duplex

Digitized by Google

fuses, so that the blowing of one fuse may not cause an arc which sets off its neighbour. There are three plug bars on both the positive and negative sides of the switchboard, so that three different voltages can be used if it should be necessary. In connection with the earth a recording ammeter is provided, together with an alarm bell, which rings if the current through the earth circuit exceeds 10 amperes. An automatic switch, which falls at 10 amperes, puts a resistance in between the earth-plate and the centre wire. The whole of this switchboard and gear, together with most of the measuring instruments on it, were manufactured and supplied by Messrs. Crompton and Co., of Chelmsford. The dynamos and the booster are connected to the board by means of indiarubber lead-covered cables drawn into Doulton casing, and the battery is coupled up by ½in. copper rod run on insulators, which are suspended on wrought-iron straps from the roof. The whole of the switchboard work and the cable and copper connections have been carried out by Messrs. Crompton and Co., Chelmsford.

Accumulators.

The accumulators, which were supplied by the Electrical Power Storage Company, Limited, are of their K W S type. Each of the two batteries contains 140 cells, with the following capacities for discharge—*i.e.*, 210 amperes for two hours, or 168 amperes for 3½ hours, or 112 amperes for seven hours, while for a discharge lasting over 10 hours 80 amperes can be taken. There are 30 plates to each cell, which are contained in wood boxes lead-lined. These plates are separated by circular glass tubes held in place at the top and bottom, and the cells are placed on two-tier stands with iron standards and wood bearers. The approximate weight of each cell complete with acid is 435lb., and the external dimensions 2ft. 1½in. by 1ft. 1½in. by 1ft. 7½in. height over all.

The Mains.

This important part of the work was entrusted to the Callender Cable and Construction Company, the mains being laid on the "solid" system. Briefly, this method may be described as follows: In the trench, square cast-iron troughs are laid, into which, at intervals of about a foot, are placed wooden bridge pieces for supporting the cable. A clearance all round the cable is thus provided, so that when bitumen is poured into the trough it flows all round the cable. Over the troughs are laid cast-iron covers. For the private supply the electricity is conveyed from the generating works to various parts of the city by six feeder cables, which feed the network of cable that distributes the current amongst the consumers. The five principal feeders are of ·4 square inch section, the other being ·25 square inch. By the side of each feeder a three-core $^{7}/_{20}$ "pilot" cable, lead sheathed and armoured, is laid direct in the earth, and runs from each feeding point to the main switchboard at the generating works. The distributing mains form a complete network of cables of various sizes, and are joined up to the feeders in Callender's disconnecting boxes. From the distributors, service lines are run to each consumer. All the feeders and distributors are triple-concentric lead-sheathed cables, which are further protected by bitumen compound in the cast-iron troughs. The cable used for conveying the energy to the public street lamps is a $^{7}/_{16}$ single lead-sheathed conductor laid direct in the ground. Each section of the public lighting cable is connected at suitable points to the network. The total amount of cable laid up to the present is 23¾ miles. This length can be dissected as follows: length of feeders, 3¾ miles; pilot cables, 3¾ miles; distributing cables, 12⅓ miles; and arc lighting cables, 3¾ miles.

Public Lighting.

At the present there are 44 arc lamps in use for the street-lighting, these being grouped in four series of nine lamp each and two series of four lamps each, and supplied with energy from the distributing network. The lamps are the Brockie-Pell single-carbon type, and are erected on posts supplied by Messrs. Hardy and Padmore, of Worcester. Each lamp is provided with an automatic switch, which inserts substitutional resistance if the circuit in the lamp be broken. For trimming and repairs the lamps are lowered by means of a winch fitted at the base of the pillars.

System of Charging.

After very careful consideration the Corporation decided to adopt a sliding scale system, whereby the price of electricity to any consumer will be regulated by the length of time during which the supply is used. The scale of charges has been fixed as follows: 7d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand recorded by the indicator and 2d. per unit for all consumption during the quarter beyond the above. The object of this sliding scale of charges is to provide for the payment by each consumer of the due proportion of the charges which are involved in laying down and always keeping ready the necessary plant for the supply of the full unit of electrical energy which the consumer may at any time demand. For motive power the following rates have been adopted: 4½d. per unit for any number of units up to the equivalent of 100 hours' use per quarter of the maximum demand recorded by the demand indicator, and 1½d. per unit for all consumption during the quarter beyond the above. That this is an extremely favourable rate to the consumer will be seen from the following: for a use of one hour per day of the maximum demand, the average price per unit will be 4·5d.; for two hours, 3·15d.; for four hours, 2·32d.; for six hours, 2·05d.; and for 12 hours, 1·77d.

The Refuse Destructor.

The population of the city is about 42,000. The refuse is collected from 9,000 houses three times per week on alternate days, and averages 25 tons per day, or 150 tons per week of six working days. The City Council desired to thoroughly cremate without causing a nuisance, and in such a manner as to utilise the heat in raising steam for the electricity works. Among the various plans submitted in response to the advertisement for tenders, it appeared that the twin-cell destructor of Messrs. Heenan and Froude best fulfilled these conditions, and accordingly the contract was allotted to them. The destructor, having a burning capacity of 50 tons per 24 hours, will consist of two cells side by side, only separated from each other by a low bridge like that at the back of a boiler, so that an open communication exists between the two cells. Each cell will have a charging door on one side of the furnace, corresponding to the clinkering door on the opposite side, and the combustion chamber will be placed above the two cells, extending the whole length of them, the boiler being fixed above the combustion chamber. The feeding will be done through a hopper provided in connection with each charging door, so that the refuse may be put straight on to the grate bars, and the men on the clinkering side can pull it forward if necessary, so that there will be a direct course either by pushing from the charging door, or pulling from the clinkering door, to get the refuse into the grate. The blast will be fed to the underside of the ashpit, the grate being supplied with air blast by a fan, the steam blast by a jet—the whole under entire control. The main feature of the destructor is that by simply altering the direction of a damper the gases from either grate can be alternately made to travel over the hot fire in the other grate, and so into the combustion chamber, and, finally, into the boiler. The whole apparatus will be compact and close together, without any long flues for loss of heat before reaching the boiler. Charging and clinkering will take place alternately, first with one cell and then the other, so that there will be always a hot fire in the one cell to cremate the smoke and fumes from the other. A water-tube boiler having 1,300ft. of heating surface will be provided over each of the two pairs of cells. These will be complete with all the necessary fittings and pipework, enabling them to work in conjunction with the boilers for supply of steam to the electricity works engines. The approach roadway will be a level one on an inclined ground, so reversing the more usual order. A portion of the roadway will be partly of girder construction, so that the space below can be used for coal storage and bunkers. Ample space is allotted for the clinker-cooling yard.

Digitized by Google

Extension of Plant.

As soon as the work of laying the mains was begun, a great demand for electricity was made upon the Corporation by intending consumers, with the result that before the works were completed the demand had already outstripped the effective capacity of the original plant. It was necessary, therefore, to make arrangements for meeting the unexpected large requirements, and extension of the works had to be undertaken before the original plant had been got into use. The extension contracts were allotted as follows: Boiler-house plant—one Lancashire boiler, 30ft. by 8ft. 6in., capable of evaporating 8,000lb. of water per hour, and fitted with Proctor's mechanical stokers. The contract was given to Messrs. Tinkers, Limited, of Hyde, who have now in hand the above-mentioned boiler, which is suitable for a daily working pressure of 160lb. per square inch, the shell of the boiler being made of plates $\frac{7}{8}$in. thick, the flues of plates $\frac{9}{16}$in. thick, and the end plates $\frac{13}{16}$in. thick. The engine-house plant is to be supplied by Messrs. Mather and Platt, of Manchester, and consists of a Willans patent central-valve triple-expansion engine of 500 i.h.p. (3-R size), running at 320 revolutions per minute, coupled direct to two Mather and Platt 150-kw. dynamos. The set is capable of giving an emergency overload of 330 kw. The diameters of the engine cylinders are as follows: high-pressure, 300mm. (11·8in.); low-pressure, 480mm. (18·89in.); low-pressure, 720mm. (28·34in.); stroke, 264mm. (10·24in.).

The supply of current at the station is on the three-wire system at 220 and 440 volts, and the set supplied consists of a couple of the above-mentioned Mather and Platt machines coupled direct to one engine, each dynamo being arranged for work on either side of the system. They are of the four-pole type, and each is designed for a normal output of 680 amperes at 220 to 250 volts, at a speed of 320 revolutions per minute. Each is capable of giving 750 amperes as an emergency load for a period of two hours. The magnet ring is of special well-annealed steel with the limbs cast on; it is divided horizontally at the centre. The magnets are fitted with removable brass spools, and provided with a shunt winding. The armature is of the drum type, wound with copper strip, laid in insulating troughs, and securely embedded in slots on the surface of the core. The armature and commutator are designed with ample through ventilation, enabling the machinery to run for long periods without undue heating. The commutator is provided with a liberal brush surface; there are four brush spindles, each fitted with seven carbon brushes. The bearing is of the spherical adjustment type, and is provided with two loose rings dipping into an oil-well, the arrangement ensuring continuous automatic lubrication.

The extensions to the switchboard were placed in the hands of Messrs. Crompton and Co., the makers of the original board. The condensing plant consists of one jet condenser, capable of dealing with 10,000lb. of steam per hour. This is to be supplied by Messrs. Ed. Chester and Co. The extension plant is in the hands of the manufacturers, and will be ready for use next winter.

The original loan borrowed by the Corporation for the purposes of the electricity supply was £43,450, and at a recent Local Government Board enquiry an additional loan of £18,000 was granted for the extension plant referred to and for the refuse destructor.

Our thanks are due to Mr. Hammond for the use of the drawings from which the diagrams were prepared, and to the various contractors for information given. The views are from photographs taken by Mr. A. H. Pitcher, of Gloucester.

THE HEMINGWAY-COLEY AUTOMATIC REPLACING FUSE.

This fuse, which, we understand, is the invention of Mr. R. J. Coley, is designed to provide against the extinction of light frequently caused by momentary short-circuit. This is done by providing two fuses, the second of which automatically comes into action when the first has been blown. The assumption is that the interval between the blow of the first fuse and the switching-in of the next is sufficient under ordinary circumstances for the accidental short-circuit to have ceased to exist. In Fig. 1 the first fuse is in circuit, which connects one fuse block to the movable contact on the right-hand side of the figure. This contact is constrained by a spring, which tends to close the connection to the subsidiary fuse. It is prevented from doing so by the fuse wire, which is in

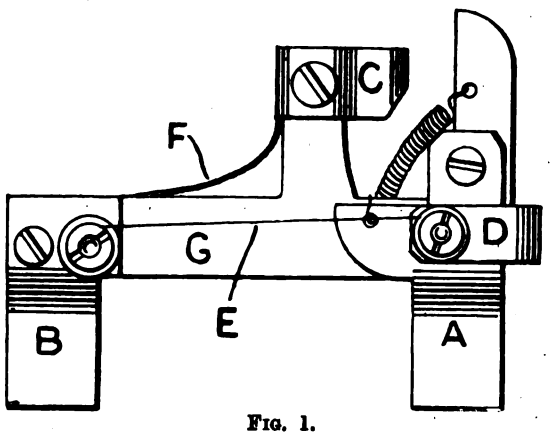


Fig. 1.

tension. As soon as this fuse wire melts, the revolving contact flies over, and put the second fuse in circuit. Fig. 2 shows the apparatus as it would be seen after the first fuse has blown. The letters on the diagram mark the following parts: *a* is the subsidiary contact, and *b* is that contact which is common to both fuses. The plate, *c*, carries the other end of the secondary fuse, and connection is made with this by means of the lever work, *b*. The whole of the fuses are mounted on an insulated bar, *g*, the fuses being labelled *e* and *f* respectively. We are informed that these fuses have stood the test of practical work, but there are certain details in the

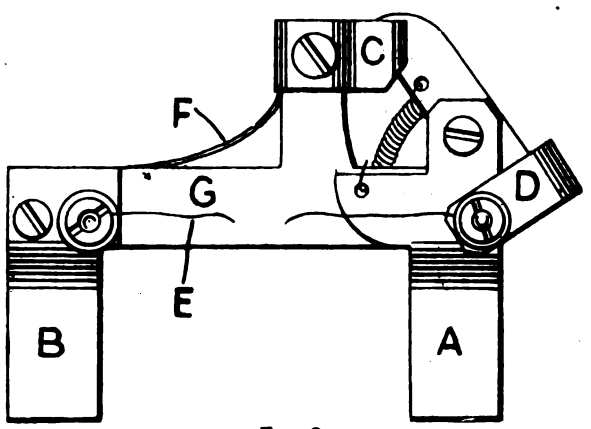


Fig. 2.

samples which have been sent to us which should be modified before they are manufactured in great quantities. We believe they can be procured from Mr. Hemingway, 39, Victoria-street, Westminster.

THE SOUTHPORT ELECTRIC TRAMWAYS.

OFFICIAL INAUGURATION OF THE SYSTEM.

Southport is to be congratulated upon the unmarred success which attended the official inauguration of its system of electric tramways on Wednesday, the 18th inst. One is prepared for hitches on such occasions, but no hitch of any kind whatever occurred during the ceremony in question. Everything worked like a clock, and, indeed, the service of electric trams in Southport might have been in operation for months past for all that a casual observer might have detected, had it not been for the gay manner in which both cars and streets were decorated. According to programme, the guests, who formed a very numerous party, including many well-known tramway engineers and others, assembled at the town hall at 11 a.m., whence they pro-

Digitized by Google

ceeded to Hoghton-street to witness the starting of the first car by the Mayoress (Mrs. T. P. Griffiths), and the second and third by Mrs. G. F. Travis (wife of the chairman of the Tramway Committee), and Mrs. T. Jones (wife of the chairman of the Electricity Committee) respectively. Several other cars also took part in the procession, all being well filled, though not crowded. The cars proceeded in company for a couple of miles or so, and then took different routes to the generating station and new car depôt, which were duly inspected. The journey was accomplished in delightful weather and without incident. During its course those present had an opportunity of admiring the neat, if not elaborate, design of the overhead equipment, while not a few envied Southport its wide, level roads and other natural advantages which help to assure the success of electric traction. The natural advantages in question, coupled with the substantial manner in which the work has been executed throughout, makes the success of the undertaking a foregone conclusion.

The lines opened on Wednesday are entirely new, and at present quite distinct from the other tramways within the borough, though this is not likely to remain the case for long, since further new lines are contemplated, besides the conversion, at an estimated cost of £40,000, of the tramways recently purchased by the Corporation from the Birkdale and Southport Tramways Company. As will be seen in another column, the application by the Corporation for sanction to borrow this amount formed the subject of a Board of Trade enquiry on Tuesday last.

Upon their return from the inspection of the overhead equipment, car depôt, and power-house, which we propose to describe fully in a future article, the guests were entertained to luncheon at the Queen's Hotel. The repast consisted of an excellent cold collation—*mit sud-deutscher Bedienung*—and provided a fitting termination to the day's proceedings. The sole fault was with regard to the speechmaking, which was prolonged to rather an unnecessary length.

The MAYOR (Mr. T. P. Griffiths), who presided, in proposing "The Southport Corporation Tramways," expressed a belief that the new tramways would prove a very successful undertaking. The permanent way was thoroughly good, and the electrical equipment throughout the best that money could buy. He looked to the success of the tramways to find them the money required for the purchase of the waterworks company's concern.

Councillor TRAVIS, chairman of the Tramways Committee, in responding, gave a brief history of the undertaking, remarking that the first real progress made by the Corporation with regard to the tramways of the borough was in 1896, when they bought the lines of the Southport Tramways Company. The lines opened that day were first contemplated in 1897. A provisional order was obtained in August last, and consent was given to their application for borrowing powers at the end of October. The work was begun only in January of this year, from which circumstances it might be deduced that it took about 2½ years to do all the talking about such a scheme and six months to do the work. The lines opened that day represented about six miles of single track, and altogether with the lines contemplated they would have about 18 miles of lines in Southport. They got their current for working the new lines from the same works as supplied the town generally, but it being an alternating-current station they had installed special machinery for the tramways. Altogether they had 3,000 h.p., and had additional building accommodation for 6,000 h.p. more. It was intended to start immediately with the conversion of the Southport and Birkdale line.

Other speeches followed by the representatives of the several contractors, etc., for the work, including Messrs. Macartney, McElroy, and Co., overhead equipment; Messrs. Callender's Cable and Construction Company, Limited, mains; Messrs. Bruce Peebles, generating plant; and Messrs. Dick, Kerr, and Co., Limited, rails and cars. The whole of the electrical work, it should be mentioned, has been executed under the supervision of Mr. C. D Taite, the borough electrical engineer, to whose untiring efforts the success of Wednesday's ceremony was in no small measure due, while the construction of the permanent way, erection of car depôt, and extension to the generating station buildings have been carried out under the direction of the borough surveyor, Mr. R. P. Hirst. Further details of the scheme we hope, as previously mentioned, to give in a future article.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 44.)

Previous to the inspection of the electrical equipment in connection with the Kaiser Wilhelm Canal, described in the second instalment of this article, the members of the Verband were afforded an opportunity of visiting various local shipbuilding yards and engineering works. Several of the warships then lying out in the harbour were also thrown open for inspection, and much enjoyment was found in the trips to these. The ship patronised by the writer was the "Brandenburg," one of Germany's older types of battleship, and resembling in point of dimensions our "Centurion" class. The officers were most courteous in giving information, and afterwards provided tea and coffee on deck, the taste of which was destroyed by the "lager" which followed for those who liked it. Compliments were exchanged and mutual success wished over this after-course, the hosts having little suspicion how soon, perhaps, a final farewell would have to be taken of the charming surroundings, the "Brandenburg" being, by-the-bye, one of the vessels recently selected for the China station, and having already departed to those troubled waters. My best wishes for the successful and safe accomplishment of the duty involved go out with the ship and her gallant crew, as do, no doubt, the wishes of all those who took part in the pleasant inspection of that eventful afternoon.

But this is no place for sentiment. Pages, indeed, might be written about the visits made during the few days of the meeting both from a social and utilitarian point of view, but the space at my disposal suffices only for a cursory notice. In dealing with the several inspections of works, etc., made, I shall therefore confine myself as far as possible to a brief description of their electrical equipment. Before proceeding with such description it might, however, be as well to explain that the same programme of visits served during two days. This arrangement is usual with the Verband, and enables members to see a maximum of the principal attractions, besides avoiding crowding. Without such explanation it might be thought the Germans managed to get through a phenomenal programme in the one day, since I shall continue with the description without reference to dates.

Of the several shipbuilding yards thrown open for inspection, the Germania-Werft (Krupp) Baltische Elektricitäts-Gesellschaft, though not so extensive as the Government's yard, nevertheless afforded great interest, being so thoroughly modern in its equipment, as the name Krupp would alone suggest. The installation serving the yard with electrical energy for lighting and power purposes is situated upon the site of an old wharf, from which central position energy is distributed both to the various workshops and ships under construction. The generators are of the continuous-current shunt-wound type by Messrs. Siemens and Halske. Each of these machines has a capacity of 40 kw., and supplies current at a terminal pressure of from 110 to 150 volts. To assist the primary generators over the load peak, and to supply the requirements of the establishment at night, besides acting as a reserve, a battery of accumulators has been added. This has a capacity of 756 ampere-hours. The two dynamos are driven by means of belts from steam-engines of the compound type. The leads from the dynamos are taken to a switchboard, whence the current generated is distributed into the numerous circuits. A separate main is run to each centre of consumption from the switchboard, at which latter point each main is provided with a double-pole switch. This arrangement has been adopted so as to facilitate as much as possible the location of earths, which are of very frequent occurrence in this class of work.

Digitized by Google

A conductor mast is erected upon each of the ships already launched, to which is connected a flexible feeder from the shore. In the interior of the ship the temporary conductors are carried by porcelain insulators attached to the deck supports. Rivet holes are made use of where it is necessary to pass the conductor through armour plating, the holes being previously lined with vulcanite tubing. The lamps employed are specially protected against mechanical injury. The landing ways and the upper decks of the ships under construction are lighted by means of arc lamps during the winter months. Distributed over the whole yard, and in the numerous workshops, etc., there is at present a total of about 1,200 incandescent lamps, besides upwards of 100 arc lamps installed. In addition to this load, the generators have to supply energy to electric motors aggregating about 50 h.p. For boring large holes in plates, etc., already fixed, portable drilling machines, driven by electric motors are employed. Electrically-driven windlasses and centrifugal pumps are also used. Yet another use for electrical energy is found here—namely, for the propulsion of a boat serving exclusively the requirements of the yard. This is equipped with 40 accumulator cells of 600 ampere-hours capacity for five hours' continuous discharge. The battery is charged at a constant potential of 110 volts.

Considerable additions in the shape of a new wharf, etc., are being made to the yard, which will entail a largely-increased consumption of electrical energy. In anticipation of this, the capacity of the generating plant already installed is to receive considerable additions. In fact, when the contemplated extensions are complete the plant will comprise four 12-pole shunt-wound dynamos, each designed for an output of 800 amperes at 550 volts terminal potential, two shunt-wound machines to yield 342 amperes at 550 volts terminal potential, and two machines of similar type to yield 750 amperes at 250 volts potential. The four large dynamos are to be driven separately by triple-expansion engines of 500 h.p. each, while the smaller dynamos will be grouped in pairs consisting each of a 550 and a 250 volt machine, and driven thus by means of a common 240-h.p. engine to each pair. The feeders to the distributing points are to be laid underground. In the workshops the machine tools will all be driven by means of electric motors, partly in groups and partly on the separate system. The pressure of the supply to the incandescent lamps is to be 240 volts.

(To be continued.)

ALTERNATING-CURRENT INDUCTION MOTORS.*

BY A. C. EBORALL, ASSOCIATE.

In the following paper some practical points connected with the construction, design, and performance of modern single and polyphase induction motors are first considered, and then follows a brief consideration of some recent developments in this branch of electrical engineering. The author originally intended to submit a short paper on starting devices for single-phase motors, but it afterwards occurred to him that it might prove of interest to bring up the whole question of alternating-current induction motors for discussion, as the subject is of considerable interest to many, and has been somewhat neglected in this country up to the present. On the other hand, some apology is needed for presenting such a paper to the Institution, because there is little that is really new in this branch of electro-technics.

Part I.—The Construction of Induction Motors.

(A) *Ironwork.*—The design of the ironwork—that is, of the stator and rotor cores, motor cases, bearings, etc.—is the same for all motors, single or polyphase, because a single-phase motor is practically a polyphase motor running on one phase. While this is perfectly true, and although the general constructional lines are similar in each case, it must be borne in mind that far greater care has to be taken with the design of a single-phase motor than with that of a polyphaser if the best results are to be obtained. The bad effects of magnetic leakage are felt far more with the former than with the latter, and the performance of the motor is affected by apparently insignificant details of design. However, a very good polyphase motor will make a fairly good single-phase motor, as a general rule. The general design of all induction motors with regard to the case and bearings is fairly uniform with all makers. Up to 100 h.p., and for pressures not exceeding 1,000 volts, all standard motors are semi-enclosed, the stator core discs being built up inside a cast-iron case and the bearings carried on open-end shields. Thus the motors are virtually without bed-plates. Bearings are always provided with ring or chain oilers, and the sleeves are of gunmetal for the small sizes and of Babbitt metal for the larger sizes. Shafts are frequently case-hardened in the neck and afterwards ground true.

For larger motors than 100 h.p., and for voltages above 1,000, a more open construction is employed, involving the use of a bed-plate, to which the stator case and the pedestals are bolted. In this case the bearings are usually spherical. With large motors, great care has to be taken to keep the bearings absolutely rigid with regard to the stator case, on account of the relatively small air-gap. For instance, for a 300-h.p. induction motor running at 200 revolutions per minute at 40 cycles, the diameter of the rotor works out to be about 8ft., and the air-gap (iron to iron) would not exceed 0·2in. With such a motor it is absolutely necessary to stiffen the pedestals by means of arms radiating from them and bolted to the stator case.

Stator stampings are usually not less than 20 mils in thickness, and are built up with or without insulation between them. Ventilating ducts are usually provided in the core for all sizes above 30 h.p. Rotors are built up from stouter stampings, which need never be insulated; ventilating ducts in them need not be provided for motors less than 50 h.p., on account of the absence of iron loss in the cores of any appreciable amount.

The windings for both stator and rotor must always be iron-clad—that is, the cores must be provided with holes or slots.

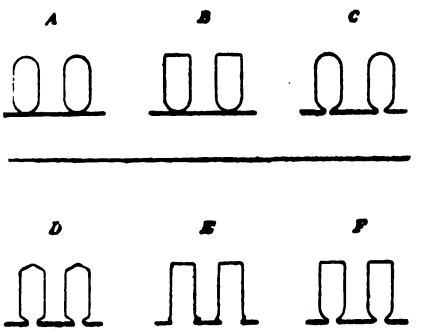


Fig. 1.

In Fig. 1 are illustrated some typical forms of stator holes and slots. The form marked A is the well-known Brown rectangular hole; that marked B is used by Messrs. Kolben and Co.; that marked C is the usual shape used in Germany; those marked D and E are American forms; while, finally, the slot marked F is generally used in the motors built by the author's firm. The greatest winding space is given with square-topped slots; the bottom of a slot or hole is best kept rounded, as it produces a more even pole.

The arguments for and against the use of holes and slots are as follows: With the employment of a hole winding the magnetising current of the motor is reduced to a minimum, because the inner periphery of the stator is smooth all round, and consequently the area of the air-gap is as large as possible. But if the small iron bridges at the bottom of the holes are more than mere shreds of metal, of the thickness of paper, there is considerable magnetic leakage across them, which may greatly affect the performance of the motor. In order to prevent this leakage, not only have the stator core discs to be tooled after being built up—that is, a cut has to be taken off the bore of the stator—but the interior of the holes has to be filed, and so the iron losses are unavoidably increased. A hole winding produces a somewhat smoother pole than a slot winding, but the former is much more difficult to wind, and the conductors are liable to get injured owing to abrasion of the insulation while being pulled through, especially as the holes get nearly filled up with wires, and this injury may easily escape detection at the time.

The only real objection to partly-closed slots is the increase of magnetising current produced by their use (it will generally increase 10 to 15 per cent.), but in the author's opinion this objection is far outweighed by the smaller iron loss and greater convenience attained with slot windings. In many American motors the slots are quite straight, as shown—that is, their sides are parallel; this permits the use of former-wound stator coils, which is an advantage, but on the other hand the magnetising current of such motors is relatively very high. A hole winding is open to another objection: unless a great many experimental data are available it is impossible to calculate the motor in question accurately, as magnetic leakage cannot be estimated with any accuracy. On the other hand, the performance of a motor having open or partly closed slots can be accurately predetermined from the drawings by means of suitable vector diagrams, such as those of Heyland or Rothert.

With regard to the relative proportioning of stator and rotor holes or slots, the lengths of these should not, if possible,

* Paper read before the Institution of Electrical Engineers.

Digitized by Google

exceed 2½ times the width, and the nearer they approximate to square or circular shape, the better. This amounts to saying that the winding depth must be kept down, as otherwise the power factor and the overload capacity of the motor will be affected. The performance of a motor at starting, particularly if it has a permanently short-circuited rotor, and especially if single-phase, may be greatly improved by so designing the rotor that the slots or holes of the latter are not parallel to the holes or slots of the stator—for instance, they may be "staggered" by an amount not exceeding their pitch. This constructional feature, first put forward by Mr. C. E. L. Brown about six years ago, is used with all the induction motors built by the author's firm, including the Heyland single-phase motors, as the results of many tests show it to be of considerable value. The insulation of holes or slots is usually effected by means of insulating tubes of compressed paper, fibre, veneer board, or micanite, the latter material being, of course, best, but not necessary for low-tension motors. The building-up of the stator core in the motor case is an important feature of the design, and, moreover, the details connected with it are frequently neglected. First, the stator core discs should always be supported away from the case; and, secondly, after having been assembled together, the stampings should not be tooled. It is frequently difficult to avoid this after-tooling, more especially on account of the absolute necessity of having everything concentric, and therefore the author thinks it may be of interest to describe one method employed by his firm, as it has been found to give excellent results from all points of view; the method described is somewhat modified for large motors.

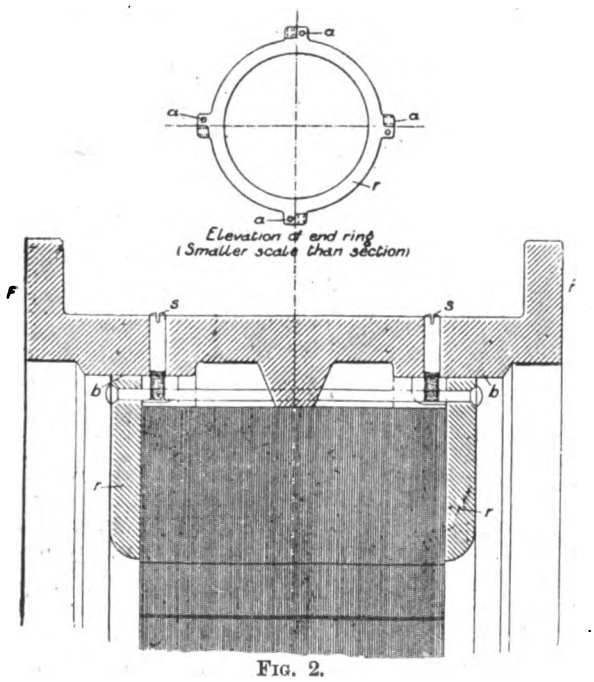


FIG. 2.

The stator core discs are first stamped out of the sheet metal as exactly as possible (with modern American tools great accuracy can be attained), and then built up on an iron mandrel. After this the end rings, *r r* (Fig. 2) are riveted on, the whole arrangement put in the lathe, and the four projections on the rings, *a a*, turned down to the right diameter, but left a trifle full. The case of the motor, already turned on the faces, *b b*, is now heated, and pushed over the core in this condition, so that after cooling the shrinkage of the case hold the core tightly and securely. But to make everything absolutely certain, two or three screws, *s*, fix the case and the core positively. After the core is fixed in the case, the flanges on the latter, F F, are turned down, and must be, therefore, absolutely concentric and true with the stator bore, and true with the axis of the latter. Finally, the slots and end rings are heavily insulated, and the winding put in. The rotor cores are built up in the ordinary manner on the shaft, or on a spider, and are then put in the lathe, and the finest possible cut taken off them. In some cases even this cut is omitted, any slight irregularity or burr being removed by grinding.

The method of building the core into the case described and illustrated above will readily be seen to possess several advantages. These are, firstly, that owing to the core being supported away from the case, leakage through the latter is minimised, and consequently wasteful eddy currents and other detrimental effects are avoided, and, moreover, a free circulation of air can take place all round the core; secondly, the eddy-current losses in the core and teeth are reduced to a minimum, and approximate very closely to the value obtained by calculation; and thirdly, as the core discs are built up quite independently of the motor case, the width of core can be adjusted within certain limits to suit the output of the motor—a great advantage in practice, as it allows a given case to be used for motors of several sizes, and to a certain extent permits convenient variations to be made from standard designs. It is usual with some constructors, notably with Mr. Kolben, to make the end rings or cheeks of the stator cores of brass or gun-metal. It is claimed that by doing this the leakage from pole to pole along the side flanks of the stator is sensibly diminished, or prevented altogether.

(B) *Windings.*—The stator and rotor windings of all modern induction motors are always of the drum type, these windings consisting in all cases either of simple rectangular coils, or regular bar windings, or modifications of the latter—for instance, the so-called squirrel-cage windings. A ring winding has three great disadvantages: firstly, it has an inherently large leakage coefficient; and, secondly, its use necessitates the employment of a massive brass frame around the stator core (in order to minimise magnetic leakage), and it practically precludes the use of an external iron containing-case for the stator, thus making the mechanical construction of the motor difficult and expensive; and, thirdly, there is much idle wire. As already stated, the stator coils of all motors are wound either in holes or slots, and for all usual sizes of motor these coils can be wire-wound with rectangular coils. With single and two-phase motors employing wire or cable-wound rectangular coils there will be two ranges of coils—one range consisting of simple rectangular coils with straight ends, the other range consisting of precisely similar coils, but with bent ends. Thus

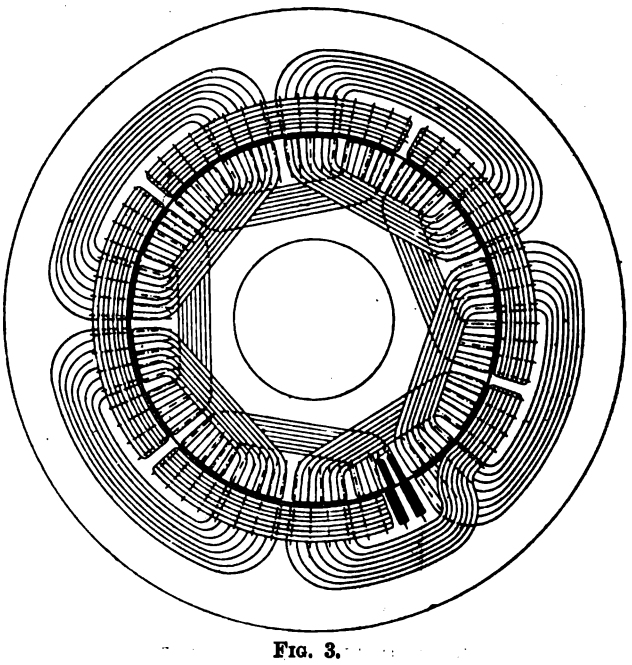


FIG. 3.

each phase of the motor (with single-phasers the starting coils, occupying not more than one-third of the total winding space, may be regarded as the second phase of the motor) will be made up of coils of definite shape, the coils of one phase being bent at the ends up and over the coils of the other phase in order to clear them; from this arises the workshop terms of the "straight phase" and the "bent phase" as applied to two-phase and single-phase motors. With the latter type of motor, the starting phase is invariably the bent phase, from motives of convenience in winding. With two-phase and single-phase motors, it is usual to wind all the poles—that is, considering one-phase only, the coils of this will be wound alternately right and left-handed with regard to the direction of the current in them—that is, they will be cross-connected in the usual manner.

It is clear that for three-phase stators having rectangular coils, it would be a great practical advantage if they could also be arranged for two sets of coils, as with three sets the crossings of the phases at the ends are not only a source of danger (from the insulation point of view), but prevent damaged coils from being easily repaired. Moreover, if each set is in a different plane, there is no possibility of removing the rotor without removing the "bent down" coils, unless the stator core is built up in sections—a quite inadmissible construction. Consequently, for all three-phase stators for motors of standard sizes, and for all high-tension motors, the coils of the various phases are always arranged in two sets, just as for two-phase motors, the coils of a given phase being alternately bent and straight; but in order to do this, and at the same time preserve the proper phase-relation and pitch of the coils, an important modification of the winding has to be made—namely, only poles of the same sign

Digitized by Google

are wound in each phase. For instance, considering one phase only, there will be as many coils as there are pairs of poles, and all coils will be precisely similar with regard to the direction of winding and to the manner of connecting them up. This winding, which simply leaves each alternate pole unwound and doubles the number of turns on the wound poles, is obviously equivalent to the winding referred to above, both electrically and mechanically, but somewhat more copper is required with it, on account of the mean length of turn being greater.

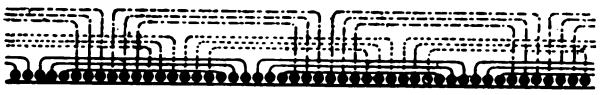


FIG. 4.

It is worthy of note that with such three-phase windings for stators having an odd number of pairs of poles, the winding becomes slightly unsymmetrical at one point, where the end connections of the phases cross one another. This can be readily seen from an inspection of Fig. 3, which shows a six-pole stator. Although for high-tension motors, and for very large low-tension motors, this may be an inconvenience, it is not found to present disadvantages in practice for motors of standard sizes and voltages. As a general rule, too, the speeds of high-tension motors can be so chosen that the number of pairs of poles required is even, while for the large low-tension motors, having an uneven number of pole pairs with bar windings, it is perfectly safe and allowable to wind the stator with three ranges of coils, the end connectors being bent up and back as shown in Fig. 4. Or, should this mode of construction be deemed inadvisable, on account of space for the end connections being limited, or for other reasons, the stator for such large motors can be conveniently and effectively wound with a closed bar winding. Such a bar winding, drawn out schematically for a two-phase motor, is shown in Fig. 5, the four-pole case being taken for simplicity. Standard three-phase stators wound with rectangular coils invariably have the coils connected star fashion. Stator bar windings for large low-tension motors can be, and very frequently are, used with the mesh connection. Combinations of star and mesh are rarely or never found with modern three-phase motors.

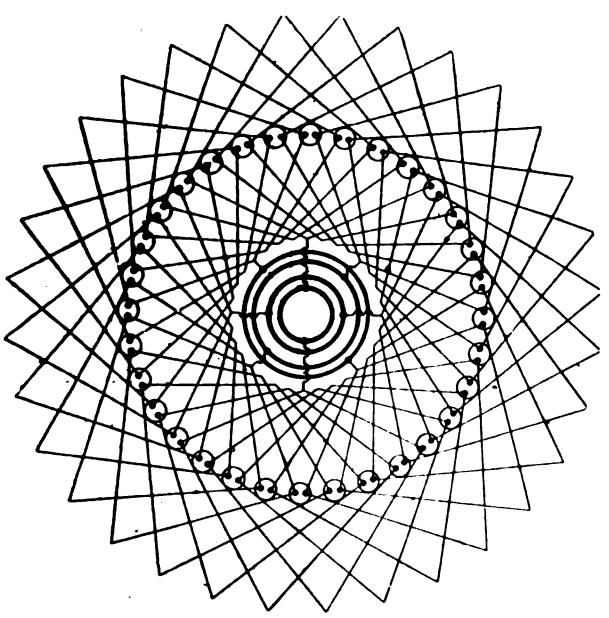


FIG. 5.

The number of holes or slots per stator pole per phase has an important bearing upon the design of all induction motors. In order to keep the winding depth down and to produce an even pole, this number is best made as high as possible—in practice it varies between four and eight. As is well known, with small motors, having squirrel-cage rotor windings, the number of stator holes or slots should be preferably prime to the number of rotor holes or slots, the latter being, if possible, more numerous than the former, as this tends to prevent a cogging-acting action taking place between the stator and rotor fields. The point is, however, of small importance when wound rotors are used.

Rotor windings for all induction motors are of two kinds—namely, permanently short-circuited rotors, and rotors having the ends of the windings brought to slip-rings for the purpose of inserting a resistance into the winding at starting. The design and arrangement of these rotors is independent of the number of phases and of the stator voltage, a given rotor serving for a single, two, or three phase motor, provided that, if slip-rings are used, the number of stator poles is the same in each case, and that the flux per pole in the gap has the same value. There appears to be some difference of opinion as to how far the permanently short-circuited rotor can be used with satisfactory results—that is, at what output of motor it is best to bring in the starting resistance. For motors having to start against load (apart from crane, elevator, and mining motors), the author is decidedly of opinion that the squirrel-cage construction, or its modifications, should be left behind with all polyphase motors above 5 b.h.p. With single-phase motors, which are usually arranged to start up light, wound rotors with slip-rings should be used after 7½ b.h.p. With the Heyland single-phase motors, referred to at length later on, a starting resistance in the rotor is used for all sizes.

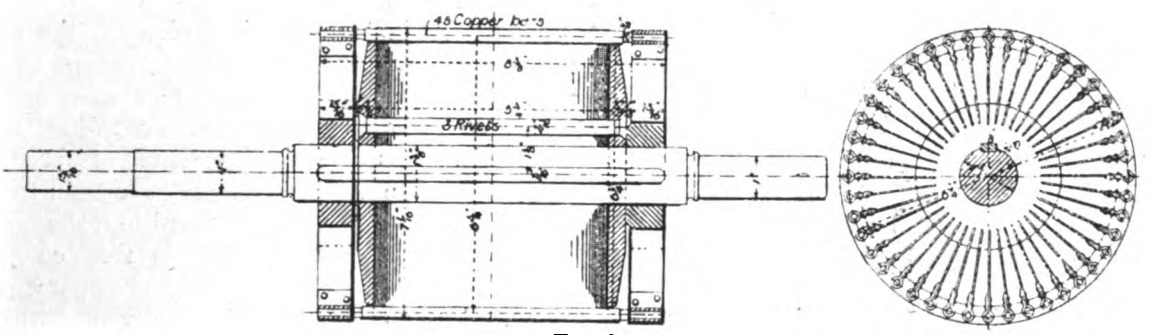


FIG. 6.

If the use of the permanently short-circuited rotor is pushed too far, the pressure regulation of the system, whatever the number of phases, is greatly impaired, owing to the excessive current consumption during the starting-up of the motors. When it is considered that the best polyphase motors with squirrel-cage rotors, and starting under full load, require a momentary rush of current equal to at least 2½ times the full-load current, this statement will be readily believed. It must not be forgotten in this connection that, under such circumstances, the power factor at the moment of starting will be low, with the result that the drop on the transformers, and perhaps even on the generators, is still further increased.

With regard to squirrel-cage rotors, and to the modification of them, the rotor wire-wound with closed coils, there is not much to say. The chief difficulty with the former lies in the fact that it is difficult to make a good mechanical job of the connections to the end rings. If the rotor bars are screwed to these rings, the contact between bar and ring is not only uncertain, but however good it may be at first, it is certain to deteriorate under the influence of the heavy rotor currents, and the heating and cooling of the rotor. Consequently, most makers sweat the rings over the projecting and flattened ends of the bars. But with this, the rings will sometimes melt right off under overloads, splashing the solder all over the stator coils, and generally doing other damage. The author's firm braze the rings on, when a motor of this character is put to work of an exceptionally heavy nature, where overloads are the rule and not the exception, or when the starting conditions are severe. Messrs. Kolben get over the difficulty in the manner shown in Fig. 6; here the rotor bars are connected to the short-circuiting rings by means of thin copper strips used as radial connectors. The rings themselves are of bronze, and are of small diameter, but very massive; they are keyed directly on the shaft without any insulation whatever. In a communication to the author, Mr. E. Kolben states that he has found this construction to prevent entirely the evil mentioned above, and that it greatly assists his single-phase motors to start well, doubtless on account of the extra resistance in the strips. Mr. Kolben also uses this construction for larger motors for crane and similar work (where large starting torques are required without, if possible, the employment of a starting resistance), as it allows of the insertion of the resistance strips of brass or other material in place of the copper connectors.

(To be continued.)

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

39-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	73	The Municipal Electrical Association:	
Gloucester Electricity Works	78	On the Maintenance of Certain Portions of Distributing Systems at Earth Potential	93
The Hemingway-Coley Automatic Replacing Fuse	85	Impressions of American Tramway Practice	96
The Southport Electric Tramways	85	The Protection of Telegraph and Telephone Wires in Connection with Overhead Traction	97
The Verband Deutscher Elektrotechniker	86	Light Railways	100
Alternating-Current Induction Motors	87	Traction Notes	103
Wireless Telegraphy	90	Lighting Notes	103
Correspondence	91	Nottingham Electricity Accounts	107
The Prevention of Scale and Corrosion in Boilers	91	Provisional Patents	107
Large Turbo-Alternator	93	Specifications Accepted	108
Questions and Answers	98	Traffic Returns	108
Companies' Meetings and Reports	101	Companies' Stock and Share List	108
Contracts for Electrical Supplies	102		

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

WIRELESS TELEGRAPHY.

It is very funny that individuals have a great difficulty in seeing that there are always two sides, or even it may be twenty sides, to every question. Similarly, inventors and patentees have so vivid an idea of their own work that other work in the same direction is ignored. Still, we think that Major Flood Page and the Marconi Syndicate have reasonable ground for grumbling when we consider the position that wireless telegraphy occupies in the public mind. Quite recently the friends of progress were a little startled to find that a successful experimental apparatus was to be taken away, especially when they also heard that the German Government was rather favourable to the introduction of similar apparatus. We must never lose sight, however, of the fact that, while we owe a good deal to Mr. Marconi for educating the public on the question, other scientific men have been experimenting more or less successfully in the same direction. Thus it may turn out that, although one particular set of apparatus has been removed, such removal indicates no intention on the part of the Government to abandon the attempt to utilise some kind of apparatus to give us what we term wireless telegraphy. Indeed, according to the reports from the correspondents at the naval manœuvres, a number of vessels have been fitted up with such apparatus. The position, then, at the present moment with regard to this country is that two or three variants in apparatus are under consideration. Whether any one will ultimately be found to be of service is a question we cannot decide. The *Times* correspondent points out, as long ago we pointed out, that the apparatus as at present used is not efficiently selective—that is, any one receiving apparatus is responsive, not only to one, but to any number of sending apparatus within a given area. Of course, there is a simple, but at the same time it is a somewhat cumbersome, method of signalling so that such interference shall not prove absolutely detrimental to the use of the apparatus. Each sender could, for example, have an individual signal to indicate the beginning and end of his particular word, and no matter how that word came through in the receiving instrument, the person or the position from whence sent would be indicated. It is not, however, our present intention to discuss the failings of any system—in the first place, because no matter what be the step in progress, initial difficulties always arise in the introduction of new apparatus. There are difficulties in relation to wireless telegraphy, but under certain conditions and in certain situations there is no doubt such a system is of incalculable benefit. Why, then, should there be any jealousy from Government departments, or from individuals, to prevent its introduction. Either the experts of our Government department which holds the monopoly of telegraphy are sufficiently educated to know that change, gradual or rapid, must inevitably come, or they know nothing of their own business. If the change, whatever it may be, is for the benefit of the community at large,

Digitized by Google

or any portion of the community, there ought to be no obstacle to its introduction. On the contrary, it ought to receive every help. Yet the following paragraph in Major Flood Page's letter to the *Times* of July 18 savours of autocratic methods of two thousand years ago. It is a stupendous disgrace that such statements can be made at this time of the world's history. Here is a new departure, a departure welcomed by many as an improvement upon older methods, and yet by some unknown cause its introduction is stopped. Whatever the cause or causes may be, it is evident that the root of the obstruction is in a governmental department. Private enterprise is quite ready to take the commercial risks in order to introduce what may be termed a commercial aid, yet the hidden power prevents private enterprise in applying apparatus that might be useful. It is better for us to quote in their entirety the words of Major Flood Page, which are as follows: "Some months ago we arranged with the South-Eastern and Chatham Railways to instal our apparatus on their boats running between Dover and Calais. They are anxious to carry out the arrangement, as safety and security for passengers, and economy in the cost of telegraphing, amongst other advantages, would have accrued, but their steamers are not fitted. Some power prevents it. One rumour says that it is the French Government that prevents it; another that the English Post Office regard this purely commercial application to the needs of a purely commercial company like the South-Eastern as an infringement of the Post Office monopoly. The installation would only be used for the business purposes of the railway company; the public would not be able to use it. Anyway, an obstruction exists. This hidden power, whatever it is, prevents the railway company availing itself of the advantages of wireless telegraphy, and hinders our earning the revenue which would accrue from this mutually advantageous and ordinary commercial transaction." In reply to this accusation the Government department may say, We hold the monopoly. We ask how long a patient public will permit a Government department to stand in the way of progress? Most of us can remember the introduction of telephony. We can remember the position of the Department in connection with that new departure, and no one with the slightest knowledge of the history of the movement can acquit our Postal Telegraph Department from the stigma of being the cause why this nation has about the worst telephonic system of all the civilised world.

Phylloxera Electrocuted.—As up to now no means has been discovered to kill the phylloxera of the vine without killing the plant itself, M. A. Berthier proposes to use electricity. How, he does not yet know; but he advocates people possessing a laboratory and vineyards to make experiments, and some good results ought certainly to be the outcome of this. Could the destructive parasite survive the prolonged action of the X-rays, is one of the questions M. Berthier proposes should be solved. We are sorry not to see more statement of facts as to past attempts by the above.

CORRESPONDENCE

"One man's word is no man's word,
Justice needs that both be heard."

SWANSEA TRAMWAYS.

SIR,—I notice in your very complete account of the Swansea tramways a small error on a point that may be important. The "negative booster" has the series winding of the generator side in series with the armature and the track feeder, not with the positive feeder. This is the arrangement adopted in stations designed by the British Electric Traction Company, as it makes the booster self-regulating within wide limits.

That is not the case with positive feeder excitation, because in practice one does not find a positive feeder in which the current will correspond with that of which the rails must be relieved from moment to moment in order to keep the drop within Board of Trade limits.—Yours, etc.,

THE BRITISH ELECTRIC TRACTION COMPANY, LIMITED,
(Henry M. Sayers, Power Engineer).

London, W.C., July 13, 1900.

THE PREVENTION OF SCALE AND CORROSION IN BOILERS.

BY R. D. SUMMERFIELD.

Although this question is one on which very much has been and is being written by many of the foremost engineers in the country, the author feels that no apology is needed for reiteration on this subject, both on account of its importance and of the fact that even now the majority of steam users appear to be either ignorant or careless of the proper treatment of feed water in order to prevent scale and corrosion in their boilers.

Before putting down any boiler the nature of the proposed feed water should be taken into consideration, and several samples of it ought to be sent to a competent chemist for analysis, so that before the boiler is put to work arrangements can be made for purifying the water in accordance with the results of the analysis.

The indiscriminate use of the nostrums advertised for purifying feed water will in most cases lead to disappointment, as although they may each be of use for some particular kind of water, yet in any other water they would probably do more harm than good, removing the scale, perhaps only to corrode and pit the plates.

There are, however, several makers of patent boiler fluids who analyse the feed water first and then supply a preparation to suit it, but as the use of soda in the proper manner and proportion will bring about the same result much more cheaply, the use of any patent fluid is quite unnecessary.

Apart from these patent preparations, the number of different substances which have been put into boilers with the object of preventing or getting rid of scale is almost incredible. Paraffin, soft soap, tallow, oak bark, elm bark, nutgalls, sugar, molasses, starch, soda, potash, lime, linseed, carcases of animals, potatoes, spoilt flitches of bacon, logwood chips, sawdust, muriate of ammonia, or sal ammoniac, washing over with Portland cement, or with blacklead and paraffin, Irish moss, chloride of tin, etc., are some of them, and many of these are used regularly at the present day.

The impurities of feed water are of two kinds—those held in suspension and those held in solution. The former consist of particles of clay, earthy matter, sewage, refuse from towns, etc., disturbed by the water in its passage, and may be got rid of by allowing the water to remain quiet for some time, when the impurities held in suspension will fall to the bottom as fine mud.

The impurities held in solution in most waters drawn from rivers, canals, lakes, or wells consist principally of sulphate of lime, bicarbonate of lime, and carbonate of magnesia, and analysis may also show traces of silica, salts of iron, sulphate of potash, chloride of magnesia, nitrate of calcium, and various acids, but the three first named, especially the sulphates and bicarbonates of lime, are

Digitized by Google

nearly always present in quantities out of all proportion to the remaining impurities.

Carbonate of lime, the principal constituent of selenite, chalk, marble, and limestone, is held in solution in fresh water by an excess of carbonic acid, and is really present in the form of a bicarbonate. In order to precipitate this, the excess of carbonic acid must be got rid of, and this can be done either by heating the water or by employing a reagent. The solubility of the bicarbonate diminishes with an increase in temperature, becoming nil at a temperature of about 290deg. F., corresponding to a gauge pressure of about 45lb. per square inch. At the ordinary pressures of 80lb. to 150lb. it is rapidly precipitated in boilers or feed heaters.

The precipitation may also be caused by introducing caustic lime or caustic soda into the water, as these substances take up the excess of carbonic acid and set free the carbonate of lime, which falls to the bottom as a white powder and settles in the quietest parts of the boiler, where the circulation is worst, remaining for some time as soft sludge or mud, but if not blown or washed out it cakes into a hard mass, which has to be chipped off.

In the lime process, such as Clark's or Archbutt and Deely's, about half a grain of caustic lime is added per gallon for each grain of bicarbonate, which causes a precipitation of nearly twice the weight of the caustic lime introduced, but this process requires for its successful application large settling tanks, containing not less than six or seven hours' water supply, besides other plant, so that the first cost is high and a good deal of space is required. These objections are often sufficient to prohibit the adoption of this system of purification.

In the caustic soda process the precipitation may be carried out in the boiler, only one small tank being required in which to mix the soda with the feed water. The proportion per 1,000 gallons is 1½oz. of pure caustic soda for each grain of lime per gallon; for instance, a water containing 10 grains of bicarbonate per gallon would require $10 \times 1\frac{1}{2} = 15$oz. of caustic soda for each 1,000 gallons. Carbonate of lime is soluble in 62,500 parts of pure water at freezing point.

Sulphate of lime, which is the same as gypsum or plaster of Paris, is also insoluble in water at a temperature of about 300deg. F., its greatest solubility being at 95deg. F., when it dissolves in 393 times its weight of water. At freezing point it is soluble in 500 parts of pure water, and at boiling point in 460 parts. If allowed to settle on the plates the sulphate soon forms a hard scale, sometimes as hard as stone, which causes great danger of overheating and great loss of fuel, about 10 per cent. more fuel being required with scale $\frac{1}{16}$in. thick, and double the quantity of fuel when the scale is ¼in. thick.

The sulphate may be precipitated in the same way as the carbonate by heating the water to a temperature of about 300deg. F., corresponding to a gauge pressure of 50lb. per square inch, or it may be precipitated by the addition of pure carbonate of soda, in the proportion of 1¾oz. of soda per 1,000 gallons of water used for every grain of sulphate of lime per gallon found in the water. Thus, if a water were found on analysis to contain five grains of sulphate per gallon, then $5 \times 1\frac{3}{4} = 8\frac{3}{4}$ ounces of carbonate of soda would be required for each 1,000 gallons of water used, but care should be taken that the carbonate of soda, and also the caustic soda used for carbonate of lime water, are as pure as can be obtained, or foreign substances may be introduced into the water, which may bring about chemical changes by no means to be desired.

Carbonate of magnesia, or magnesian limestone, forms scale in the same manner as carbonate of lime. It is soluble in 5,532 parts of pure water at 32deg. F., in 9,623 parts of water at 212deg. F., and insoluble at the same temperature as carbonate or sulphate of lime. It may be precipitated by the use of carbonate of soda in about the same proportion as for carbonate of lime, but the best way to get rid of it is to heat the feed water before entering the boiler. In brackish water chloride of magnesia may be present, and when concentrated this decomposes at 212deg. F., forming magnesia and hydrochloric acid, which latter, on being set free, rapidly corrodes the iron.

This brings us to the question of acid waters, which are as dangerous, although not so common, as scale-forming waters. Besides the hydrochloric acid, which is formed as mentioned above, water may contain tannic acid, produced by the decomposition in the water of the bark, leaves, or wood of various trees, such as oak, hemlock, logwood, etc., acetic acid, formed by chemical changes from sugar or other sweet substances, carbonic acid, produced in putrid waters or waters turning putrid, and various other acids, which all, however, show their presence by pitting or corroding the iron plates and other parts of the boiler more or less rapidly. Acid waters should be treated by the addition of an alkali in order to neutralise the acid. The best alkali to use is pure carbonate of soda, which should be added in the proportion of one grain of soda per gallon for each degree of acidity in the water. The soda should be mixed with the feed water in a separate vessel before it enters the boiler, as it often causes foaming when introduced into the boiler itself.

Although the chief danger to a boiler from the presence of oil or grease is overheating and foaming, yet substances of this description are also indirectly the cause of scale and corrosion, and great care should be taken to prevent them entering the boiler. The grease or oil floats on the surface of the water and mixes with the carbonate of lime, which, when it is present, often floats on the surface also as a loose powder before it falls to the bottom. The mixture of oil and lime forms a sticky paste, which adheres to the hot parts of the boiler so closely that blowing out two or three times a day will not move it, and in time it hardens and becomes a dangerous scale. Then the grease may decompose and form acid, as mentioned before.

Feed water drawn from the hot-well of a condensing engine is always more or less greasy, and should be passed through a good oil-filter before entering the boiler, but as grease or oil may enter from other sources—from the boiler fittings, for instance—a scum trough should be fixed in the boiler, and this should be blown out every time the bottom blow-off cock is opened, say three times a day. Blowing out is a most important point in the prevention of scale. It should be done at regular intervals several times a day when the boiler is working, no matter whether the water has been chemically treated before it enter the boiler or not. The great point, however, is to prevent the scale-forming substances from entering the boiler at all, so that it may contain nothing but sweet and pure water, and practically the only way to bring this about is to employ some form of feed-water heater.

The proper way, then, to treat feed water containing sulphate or bicarbonate of lime or carbonate of magnesia is first to dissolve in it pure soda in the proportion mentioned above, and after that to pass it through a vessel in which it is heated to a temperature of about 300deg. F. before entering the boiler.

The design of an efficient feed heater is not a simple matter by any means. Numbers have been tried, and quantities of patents are still taken out in connection with them, but the best are a long way from engineering perfection. The principal points to be considered in a heater are that the water must not pass through it too quickly, in order that the impurities may have time to be precipitated. For this reason also the heating surface must be as large as possible; the heater must be strong enough to stand the full boiler pressure; it must be simple, not liable to get out of order, easily got at, and easily cleaned out, which last is the most important point about it, as its efficiency depends on the cleanliness of the collecting surfaces, and if these are difficult to get at, the cleaning will surely be shirked by the boiler attendant, with the result that the water, not being able to deposit all its impurities in the heater owing to the thick deposit of scale already there, carries the remainder into the boiler.

In the author's opinion the question of cleaning should receive more consideration than any other in the design of a feed heater; he would suggest that the shell of the heater be a plain cylindrical drum having a cover bolted to each end, the drum to be of sufficient diameter for a man to work in, and to be placed across the main flue in such a position that both covers might be easily taken off for cleaning. The feed water, after passing through a tank in which a proper proportion of soda has been dissolved,

Digitized by Google

should enter at the circumference of the drum, and pass first over the surface of the outer shell, afterwards passing over inner surfaces, and finally being taken away to the boilers from the centre of the heater. The internal part, consisting of baffle-plates and water passages or tubes, should be made to slide easily into the drum, so that it might be withdrawn bodily for cleaning, and a duplicate internal part should be provided, which could be slipped into the drum as soon as this had been scraped out. This would greatly lessen the time during which the heater would be out of action, and would ensure the thorough cleaning of the part taken out, as the manager would be always able to see it before it went into the heater again. It is important that the cleaning should take place at regular intervals, depending on the quality of the feed water. With some waters the heater might require cleaning out every three or four days, while with others a monthly or bi-monthly cleaning would suffice; the quality of the feed will also determine the amount of water which must be blown out of the heater every day through the blow-off cock, generally a quantity equal to the contents of the heater should be blown out every six hours.

In the author's opinion a suitable feed-water heater and purifier is as necessary to a boiler as the firegrate, and when steam users generally begin to realise the enormous saving in the coal bill which is effected by a boiler always clean and free from scale, no doubt feed heaters will be considered indispensable.

At present there is no heater on the market which can be said to have stood the test of time satisfactorily, and many persons have even discontinued the use of them after a time, principally owing to the difficulty of keeping them properly clean. This question of cleaning is of the utmost importance, as mentioned before, but it is a point which inventors often miss, and, in fact, one which is frequently missed by buyers as long as the apparatus gives good results when new.

This refers to boilers quite as much as to feed-water heaters. For instance, during the last few years a number of water-tube boilers have been brought out with variously curved tubes, and some of these boilers have given wonderfully good results when tested for efficiency; but unless the water supplied to them has been purified, or is naturally pure, the author imagines that this efficiency will soon fall below that of an ordinary Lancashire boiler unless they are kept very clean, the cost of which will probably more than equal any increased gain in evaporative power—in fact, it is probable that a short experience of these kind of boilers will bring out the fact that without a thoroughly efficient feed-water purifier the enormous cost of cleaning the tubes will prohibit their use altogether.

LARGE TURBO-ALTERNATOR.

We are pleased to hear that the newly-formed Brown-Boveri-Parsons Syndicate have received an order from the Frankfort Corporation for a 4,000-h.p. single-phase turbo-alternator for the extension of their well-known central station. The present plant in that station consists of four 500-kw. units and two 1,000 kw. units, while two more 1,000-kw. units are being erected. It is interesting to note in this connection that, although a single-phase plant, yet the total capacity of the motors connected to the Frankfort mains exceeds 5,000 h.p., which is the best possible proof that a properly-proportioned single-phase installation compares favourably with others, even as regards power distribution. At all events, there is no town in England which can show a motor load approaching that of Frankfort. The fact that the Frankfort Corporation have, acting on the advice of their resident and consulting engineers and on the report made by a committee of eminent engineers, decided to adopt steam-turbines is a proof that these have come to stay, the more so because all the machines installed in the Frankfort central station up to the present were built by the most renowned Continental firms, and are coupled to splendid engines of the latest types.

The turbo-alternator which has been ordered will run at a speed of 1,360 revolutions per minute, giving current at a pressure of 3,000 volts. It will be capable of giving its full output of 4,000 h.p. when working on an inductive load having a power factor of 80 per cent. The alternator will be provided with a special winding, by means of which it can be made to generate three-phase current, in which case its output will be 5,000 h.p. The set will be by far the largest turbo-alternator ever made, and, moreover, will rival in power with the largest reciprocating steam-engines ever built for direct connection to electrical machines.

MUNICIPAL ELECTRICAL ASSOCIATION.

CARDIFF CONVENTION.

(Concluded from page 50.)

The following was the next paper read:

On the Maintenance of Certain Portions of Distributing Systems at Earth Potential.

BY C. H WORDINGHAM, M.I.C.E., CITY ELECTRICAL AND TRAMWAYS ENGINEER, MANCHESTER.

From the very earliest days of the application of the science of electricity to practical needs, the earth, or, as our American brothers prefer to term it, the ground, has played a prominent part, and each branch of electrical industry has in turn set up a claim to a vested interest in it. The potential of the earth is usually taken as zero, other potentials being reckoned with respect to it. This, however, does not accord strictly with the facts, since a difference of potential may, and very frequently does, exist between two points on the earth's surface. Such difference of potential, however, is never very great. The earth, in some text-books, is regarded as forming a large reservoir, and its office is stated to be that of maintaining the potential of a point connected to it at zero. Thus, if a battery has one pole connected to earth and the other to one end of a long conductor, and the far end of the conductor be connected to earth so that a current flows, the earth is regarded as merely absorbing the electricity that passes along the wire by draining down its potential to the same value as the potential of the earth at the battery end of the line, and no actual current is supposed to flow through the earth back to the battery. This explanation is not borne out by experience, as the return currents can actually be detected, and it is more correct and more convenient to regard the earth as a large conductor through which the current actually does flow. The earth may be used in two distinct ways. It may either be employed to take the place of an ordinary conductor, as in telegraphy and telephony, in which case the whole of the outgoing current has to return by the earth, or it may be employed merely to keep one of the conductors of an electrical system at or near zero potential.

No one would now think of intentionally employing the earth in the former manner when energy was to be transmitted at any appreciable rate, and even for signalling circuits its use in this manner is attended with great disadvantages. We may therefore confine our attention to the second way in which the earth is employed—namely, to keep down the potential of one portion of an electric system of transmission. It will be convenient in considering the various practical instances of earth connections to divide the subject into high-pressure and low-pressure circuits, and to further subdivide the latter into those circuits which have a conductor earthed at one point only, and those which are earthed at more than one point. If there be a two-wire circuit, consisting of a generator, two conductors and a consuming device, such as a transformer, and if a given difference of potential be maintained between the two conductors by the generator, then if all parts of the circuit be equally well insulated, each conductor will assume a potential relatively to the earth which is half the difference of potential between the two. In other words, if the pressure be 10,000 volts one conductor will be 5,000 volts above earth, and the other 5,000 volts below earth. If, however, the insulation resistance of one conductor falls below that of the other, the conductor's potential with respect to the earth will at once diminish, while that of the other conductor will increase, and, if the insulation of one conductor fail altogether, it will arrive at earth potential, while the other conductor will alter to 10,000 volts above or below the earth, as the case may be.

Now, it is obvious that if the conductors be insulated only with a view to withstanding the normal potential from earth—*i.e.*, 5,000 volts, an undue stress will be placed upon the better-insulated conductor when the insulation resistance of the other falls, and this stress may be sufficient to cause the other to break down also. Inasmuch as it is impossible to foresee which conductor may assume the potential of the earth, it would appear that if both have to be insulated, both must be

Digitized by Google

capable of withstanding a pressure of 10,000 volts. It was first pointed out, the author believes, by Mr. Ferranti, that, seeing that either conductor might have to withstand the full pressure, it would be best to at once face the situation and insulate one of them for the maximum pressure possible, and ensure that it alone should be subjected to this pressure by deliberately connecting the other conductor to earth. This exceedingly simple, and at the same time ingenious device, at once diminished the risk of breakdown and cheapened the cost of insulation, but at the same time it enabled a further great advantage to be reaped by admitting of much greater security to life being introduced. This end was attained by completely enclosing the insulated conductor within the uninsulated one, thus rendering it physically impossible to handle a conductor at a dangerously high potential; and if by any chance the outer conductor should be cut through, a short-circuit would be established before the inner conductor could be touched. This system has been almost universally adopted for two-wire high-pressure circuits, and is perfectly familiar to all at the present time, but it is worth while recording the fact that when originally introduced many people looked askance at connecting a high-pressure conductor to earth.

For systems of transmissions employing more than two wires the same perfect security cannot be attained, but a near approach may be made with two-phase working by employing two separate concentric cables, the outer conductors of which are connected to earth, or by enclosing two parallel conductors within an outer envelope. In three-phase working, if a star winding be employed, the middle point of such winding may be connected to earth. When this is done, the stress on the insulation from earth is diminished to the smallest possible value, but all three conductors have to be insulated. It is important that one point only of the zero potential conductor should be conducted to earth, because, inasmuch as there must of necessity be some fall of potential in the outer conductor, there exists between any point and the one connected to earth a difference of potential depending upon the resistance of the conductor and the current flowing through it. So long as the outer conductor is insulated from earth, except at one earth connection, no current can pass through the earth, but if a connection be established with earth at some distant point, the difference of potential between it and the other point will cause current to flow through the earth.

A digression may here be made to point out exactly the manner in which such return currents travel through the earth. A most instructive experiment carried out by the author in his student days, under Prof. W. Grylls Adams, made such an impression on him, and has been found by him to be so helpful, that he may perhaps be pardoned for describing it. In a large flat sheet of tinfoil two needles were fixed, connected respectively to the two poles of a battery, which thus sends a current through the tinfoil. A sensitive galvanometer was provided and its ends connected each to a needle; one of these needles was stuck at random into the tinfoil, and the other was moved about on the tinfoil until a point was found which gave no deflection on the galvanometer. The needle was then pressed into the tinfoil, and an impression left on a sheet of clean paper underneath. A series of such positions were found, corresponding to an equipotential line in the tinfoil. The first needle was then moved to a new position and a second equipotential line traced out. When a sufficient number of such lines had been determined, other lines normal to them were drawn between the two points to which the battery had been connected. This, of course, represented the lines of flow of the current. Anyone who carries out this experiment for himself will be at once struck with the number and diversity of the paths along which the current can flow. These paths spread out in the same manner as the lines of force from a magnet, and extend to a great distance away from a direct line. In the case considered of a conductor carrying a heavy current and earthed at two points of its length, the current may return from one point to the other by paths that are an almost incredible distance away from the main conductor, though, of course, the bulk of the current will take the shortest possible path through the earth. If two plates be buried in the earth at two points along a line of flow, and be connected together through a conductor, this conductor will take up a portion of the current. If the conductor be part of a signalling circuit the signalling currents will be interfered with, and with any conductor electrolytic action may take place at one or both points of connection with the earth. If, instead of dealing with the high pressures, we are dealing with low, exactly the same effect will be produced by making one or more earth connections to a conductor, but the objects of making the earth connection are usually different.

In the case of a low-pressure distribution system, the object of earthing one conductor is not to diminish the cost of the insulation, since no appreciable saving is made by using a pressure of, say, 200 volts instead of 400 volts, nor is it to secure safety to life; the chief object is to enable a consumer to be supplied at such a pressure that no one of the conductors brought into his house will exceed the limit of pressure defined by the Board of Trade to be low pressure. In the case of electrically-driven tramways, the one object is to enable the rails to be used as one conductor, chiefly with a view to simplifying the working arrangements, and partly to enable the conducting power of the rails, which must in any case be laid, to be utilised. In this last case it is obvious that the conductor is connected to earth throughout its length, and the only way to obviate the difficulties pointed out on the score of current returning by the earth is to keep the difference of potential between the ends of the earth conductor so low as to cause the amount of current returning by the earth and metallic structures buried in it other than the rails to be very small. With these preliminary observations we may now consider some particular cases. The author regards all the high-pressure systems as systems of transmission, though it is true that at present high pressure is still used to some extent for distribution. Inasmuch as this paper deals only with the earthing of distribution systems, the author proposes to confine his attention to these.

The most important case of earthing conductors is undoubtedly that of tramways. The system adopted so largely in America has been imported into this country, and every tramway system, excluding battery-driven cars, is being worked with one conductor insulated and the other, consisting of the rails, connected to earth. It is well known that if the difference of potential between the end of the earthed conductor which is connected to the source of energy differ in potential considerably from that of a distant point on the same conductor, the current returning through the mass of the earth and through pipes buried in it may be very large, and may cause most serious damage to the pipes by causing the metal to be dissolved at the points at which the current leaves. How great this difference of potential must be before serious damage is done is a matter upon which there is not a large amount of information available. The Board of Trade have fixed the limit of what may be allowed at seven volts, but it is maintained by some authorities that this limit is too high, and that a lower potential than seven volts will cause damage. This point is receiving a considerable amount of attention at the present time, and the author is himself engaged in a joint investigation with engineers of other departments of the Manchester Corporation with a view to thoroughly thrashing out what is the minimum difference of potential that can be allowed. It is obviously in the interests of all concerned to arrive at reliable data on the subject. If seven volts be found to be safe, well and good; but if not, the sooner it is known to be dangerous the better.

All engineers must be agreed that the lower one can keep down the difference of potential the better. The object may be effected in various ways. One of the most common is to provide auxiliary conductors of low resistance, which are tapped on to the rails at various points to supplement their conductivity. Another device is to employ similar conductors, but to lower the potential of the far end by means of so-called negative boosters, which subtract instead of add a certain number of volts. A third means, and in the author's opinion the best and most effectual, is to feed the line from a number of independent points either by means of a number of generating stations, or, preferably, by means of a number of transforming sub-stations. Except in the case of very heavy traffic, this method should prove effectual without either the employment of return feeders or negative boosters. The simplicity and reliability of the so-called overhead system of traction are such as to render it worth while to go to great lengths to retain the system, but if it be found and clearly demonstrated that extremely minute differences of potential are sufficient to cause serious damage to underground structures in urban districts, it will be necessary to reconsider the whole position, and perhaps to adopt an insulated return conductor, or else to fall back upon a battery system of self-contained cars, either of which expedients would be greatly to be deplored. The second case of earthing in order of importance is that of one conductor of ordinary lighting and power circuits, and it is on this point that the author desires to raise discussion chiefly.

It has been hotly debated, and much difference of opinion still exists as to whether it is desirable or not to earth the middle wire of a three-wire system. Let us consider what are the advantages and disadvantages of such a course. The main advantages are the following: (1) by earthing the middle conductor the extreme difference of potential that can be attained by any one of the conductors from earth is halved, and all can be handled not only with great safety, but practically without inconvenience; (2) the stress on the insulation is halved; (3) all three conductors may be taken into a consumer's premises for all pressures up to and including 500 volts pressure across the outers without contravention of the regulations of the Board of Trade — this advantage is undoubtedly by far the most important; (4) immediate notice of a leak on one of the outer conductors is given. The disadvantages of earthing the middle conductor are: (1) if a leak exists on one conductor, current is continually forced through it, thus causing in many cases complete destruction of the insulating material; (2) a leak on

Digitized by Google

one conductor produces a short-circuit on one side of the system of distribution, unless the earth connection is removable at will.

In Manchester the Board of Trade require that the middle conductor shall be maintained at or near the earth potential, and the author has now had nearly seven years' experience of this system. In his judgment there can be no possible doubt that, at all events with continuous current, and quite possibly with alternating, the effect upon the insulating material of the negative main is most severe. In operating a system of distribution by means of continuous currents, it is always found that if none of the conductors be deliberately earthed those connected to the negative pole assume earth potential; the positive conductors consequently being at the maximum potential above earth corresponding to the pressure used on the system. The reason for this is well known. It is the phenomenon known as electric osmosis, whereby moisture tends to travel away from the positive pole and towards the negative pole. Whatever system of mains be employed there are always many points at which surface leakage can take place, and whether the conductors be bare copper on porcelain insulators or be continuously-insulated cables, at every point where the conductor is exposed leakage from the negative pole will take place, but if the negative conductor be kept near earth potential this tendency will be small. If, however, the middle conductor be deliberately connected with earth so that the negative outer is kept below earth potential, a current corresponding to the amount of the leakage will be constantly forced through the leak, and the tendency for moisture to flow to the negative conductor will be maintained. If the leakage was confined to the surface of the insulation at points of connection to the conductors the result would not be so serious, but the author has found that with certain makes of rubber the material is evidently porous, and small as is the leakage current at first, it is sufficient to cause water to enter through the pores of the rubber, and the conductivity of this water so increases the leak that in course of time the whole of the rubber on the negative conductors is destroyed, large blisters forming within its substance and becoming filled with strongly alkaline liquid, almost certainly derived from the substances mixed with the rubber. The rubber is often much distended, causing the liquid to be under considerable pressure. In course of time this pressure increases to such an extent as to burst the rubber, causing a hole completely through the insulating material. It is clear that the water could not merely flow into these blisters; it is almost certainly driven in by osmosis. What happens with rubber may happen with other materials, and, in the author's opinion, there can be doubt whatever that very grave risk of breakdown of the insulation of the negative conductors is introduced by earthing the middle conductor.

As a set-off against the above inconvenience, it must not be forgotten that the insulation resistance of the positive conductors is substantially improved by earthing the middle one, but very little importance need be attached to this, since, as already stated, the negative conductor would be at earth potential if the middle one was not earthed, and the tendency to dry the positive outer would then be doubled. The only consideration that impels one to desire to earth the middle conductor is the fact that it admits of all three conductors being brought into a consumer's premises, thus enabling every installation to be balanced within itself if it be of sufficient size to render it desirable to do so. The author is convinced that the only method of effectually balancing a multiple-wire system is to carry that balancing back to every consumer except to consumers of the very smallest size, and therefore it is of great importance to be allowed to bring the three conductors into installations. Serious as are the disadvantages, this advantage is in his judgment sufficient to outweigh them, and therefore he would on the whole decide in favour of earthing the middle conductor, but if this be done it must be clearly understood that it necessitates the utmost care in protecting the mains from moisture, and the only possible system of laying them becomes the so-called solid system, in which every cable is completely surrounded by a thoroughly waterproof material, or an air-insulated system with accessible porcelain insulators at intervals, as in the Crompton system of bare copper. If it be granted that the middle conductor should be earthed, the question at once arises, should it be permanently and irrevocably earthed, or should the earth connection be capable of removal at will. The author would unhesitatingly reply, "it must be removable." The first consideration is continuity of supply, and if a leak developing on one conductor is to cause a short-circuit, the chances of interruption are increased manifold beyond what they would be if the earth connection could be removed until the fault had been localised and repaired. It is quite clear that the chances of a leak occurring on one conductor are many times greater than those of two leaks occurring on two separate conductors simultaneously. It may be argued that if the earth connection is liable to be removed, all the advantages of making it at all are done away with, since the distribution of potential will alter when it is cut off. To some extent this is true, but it must be remembered that the connection would only need to be removed for short periods and at long intervals, and, therefore, in practice but little risk would arise. If it were a question of dangerous pressures, it would be entirely different. In such case the earth connection must never be removed while the main is in use. Once it be granted that the earth connection must be removable, it becomes obvious that the conductors must be earthed at one point only, and that must be easily accessible from the generating station. This consideration shows that it is impossible to allow one of the conductors in a consumer's installation to be uninsulated, a system of wiring frequently advocated by some on account of its cheapness and some other advantages.

There is, however, another reason for not using this system of wiring, depending on the undesirability, already pointed out, of earthing a conductor at more points than one. It is often argued by the advocates of the system that the balancing wires carry so little current that the fall of potential in them is negligible. It is true that balancing wires frequently bring back but little current to the generating station, but locally it is unavoidable that these should be heavy currents, causing substantial differences of potential, flowing between the various installations, composing a balanced main, and these differences of potential may cause destructive electrolysis, and, with alternating currents, interference with telephone lines. Certain special features arise in connection with a distributing network fed from transforming sub-stations supplied with high-pressure current to which attention may be called. In a case likely to become not unusual in practice—namely, that of three-phase transmission with rotatory converters supplying continuous current to the network, it will probably be required that the grouping of the transformers shall be star and the middle point be earthed. Now, if this point, which is also directly connected to the middle distributing conductor, be earthed at the transformer, we shall have all the disadvantages of a middle conductor earthed at several points. A much more serious case will, however, arise if, in addition to this, the middle wire be opened between two sub-stations, but the outers be carried through. In such an event, the whole balancing current may be conveyed by the earth and do great damage. A similar difficulty would arise with balancing transformers distributed at various points of the network if the middle wires are not continuous throughout and an earth connection is made in the balancers. In order to comply with this condition of earthing, the middle point of the transformers, the earth should be made by connecting the middle wire to the point in question and earthing this middle wire at one point only for the whole system.

The author has made no attempt to treat this subject at all fully, his desire being merely to raise a discussion on the subject generally of connecting any portion of a distribution system to earth, the chief points being: (1) should any portion of any system of distributing conductors, whether for the ordinary supply of energy or for traction, be connected to earth; (2) if such a course is desirable, what conductor or conductors should be earthed, and at what point or points; (3) what difficulties may be expected from earthed conductors, and in what way may these difficulties be met, especially in the case of distribution for electric traction purposes.

Before the discussion was opened the Secretary read the following contribution to the same from Mr. A. P. TROTTER: In this valuable paper, the author assumes, in accordance with his own practice, that no resistance is intentionally introduced in the earth connection. The advantages and disadvantages of adding, say, one ohm, to prevent a dead short-circuit might be discussed, and it would be interesting to hear the experiences of those who use recording ampere-meters in the earthing circuit. It has been proposed to earth at the feeding points instead of at the works. Ampere-meters would have to be placed at the works in order that leaks might be noted, observing by the current passing to earth at each point, but the advantages to be gained do not seem to balance the disadvantages, the chief of which is the impossibility of cutting off the earth connection, temporarily, at short notice, in case of an accident. Lead-sheathing of cables generally constitutes a connection to earth, and electrical precautions for its protection seem to come within the scope of this paper. The advisability of keeping the lead two or four volts negative to the middle 'bus bar seems worthy of consideration.

Mr. S. Z. DE FERRANTI agreed with Mr. Wordingham that the outer conductor should be earthed in one part of the system.

Mr. SNELL said he was struck very frequently with the exceedingly small difference in the cost of two and three-wire feeders for the direct-current system. In a tender he had recently received the difference in favour of the two-

Digitized by Google

wire feeder was only 8 per cent. At St. Pancras they used to have a five-wire system, and it was found that the middle wire always was at earth potential. However, if the middle wire were earthed, it became more difficult to find a fault.

Mr. CHAMEN said that he found it advisable to earth the middle wire through a resistance, as it was extremely important that a concentric cable should not be overheated by a short-circuit. He also thought that earthing the wire tended to prevent electrolysis. Electrolysis affected the lead, but he had devised a means for ascertaining whether there were earths at any points of the system. This consisted of interposing an E.M.F. between the earth wire and its return, and noting the alteration in the earth current.

Mr. TREMLETT CARTER said that while on a visit to the United States a year or two ago he inspected a double trolley line at Cincinnati. The complication introduced by the double trolley line, in his opinion, was very much against its use. With respect to the Board of Trade limit of seven volts, he did not think that this was low enough to prevent troubles from electrolysis.

Mr. R. C. QUIN, of Blackpool, said it was very important that the middle wire should be properly earthed, in order to prevent trouble when earth occurred on one of the poles. He described a fault which had occurred in the old days in Brighton, due to the high-tension alternating current getting into the low tension mains of the continuous-current system. In Blackpool they had not found any trouble from electrolysis.

Mr. C. H. WORDINGHAM then replied, and pointed out the importance of keeping continuous records both of the current in the earth circuit and also of the direction of the same.

The discussion on Mr. Wordingham's paper being completed, Mr. Le Rossignol read the following paper:

Impressions of American Tramway Practice.

BY A. E. LE ROSSIGNOL, CORPORATION TRAMWAYS ENGINEER, NEWCASTLE ON TYNE.

When I was asked to read a paper, I thought that, having paid a visit to the United States this year, some account of my impressions of the present state of tramway engineering practice in that country might be interesting to the members of this association. The conditions governing tramway practice in America are essentially different from those prevailing in this country. On that side of the Atlantic the tramway concessions are almost without exception in the hands of companies, who in very many cases have been granted them in perpetuity, and in some cases at merely nominal rents, so that now the value of these concessions is very great. In addition, the process for obtaining leave to extend is very much simpler and quicker. There are practically no limitations set by law to any combinations or absorptions the companies may choose to make with other companies, the speed of running is very great, and the doctrine that might is right holds to an extent we would not tolerate here. Contrast these with the conditions prevailing on this side of the water: in Great Britain concessions for tramway construction take a long time to carry through and are difficult to obtain. Combinations or absorptions are jealously watched and difficult to bring about, and companies and corporations are very much hampered, therefore, in developing their tramway systems to anything like the scale which American tramway undertakings attain if successful, while the maximum speed allowed is so low that competition with railways is out of the question. Again, owing to the inherent conservatism and venerable age of British institutions, the delimitations of local authorities are very much more circumscribed and divided up than in America, so that extensions which involve trenching on the ground under the control of different and distinct local authorities involve much more difficulty in obtaining leave for extension, both to companies and to municipal authorities who may wish to extend a tramway system owned by them.

Need we wonder, then, at the great extent reached by some of the tramway systems in America, systems formed by the gradual acquisition by one master company of all the competing lines in any one city or district, till at last all the lines are under one control, and competition is entirely done away with. As you may have noticed, a typical instance of this spirit of absorption has just been completed in New York. Prior to this year there were two tramway companies in New York—the Metropolitan, which had gradually absorbed all the smaller companies, with the exception of one, and the Third Avenue Company, which owned two lines running from the heart of the city out to the Haarlem River, and beyond that owned a large extent of country lines. Early this year the Third Avenue Company got into financial difficulties over the provision of new capital to meet the heavy expenditure it incurred in converting the cable system into an underground conduit system, and the Metropolitan Company stepped into the breach, provided the capital required, and thus obtained control of the last opposition company left in New York. Latterly the American tramway world has become greatly exercised over the question of municipal ownership, the municipalities, who originally granted free wayleaves, and in some cases ground rights on the streets as well, to the tramway companies in order to get them to run lines out into the country and create new populated districts, now find that these rights and privileges granted by them are becoming very valuable, and are seeking either to get hold of the tramways again, or else to make the companies reduce the fares or pay higher percentages of their receipts to the municipal authorities. The companies are, therefore, deprecating in the Press municipal ownership, and as an argument in their favour compare the extent of the largest tramway system we have on this side under municipal control with the largest tramway system in a town in the States of a similar size, greatly to the advantage of the latter, of course. In their comparisons, however, such reasons as I have given in the first part of this paper are entirely overlooked, but there is no doubt that municipal ownership in the United States under the conditions prevalent at present in municipal circles on that side would give rise to a great deal of bribery and corruption, until in course of time a better moral condition of municipal life comes to the front. At the time the combination took place between the Metropolitan Traction Company and the Third Avenue Company in New York, the former had very nearly finished a very large power station, from which they were already supplying the lines they had converted to electric traction, and the Third Avenue Company were only laying the foundations of a still larger power station, so that the amalgamation has in this case come at a suitable time when the question of the provision of the requisite amount of power for the combined system will not be complicated by the existence of too many power stations. In most previous amalgamations of this kind in the States, of which Philadelphia is a typical example, the combined company has left on its hands a multitude of small power stations, each of which have been owned by one or other of the smaller companies it has absorbed.

Due to the fact that conversion to electric traction was just in progress, the combined company in New York is now in a very favourable position to extend its large system in the best and most economical way, and the present tendency, one might almost say the fashion, in tramway construction in America, leans towards the erection of a large central station with high-pressure distribution to sub-stations. Those companies which are hampered with a number of low-tension power stations do not, however, admit that their economical results are very greatly inferior, if at all, to those attained as yet by the larger single systems, and are in many cases providing for additional extensions by adopting battery sub-stations with charging mains to those fed by boosters. By the almost universal adoption of coal handling and storing machinery, too, the fuel costs of stations in America are kept remarkably low. As they are all owned by private companies, however, a strict reticence as to these costs is maintained, in complete contrast to the practice on this side of the water, where we are accustomed to publish full details of all working costs. As economy in current generation is greatly influenced by the expenditure on labour in the station, central-station practice in America rightly tends to the introduction of very large steam-power units, but these are all of the open slow-moving type, and so require a larger amount of attendance than would the same size units if enclosed, and provided with automatic lubrication, such as have been largely adopted in this country. A system of mechanical oil supply to these large open engines has been adopted, but if the enclosed type were made as strong in proportion and as reliable in operation as the large open type, there is no doubt that increased economy in labour would be obtained, and doubtless English manufacturers will awaken to this fact in a short time. Due to the heavy strains encountered in direct-current traction work, American steam units have gradually grown to huge proportions of the strain-bearing part, the shaft, and even though the strains probable in alternate-current work will be very much less, the same proportioned engines are being installed in the three-phase plants. Owing to the adoption of large steam units, the question of provision of adequate boiler power in a reasonable amount of floor space to correspond with the engine floor space has been met by the adoption of two or more boiler floors one above the other, surmounted by huge coal bunkers at the top, and exemplify the trust placed by American engineers in steel-framed buildings. The question of control of the large amount of electric power generated by the large units is now being taken into adequate consideration; up to the present switchboards have always been strongly suggestive of the instrument-making days, but in the new power station of the Metropolitan Traction Company the switches are built on engineering lines of generous proportions and are worked by pneumatic power and controlled electrically. Three large galleries at one

Digitized by Google

end of the engine-house are given up entirely to the switches, each in a brisk cell of its own, while the actual controlling boards take up very little space.

Underground open conduits seem to work very successfully, but have only been introduced in two cities, New York and Washington, in both of which towns no sanction for overhead wires could be obtained, and the companies had to face the heavy costs of underground conduit construction. In both towns the companies were greatly assisted in the expense by having to convert a large extent of cable traction into underground conduit, a change that is and has been carried out without much interruption of the service. Two conductors are always used and means provided for changing these conductors on to either positive or negative bars so as to enable traffic to be kept running, even with one conductor grounded in any or every section. Transformers are mostly of the air-blast cooled type and have the low-tension side directly connected, without switches, to their rotaries. These latter apparently work very well and do not give any trouble with overloading, providing no over-compounding is attempted. Compounding for a level voltage is provided for by the introduction of self-induction in the high-tension feeders and a series winding on the direct-current side of the rotary. Return-current automatic cut-outs on the high-tension feeders have been installed at sub-stations, but up to the present do not seem to be very reliable in their working. In no case, so far as I am aware, are return-current boosters used, the current having always to find its way back to the station by the rails and supplementary cables, so that even with good bonding the maximum fall of voltage from one end of a line to the station is sometimes very great. There is no limit fixed by law, and the only limit the companies recognise is an economic one when too much pressure is lost in the return circuit. A good deal of electric welding and cast welding of the rail joints has been done, and the last is looked upon, I think, with more favour. No bonds are used with this method of jointing, but if used in this country, with the Board of Trade limiting the total fall of potential to seven volts, bonds would certainly have to be provided. Overhead work in America does not compare at all with what is put up in this country, either as to strength or neatness, but in many other traction matters we have something to learn from our American cousins, especially from the way they have realised the great part electric traction plays in making adequate provision for the population of large cities; enabling poor people to live at a greater distance from their work and in better surroundings than is otherwise the case.

In conclusion, I would like to express my thanks for the kind hospitality dealt out to me by all the engineers I met during my visit.

Mr. C. H. WORDINGHAM, of Manchester, agreed with the author that there was a great advantage in having the supply of light and power in one generating works. He would like to ask the author his opinion after his recent visit as to the relative advantages of motor-generators as compared with rotary converters. He considered that the switch gear in a station was a most vital part, and thought, with the author, that the Americans paid much more attention to this detail than we did. Mr. Wordingham also raised some points as to the placing of ducts for electric lighting purposes under the tramway track, and as to the consequent electrolytic troubles.

Mr. S. Z. DE FERRANTI also remarked on the perfection to which switch gear was brought in America. In a station recently brought to his notice there were no less than two complete sets of switches, there being two switches in series in each circuit. The switches were separately controlled, so that if one failed to break the high-tension circuit, the other could be tried immediately. This seemed to the speaker to be rather complicated. He also noticed that at Niagara there had been introduced an air-blast to blow out the arc in connection with a pneumatic control. Both these points had been developed in the station at Deptford. He believed in an oil brake for switches. With regard to the capital cost of large schemes in America, he regretted to find that the outlay per kilowatt did not go down as he thought it should do. Perhaps the reason for this was the complicated transforming gear which were employed. Thus Prof. Short had assured him that he (Prof. Short) had carefully looked into the question of the distribution of light and power in New York, being provided with the actual cost of land in various parts. Prof. Short had come to the conclusion that several stations would cost less than one large station with transforming gear in sub stations all over the city.

Bailie BIRT, of Glasgow, said that in Glasgow they had started a tramway undertaking without prejudice, and he was of opinion that the tramway was in his town even more important than electric lighting. There was great need in Glasgow to get the population distributed over a larger area, and it could only be done by quick-running tramways. They had a Bill now before Parliament respecting the changes which they would make on these tramways, and also on the running speeds. They hoped to have their tramways completed for the Glasgow exhibition next year.

Mr. BRIDGES, of Eastbourne, referred to the important scheme for tramways now being considered in that town, and which would open up a large amount of land now inaccessible. He believed that in America the policy was to put down a very cheap track in the first instance, and only to construct a good track after the line paid.

Mr. LE ROSSIGNOL, in reply, said that nothing opened up the country like tramways, and it should be considered, when talking of the cost of these tramways, how small the cost was of converting a country district into a suburban one by the aid of electrical traction. Glasgow was a special case in point, where the density of population demanded some such means being adopted to relieve congestion. He gathered from his visit that there was now very little trouble with rotary converters if properly designed. After a few other remarks, Mr. Le Rossignol said he would answer other queries in writing.

Mr. R. C. Quin's paper on the protection of telegraph and telephone wires was then read.

The Protection of Telegraph and Telephone Wires in Connection with Overhead Traction.

BY R. C. QUIN, BOROUGH ELECTRICAL AND TRAMWAY ENGINEER, BLACKPOOL

This question at the present time is of special importance in view of the number of traction systems now being installed throughout the kingdom, and in view also of the fact that there is such a divergence of opinion and practice. This latter is most marked in connection with the two Government departments concerned, the Board of Trade and the Post Office. That overhead telegraph and telephone wires need protection will be admitted, but how shall this protection be best given? To the author the best method appears, and he thinks his readers will agree with him, to be the placing of these telegraph and telephone wires underground where they cross the line of tramway route. He believes the Telephone Company are not averse to this course being adopted; but we are met with the absolute refusal of the Post Office to consider any such proposition. Under these circumstances we must recognise the existence of crossing overhead wires. The most usual practice until a comparatively recent date was to place guard wires above the overhead trolley line at a distance of about 18in., these wires being of galvanised steel and supported by insulators. There is a question which the author has often asked, and to which he has not, as yet, received a satisfactory reply, and, therefore, he takes the liberty of placing the question before his readers. It is this: "What are the insulators intended for?" Are they to protect the telegraph or telephone wires or the trolley line? Assuming that we adopt guard wires, they should be supported on poles 2ft. above the trolley line, but they should not be insulated. If a telegraph or telephone wire break, what need is there to insulate from earth? If two guard wires in the same horizontal plane and 18in. apart be placed over the trolley line, the probability is that the broken telegraph or telephone wire would not come in contact with the trolley line or passing trolley; but it might do so. In that event it is better that the guard wire should be efficiently connected to earth, as a short-circuit would be the result, and if both lines, telegraph and telephone, and trolley line be properly protected by maximum-current apparatus no damage would ensue. The author would, however, point out that it is not sufficient to have these guard wires clamped to a traction post, when the traction post is bedded in concrete. There should in all cases of guard wires be two poles bonded to the rails, and these poles should preferably be the end ones of the guard-wire section. The telephone and telegraph wires should be provided with fusible cut-outs or other similar device for the protection of the terminal instruments, and this is a matter of no great cost. With these precautions there need be no fear of electrical accidents from overhead telegraph and telephone wires.

There is another system of protection now largely adopted, and which consists of fastening to the trolley line brass clips, and placing vertically over the trolley line, a wooden moulding of greater width than the trolley wire. This system, to the author, appears to have several objections. It is more

Digitized by Google

unsightly than the guard wires, and brings the trolley line into greater prominence. There also appears to be difficulty in thoroughly securing these strips, for in most towns in which they are in use many lengths have become detached. Further, they do not afford the same protection as guard wires. A telephone wire may break and fall on the strip, but so far no great damage results. A car, however, comes along, and, as has happened, the driver does not notice the fallen wire, but the cheeks of his trolley wheel touch the wire, forming contact between it and the trolley line. We then have a live telephone wire earthed only through its terminal instruments, and a live dangling wire on the car, which is not assuring to the passengers. There is a third method which is advocated by the Post Office, and that is a system of bunching telegraph wires so as to reduce the number of crossing places, and then forming an insulated cradle or hammock round these wires. The principal objection, to this course would be extreme unsightliness. It, moreover, by no means follows that if a wire breaks it will not fall through the cradle, as the meshes are 2ft. to 3ft. square. If we are to regard as impossible the laying underground at crossing places of telegraph and telephone wires, then the author suggests the following as the best method to protect telegraph and telephone wires: (1) the erection of two guard wires 18in. apart at a minimum height of 2ft. above the trolley line; (2) the length of the guard wires to be such that, should the crossing telegraph or telephone wire break close up to one span insulator and be blown horizontally in either direction, it could not, when falling, come in contact with an unguarded portion of the line; (3) each span of guard wires should be separate and distinct from its neighbour, but metallically looped across; (4) no insulators whatever should be used, but guard-wire standards be bolted direct to the bracket arms, or to the span wire, as the case may be; (5) the terminal posts of each length of guard wire should be bonded to the tramrails; (6) the trolley line should be divided into sections, and each protected by a maximum-current device—these sections should preferably not be of equal length, but proportioned for equal maximum working current; (7) the crossing span of telegraph or telephone wires should be terminated by a disconnecting insulating shackle on each side, and the connection across these shackles should be by fusible metal bridge.

If these suggestions be carried out, the author considers that all that is humanly possible to protect overhead telegraph and telephone wires will have been done.

Mr. A. S. BARNARD, of Hull, said he considered 2ft. too big a distance to leave between the trolley wire and the earth wire. Loose ends of telephone wires were then apt to swing round and short-circuit the trolley wire. In Hull he recently had all the trolley wires carefully levelled up, so that he could work the trolleys with only an 8in. rise to the stock. This enabled a much shorter distance to be maintained between the trolley wire and the earth wire. He thought that the extreme alteration in vertical height of the trolley wire above the track should be limited to 6in.

Mr. A. E. LE ROSSIGNOL, of Newcastle-on-Tyne, advised that the guard wire should be earthed through a switch in the switch pillars. It was often necessary for men to work on the trolley wire while the current was on. The earth wire was then a great danger to the linesmen. He did not believe in making the maximum-current cut-outs in the switch pillars go at any current at all comparable with the working current, otherwise a defect in one section causing a grouping of cars on the section before would most likely blow the cut-outs in that section before, and so make matters worse. He was not at all sure that a better plan was adopted in Germany of placing an earthed stirrup under the telephone wires a short distance from the post. The telephone wire then was burnt out automatically by the current passing along it from the trolley wire to earth.

One of the Glasgow Bailies then explained what an excellent system of telephones they were proposing to have in Glasgow, and that they were avoiding the troubles the author referred to by placing all the telephone wires under ground.

Mr. QUIN then replied, and pointed out that until the General Post Office were forced to put their wires underground the municipalisation of the telephones would not give the relief spoken of by the Glasgow representative.

This concluded the business of the meeting to which the Press was admitted. The afternoon on Friday was devoted to the inspection of the electric lighting and tramway systems of Leeds.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

289. What is the best method of determining the counter E.M.F. of electrolytic baths?—W. G.

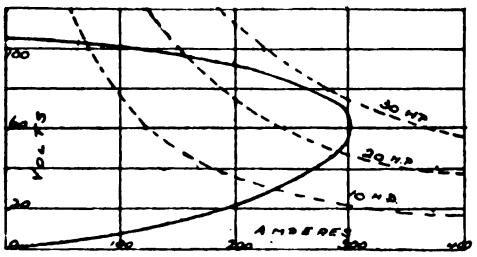
290. Give comparative figures as to the weights and efficiencies of true direct-current dynamos of about 200 kw. capacity, running at a speed of about 50 revolutions per minute, the first machine to be a two-pole one and the second a multipolar. Figures from actual machines would be of greatest service.

ANSWERS.

Question No. 283.—When two dynamos are running in parallel, each with full load, 200 amperes at 100 volts, if belt comes off one, will the extra current at lower voltage harm remaining armature if the starting lever is not moved? If so, how?

Best Answer to No. 283 (*awarded* 10*s.*).—There is not sufficient data given in the question to make it possible to give a definite answer to the particular case quoted; all that one can do is to deal generally with one or two cases under varying conditions.

In the first place, if the two machines are connected up to a common 'bus bar, there should be fuses or cut-outs of some description inserted between them and the 'bus bar, so that in the event of anything taking place which would cause an injurious current to flow from either machine, the circuit would be broken thereby before the armature could be seriously harmed. Let us assume, however, that there are no cut-outs, and that the machines are coupled directly to the bars. It is not stated whether the machines are series or compound wound. Let us suppose them first to be shunt wound, and to have characteristic curves something similar to the one shown in the figure, which was taken



from actual practice. It will be seen from the curve in question that if the resistance in the external circuit be gradually decreased, the current will increase and the E.M.F. decrease until a point is reached where the voltage drop is so rapid that it more than counterbalances the tendency of the decreasing resistance to increase the current. The result is that there is a certain maximum current beyond which it is impossible to force the machine. The worst, therefore, that could happen would be that the total load thrown upon the one machine should be just sufficient to attain this maximum; any tendency on the part of the dynamo to give out a greater current would simply have the reverse effect.

The question then becomes: Is the dynamo designed upon a sufficiently liberal scale that it will take the maximum load shown on the curve (300 amperes according to the figure) for a short time without overheating? If so, that settles the question, as far as a shunt machine is concerned. If not, there is another safeguard we may, perhaps, fall back upon which will limit the output of the

Digitized by Google

dynamo—*i.e.*, the maximum power of the engine. The dotted curves shown in the figure are H.P. curves calculated from varying values of volts and amperes. If a similar curve be plotted corresponding with the greatest output of the engine, it may, perhaps, intersect the dynamo curve, and thus further limit the current possible to be generated in the armature. Should the machines in question be compound wound, the drop in volts with the increased current would, of course, be either wholly or partly annulled by the increased magnetising current passing through the series turns on the field magnets; and in this case, if the increased load is large enough and the engine sufficiently powerful, the armature will probably burn out.

Finally, in all cases where a load of large dimensions is suddenly thrown upon a machine, there is always a chance that mechanical damage may be done either to the dynamo or engine. In one case within my knowledge it was the cause of a governor spring breaking and the consequent running away and breaking up of the engine.—W. G. MARRIN.

Answer to No. 283 (*awarded* 5*s.*).—The remaining generator would be called upon to supply more than twice its normal current, for in addition to the load of 200 amperes which No. 2 was carrying, No. 1 would have to supply current to keep No. 2 running as a motor. Of course, if such amount of current were supplied for any appreciable time, the armature of No. 1 would be damaged. In practice, however, the sudden increase of load would in all probability break or throw the belt off No. 1, and so cut it out of circuit as a generator, and the two machines would then stop. If the belt did not give way, however, No. 1 armature would not be damaged, provided the dynamo is an ordinary shunt-wound machine, for the following reasons: The great increase in current in No. 1 would cause a very large drop in its armature, thus materially reducing the volts applied at terminals of the shunt coils. Further, the armature reaction would now be so great that it would almost certainly demagnetise the field. The conditions, in fact, are such that the working point is transferred from a stable part of the external characteristic curve to an unstable part, and directly the armature current exceeds the critical value, the dynamo loses its magnetism and the volts drop to zero.

The answer, then, to the question is that the dynamo left as a generator will not be damaged, if it is an ordinary self-exciting shunt machine, but that the whole plant must inevitably shut down. A very practical example of the behaviour of shunt machines in parallel occurred in the Brighton central station some two years ago, when, owing to the burning out of an armature carrying 900 amperes, the remaining machines were so overloaded that they lost their excitation, and in 40 seconds the whole station was shut down. The total current being supplied just before the accident was 9,000 amperes at 230 volts.—E. M.

Answer to No. 283 (*awarded* 5*s.*).—When a sudden overload to the extent mentioned in the question is thrown on a running dynamo, in most cases the belt of the machine will be thrown off, or, again, if a fuse is in circuit current will be generated to blow the fuse, but beyond a temporary heating of the armature no harm will be done. From the question it is obvious that neither of these conditions are meant. If the dynamos are driven by separate engines, the engine running the overloaded dynamo will be pulled up, and will then try to take up the overload. If one engine runs the two sets no difference will be observed, for the engine will only have to take up the same load on one dynamo. The first result of such an overload on the dynamo would be violent sparking at the brushes, as the output of any dynamo is governed by the sparking limit. This sparking would cause great damage to the commutator by burning flats in the segments. The next thing would be injuring the armature conductors. When any conductor is overloaded for a time, the copper becomes very hot and damages the insulation. Of course, the flow of current in any conductor is proportional to its resistance, and armature conductors have a very low resistance, so the flow of current in them will be very great, resulting in the heating of the conductors and consequent charring of the insulation, this would mean new windings on the armature. Another result, which would not occur in slotted armatures, would be the displacement of the conductors; in every armature the magnets exert a certain pull on the conductors which is proportional to the output, hence the need of driving pegs in the smooth-core armatures. Taking off such a large current would involve a tremendous strain on the conductors, and if driving pegs were weak a stripped armature would result. I have seen armatures without driving pegs in which the winding has slipped quarter of the armature circumference through a continued strain being thrown on the machine. A bent shaft would also result if the shaft was weak. The lower voltage would not have much to do with the question, the current working the damage. In most cases a sudden overload like this would mean a new armature.—F. M. MOODY.

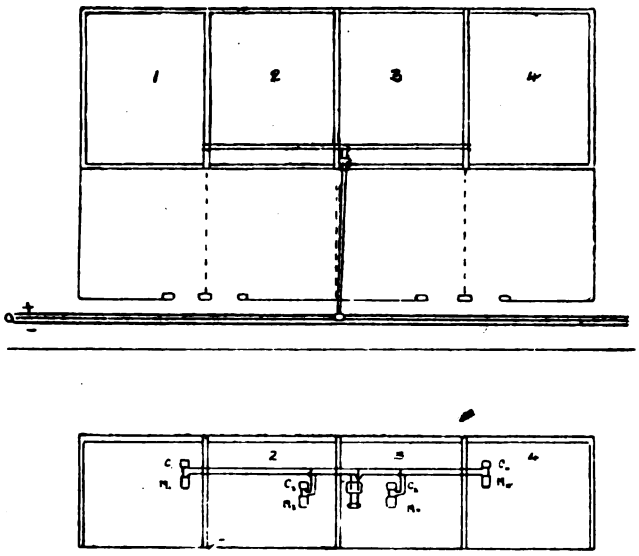
Answer to No. 283 (*awarded* 5*s.*).—The words "if the starting lever is not moved" presumably refer to the belt striking gear of the machine whose belt remains on, not being interfered with, so that this machine continues to run round. Under these circumstances, supposing the voltage remained unchanged, the current given by the belted machine would be more than double its normal full load, for it would not only have to supply the whole outside load, which was previously supplied by both machines in parallel, but it would, at the same time, have to supply a certain amount of current (say 10 or 15 per cent. of full load) to run the beltless machine round as a motor. The actual case would, however, not be quite so bad as this, for the voltage of the belted machine is bound to drop, to a greater or less extent, as soon as its load increases. If the dynamos are compound wound, this drop will be less than if they use plain shunt-wound ones; and, again, if each dynamo is driven by its own small engine, only just capable of supplying its normal full load, the speed will fall off at the overload to a far greater extent than if the two machines are driven from one engine, or from a common line of shafting, for in the latter case the total load on the engine, and, consequently, the speed, will remain almost unchanged. The result of this drop in voltage will, in practice, be that, instead of the load on the remaining machine doubling or more than doubling itself, it will not rise more than 50 to 75 per cent. above the normal, depending on the amount of drop in the characteristic curve of the dynamo and on the speed curve of the engine. With some shunt-wound dynamos having large armature reaction, it is quite possible that such an overload as the above will make the machine lose its field and the voltage die down to nothing, in which case, of course, no damage can result. In my case, however, a well-constructed dynamo should be readily able to carry the 75 per cent. increased current without burning out for at least a few minutes, by which time the lamps can be switched out or the faulty belt replaced.—Q.

Question No. 284.—Describe some good and cheap way of making connections from consumers to distribution mains, applicable where several adjacent houses take the supply.

Best Answer to No. 284 (*awarded* 10*s.*).—As the connection of consumers to the distributing mains of an electric supply undertaking is a very heavy charge against the concern, it is important that the expenditure in this direction should be kept as low as possible. Where several adjacent houses take the supply, something towards this end may be done. Let 1, 2, 3, and 4 (see sketch) be four such houses. The service box would be put on the main opposite the division wall of 2 and 3, and if an extension has been run to the houses the main would end here. A service heavy enough to deal with the demand of the four houses would be run up the garden of, say, No. 3 into the cellar, where a suitable cut-out has been fixed to receive the ends. From the further side of this cut-out leads are run through cellars 2 and 3 just into cellars 1 and 4. As the ends come through the walls, they are taken into one terminal of the meter and of the cut-out with which the wiring contractor has finished off his work. This does away with the necessity of making joints at these two points. The cut-outs are shown at C_1, C_2, C_3, and C_4, and the meters at M_1, M_2, M_3, and M_4. Tee-joints are made in cellars 2 and 3, and the branches connected into meters and cut-outs there. Each installation is pro-

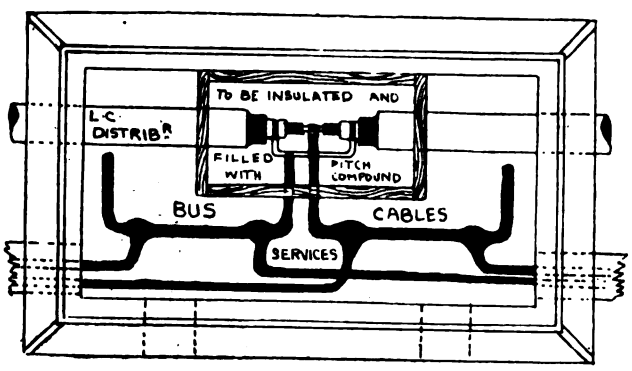
Digitized by Google

tected by its own cut-out, and the services by the main cut-out. Where there is no cellaring, as is sometimes the case in flat sandy districts, the leads can usually be run under the floors, as there is generally sufficient room underneath in which to work. If not, an occasional floorboard can be taken up without much trouble. The meters could then be fixed in the orthodox position—"the cupboard under



the stairs." The leads through the cellars may be cleated up to the floor joists, run in casing or in iron pipe, according to circumstances, care being taken in the case of an alternating supply that the two cables are run in the same pipe to obviate induction effect. If the distribution is done on the three-wire system, the block of houses may be balanced on itself. This would, however, scarcely be necessary, as the using of that system would imply the presence of actual or possible consumers at no great distance. If the system is two-wire concentric throughout, probably the cheapest way would be to take the houses in pairs. A double service box would be placed opposite division walls separating 1 from 2 and 3 from 4, and the services to the two adjacent houses run in the same trench; or a single service box might be used, and a tee-joint made in, say, cellars 2 and 3, and the branches taken through into cellars 1 and 4. Concentric services, however, mean complication, as either a cut-out with special contacts is necessary, or else the end must be finished off with some form of fork or bottle joint.—P. S. T.

Answer to No. 284 (*awarded* 5*s.*).—The sketch shows a simple method of making multiple connections from a



single joint on a concentric distributor. It is equally applicable to singles, triple-concentric, or three-core. The distributor is assumed to be of a hygroscopic character; the 'bus cable joints to it are therefore insulated with the usual well-boiled tapes, and then encased in a strong wooden box which is filled with a compound of pitch and diatrine (or bitumen) proportions about 4 to 1 respectively. This keeps the pitch from cracking, and makes it strongly adherent to all surfaces, thus preventing moisture creeping to joint. The 'bus cables should have fairly inflexible strands (to prevent sagging), insulated with vulcanised rubber of cheap quality (good-quality rubber would get spoiled by the jointing operations upon them), and the insulation is sufficiently preserved by being embedded in the compound and suspended in air. The service leads are also of cheap-quality rubber, and are laid in pitched troughing to the various consumers' premises. In the event of a considerable distance occurring between the joint and consumer's fuse (or where there is a likelihood of injury to service leads), the section of the lead might be reduced by cutting out some wires at a place as far as possible from joint (but accessible in pavement box) and reinsulating, thus providing a fusible cut-out in case of anything going wrong on the service line. A foot or so of slack should be left on service leads in the brick box. This box should have a removable cover properly caulked at the joints, and should be well ventilated by means of a gas-pipe running out from each side of box to nearest wall, and suitably bent at end to keep intrusive substances out (so-called ventilating-box covers are a snare and a delusion). This method of service jointing is cheaper and more accessible than most systems, and for a dry locality is all that can be desired. Excessive dampness that might tend to injure the service joints can be guarded against by making a clinker bottom to brick box and coating the exposed cables with paraffin wax. There are other and more expensive methods, entailing cast-iron boxes and gunmetal fittings; but they are also inelastic, so that to put in a two-service box and eventually find that four are wanted is not less vexing than to put in a more expensive four-service box at another place and to find that the original two consumers will never have company. With the system described above, a yard of 'bus cable will suffice for one or a dozen services, and scrap cable ends can be used.—J. H. C. B.

LIGHT RAILWAYS.

We have received from the Light Railway Commissioners the following statement: It is announced for the convenience and information of the public and the parties interested that the following dates have been provisionally proposed for the holding of local enquiries by the Light Railway Commissioners. Due notice, by advertisement and otherwise, will be given in the usual way when any date is finally arranged: July 23—Kingston, Surbiton, and District Light Railway, 1899, and Kingston, Surbiton, and District Light Railway Extensions, 1900; July 24—Hayling Island Light Railway; July 26—Norwich and Dereham Light Railway; July 30—Bath and District Light Railway; July 31—Bridgwater, Stowey, and Stogursey Light Railway; Aug. 1—Devon South Hams Light Railway; Aug. 3—Mid-Anglian Light Railway, 1899, and Mid-Anglian (Amending) Light Railway, 1900; Sept. 20—Rhyl and Prestatyn (Extension) Light Railway; Sept. 21—Pwllheli and Nevin Light Railway; Sept. 22—Warrington and Runcorn Light Railway; Sept. 24—Windermere and District Light Railway; Sept. 25—Blackburn, Whalley, and Burnley Light Railway; Sept. 26—Wigan Light Railway; Sept. 27—Hyde and Dukinfield Light Railway; Oct. 8—Deanhead Light Railway; Oct. 9—Nidd Valley Light Railway; Oct. 10—Durham and District Light Railway, and West Hartlepool (Extensions) Light Railway, 1899; Oct. 11—Jarrow and South Shields Light Railway; Oct. 12—Wales and Laughton Light Railway, and Barnsley and District (Extension No. 2) Light Railway; Oct. 17—Kidderminster and Bewdley Light Railway; Oct. 18—Cleobury Mortimer and Ditton Priors Light Railway; Oct. 25—Swansea and District; Oct. 26—Llanelly and District; Oct. 27—Rhondda Valley.

At a meeting of the Gloucester County Council a proposal that the Council make application to the Light Railway Commissioners for an order, under the Light Railways Act, 1896, authorising the County Council to advance £15,000 to the Witney, Burford, and Andoversford Light Railway on condition that the Oxfordshire County Council did the same, that her Majesty's Treasury made a free grant under Section 5, and that the balance required for the construction of the railway be raised by means of debentures or ordinary shares, was defeated.

A short report of the action taken by the committee appointed to oppose, on behalf of residents and ratepayers of Blackheath, the light railways schemes of the London County Council, so far as that scheme affected Blackheath, has been issued.

A communication was read at the last meeting of the Ogwen District Council from Messrs. Bennett and Ward-Thomas, of Manchester, stating that it was proposed to construct light railways from Carnarvon to Bethel, Ebenezer, and Bethesda, and from Carnarvon to Dinas Dinlle. It was decided that the question should be deferred in order to obtain further particulars.

Sir Courtenay Boyle had last week before him for confirmation the light railway orders granted by the Light Railway

Digitized by Google

Commissioners for light railways from Colne to Trawden and from Colne to Nelson and Barrowford. The Colne and Trawden line was promoted by Messrs. Greenwood and Batley, Limited, of Leeds; the Nelson order was promoted by the Corporation; and the Barrowford order by the Urban District Council of Barrowford. Sir Courtenay Boyle said he would report to the Board of Trade on all the schemes.

In connection with the scheme promoted by the British Electric Traction Company for the construction of a system of light railways in Kingston, Surbiton, and district, a public enquiry is to be held by the Light Railway Commissioners at the Assize Courts, Kingston, on the 23rd inst.

COMPANIES' MEETINGS AND REPORTS.

ELECTRIC CONSTRUCTION.

The ordinary general meeting of the Electric Construction Company, Limited, was held on Thursday week at Winchester House, E.C., Mr. J. W. Barclay presiding.

The **Chairman**, in moving the adoption of the report, said they had to deal with a profit of £21,729. It was proposed to pay the fixed preferential dividend and to distribute 6 per cent. to the ordinary shareholders, carrying £4,777 forward. The cost of maintaining the works, etc., and £5,000 to the credit of the general depreciation account, all came out of profits, as usual. For the past seven years they had applied £33,000 of profits in reducing the capital account, while the works had now more capacity for earning dividends than ever before. During the last seven years the size of the machines they were required to produce had very largely increased, but practical considerations led to the conclusion that the limit of size had nearly been reached, and the directors were of opinion that the works would be able to cope with the largest machines that would be demanded. During the past year the Company had successfully completed the equipment of the City and South London Railway extensions with plant and appliances of exclusively British manufacture. As to the future, they were full of orders, and the Board were pressing forward the completion of the new shops to enable the Company to execute them without undue delay. On the whole, their position in the manufacturing world was becoming more and more firmly established, and they might regard the future with confidence.

The motion was seconded and carried.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The half-yearly general meeting of this Company was held at the offices, 38, Old Broad-street, on Tuesday, Sir R. G. W. Herbert presiding.

The **Chairman** said their factories had been closely employed since they met them last, doing good work, and so had the ships. The new ship "Anglia" had lately completed one voyage and was about to enter on another, laden with a greater amount of cable than had ever before been carried by any telegraph cable ship. They had work in hand which would occupy them sufficiently well during the remainder of this year, and did not anticipate that there would be any less favourable accounts to render to them when the annual meeting came round.

Mr. Croft said that there was only one subject on which he would like to make a remark, this being the Pacific cable. Probably everyone had seen an advertisement in the papers with respect to tenders being asked for on behalf of that cable. He thought it would be satisfactory if the chairman were enabled to say whether the Company was in a favourable position as regarded tendering for that cable.

The **Chairman** said that Mr. Croft was right in saying that a notice had appeared in the papers that tenders were about to be called for. They had only just received the detailed specifications, and the Board had not had time to give very close consideration to them. The proposals of the Government were that the work should be divided into sections—the long section from Vancouver to Fanning Island, and the short section from Fiji to Norfolk Island, Norfolk Island to New Zealand, and from Norfolk Island to Australia—and that tenders might be offered for those sections. A company able to do the section from Vancouver to Fanning might, if it had the means in its establishment, be able to undertake other sections also. Whether they would be able to offer to do this very exceptional work at prices which would satisfy the Australian Colonies and Canada that they ought to incur the expenditure he could not say, but they were quite sure that no other institution had a better prospect of being able to do the work, both economically and soundly, than their Company.

CALCUTTA TRAMWAYS.

The ordinary general meeting of this Company was held on Wednesday at Cannon-street Hotel, E.C., Mr. E. C. Morgan presiding.

The **Chairman** said the general condition of the Company was very satisfactory, but there had been a diminution in the receipts as compared with those in the previous year. Having regard to the wholesale reconstruction which was being carried on throughout the year, it had been a work of the greatest difficulty to maintain the service of the lines, and great credit was due to the staff in Calcutta for the relatively small inconvenience caused to the public in these trying circumstances. A large decrease of car mileage was necessitated by the practical reduction of the lines to single track during the greater portion of the year, and it was necessary to discontinue temporarily the facilities usually granted for transfer from one line to another. It was satisfactory to observe that, in spite of difficulties, the loss of traffic was inconsiderable, and that it had been possible to effect important savings in expenditure. As to the present position of the Company, when they met on Dec. 19 last the agreement with the Corporation had just been concluded. No time was lost in pushing on with the necessary surveys and plans for the new installation, and a definite contract had been entered into for the completion of the work by Dec. 31, 1901, at a cost not to exceed £170,000. He also mentioned last December that they had come to an arrangement with the Government of Bengal for the doubling of the line across the Maidan to the docks, and for its electrical equipment. This doubling was now almost complete, and had been found, even without the new motive power, to afford the greatest convenience to the Calcutta public. The contract mentioned covered the electrical equipment of this line, as well as that of all the lines now existing within the municipal boundaries, but it did not cover the cost of erecting the power-house and the alteration of the car-sheds. In order to provide the necessary funds for the heavy expenditure involved, the directors created an issue of first debenture stock for £350,000, and offered £250,000 of the amount for public subscription on March 26 last, and the Board were now in possession of ample funds for present requirements. He concluded by moving the adoption of the report, which was seconded by **Mr. C. Sanderson** and agreed to.

BRITISH COLUMBIA ELECTRIC RAILWAY.

The report of the directors of this Company for the year ended March 31 states that the net earnings, which were £33,258 for 1898-99, have now reached £40,512. The ratio of working expenses to gross earnings has fallen by 4·18 per cent., which would represent a saving of £3,554, and this amount forms part of the increased profit. The net profit for the year, after deducting expenses, amounts to £38,216, besides the balance brought forward of £189. From this the directors have provided for the payment of debenture interest, £11,250; preference share interest, £6,028. Deducting interim dividend on ordinary shares there remains for distribution £17,127, from which the directors have decided to write off a further 20 per cent. of preliminary expenses, making in all 60 per cent. now written off, and to recommend a final dividend on the ordinary shares of 2 per cent., making 4 per cent. for the year. In order to provide for the growth of the business, the directors recently made a further issue of 1,600 5 per cent. non-cumulative preference shares of £10 each.

DIRECT UNITED STATES CABLE.

The report of the directors of this Company for the last half-year states that the revenue, after deducting out-payments, amounted to £52,204, as compared with £51,951 for the corresponding period of 1899. The working and other expenses, including income tax, amounted to £20,506, leaving £31,698 as net profit, making, with £6,347 brought forward, £38,045. Three quarterly interim dividends of 3s. each per share have been declared, and a final dividend of 3s. per share is now proposed, together with a bonus of 2s. per share, making 3½ per cent. for the year. After transferring £10,000 to the reserve fund account, the balance of £3,761 on the revenue account is proposed to be carried forward.

SOUTH STAFFORDSHIRE TRAMWAYS.

The report of the directors states that the total receipts for the year amounted to £36,330. 11s., an increase on the previous year of £2,023. 4s. 8d., and the total receipts per car mile were 14·77d., as against 13·95d. The total expenditure for the year was £33,063 8s. 9d. The directors recommend that a dividend of 2s. 5d. per share should be declared upon the preference shares. The Board of Trade has renewed the steam license to April 24, 1901, and the electric license to Dec. 9, 1903. The increase in working expenses is due to the great rise in the price of materials.

The tenth ordinary meeting of the Company was held on Wednesday last at Winchester House, E.C., Mr. S. S. Schuster presiding, when the above report was presented, and a resolution "That a dividend at the rate of 2s. 5d. per share (free of income tax) be paid upon the preference shares of the Company for the year ended Dec. 31, 1899," was carried *nem. con.*

NATIONAL TELEPHONE.

The report of the directors of the National Telephone Company, Limited, for the half-year ended June 30 last, states that the income accrued in respect of the business of the half year amounts to £700,140, as compared with £602,640 for the corresponding period of 1899, being an increase of £97,500. The working expenses for the half-year, including the special expenditure of £25,013 incurred in repairing the damage caused by the snow-storm in February last, amount to £404,520, as compared with £327,497 for the corresponding period of 1899, being an increase of £77,022. The net result for the half-year is a profit balance of £227,262, as compared with £216,257 for the corresponding period of 1899, being an increase of £11,005. The rentals carried forward

Digitized by Google

for unexpired terms of running contracts amount to £733,614, as compared with £651,741 at the corresponding period of 1899, or an increase of £81,873. Out of the available balance of £178,195 shown by the net revenue account, the Board recommend the payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, and 6 per cent. per annum on the ordinary shares. The Board also propose to transfer £55,000 to the reserve fund, and to carry forward the balance of £4,325. The sum of £366,223 has been expended on capital account during the half year in the erection of 11,696 additional exchange and private lines and in the construction of underground lines. In considering the profit results of the half-year's working, it must be remembered how very adversely they have been affected by two exceptional causes—first, the large amount of £25,013 to repair the damage arising from the snowstorm in February, and, second, the considerable increase in the cost of materials and labour consequent upon the abnormal commercial activity existing throughout the country.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bermondsey.—The Vestry invite tenders for the erection of a generating station in Neckinger, Spa-road. Tenders by 26th inst.

Manchester.—The Tramways Committee invite tenders for supply of special (permanent way) track work. Tenders by 23rd inst.

Sheffield.—The Corporation invite tenders for 12 months' supply of transformers. Tenders by 21st inst. Details in our advertisement columns.

Hull.—The Corporation invite tenders for the electric lighting installation and fittings for the Springhead pumping station, near Hull. Tenders by 23rd inst.

Manchester.—The Tramways Committee invite tenders for the electrical equipment of 150 cars. Tenders by 21st inst. Details in our advertisement columns.

Stockport.—The Tramways Committee invite tenders for 20 double-deck tramcars, complete with electric equipment for overhead traction. Tenders by Aug. 31.

Cardiff.—The Corporation invite tenders for the manufacture and delivery of 10 30 kw. transformers. Tenders by 24th inst. Details in our advertisement columns.

Darlington.—The Corporation invite tenders for the supply and delivery of arc lamp posts and brackets. Tenders by 28th inst. Details in our advertisement columns.

Southend-on-Sea.—Tenders are invited for the supply and delivery of about 1,180 tons of steel girder rails and about 46 tons of steel fishplates. Tenders by July 25.

Birkenhead.—The Corporation invite tenders for constructing and erecting a new car shed in connection with the electric tramways in Laird-street, Birkenhead. Tenders by July 24.

Southend-on-Sea.—Tenders are invited for the construction of about 7½ miles of permanent way in connection with the Southend-on-Sea and District Light Railways. Tenders by 25th inst.

Rugby.—The Urban District Council invite tenders for taking a lease of their powers under the Rugby Electric Light Order, 1898. Tenders by Aug. 1. Details in our advertisement columns.

Algemesi (Valencia, Spain).—The Municipal Authorities will receive tenders for the installation and working of the electric lighting by July 21. Specifications may be inspected at this office.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of lighting cables, tramway feeders, and street lighting. Tenders by Aug. 13. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply and fixing of coal-conveying plant at the electric supply station, Dunning-street, Sunderland. Tenders by 27th inst. Details in our advertisement columns.

Algenci (Spain).—Tenders are invited for an installation of public and private electric lighting. Specifications are to be obtained from and tenders addressed to the Municipal Authorities of the above place before July 21.

Hull.—The Electric Lighting Committee invite tenders for the supply and erection of five high-tension continuous-current rotary transformers, with switch gear and accessories. Tenders by 26th inst. Details in our advertisement columns.

Aston Manor.—The Urban District Council invite tenders for steam dynamo, motors, switchboard, pipework, storage battery, pumps, arc lamps and posts, travelling crane, and wiring. Tenders by 24th inst. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for the supply and erection of boilers and auxiliaries, steam generators and switchboard and cranes, feeders and distributors, line equipments, trucks and car equipments. Tenders by July 25. Details in our advertisement columns.

Islington.—The Electric Lighting Committee invite tenders for relaying York and other stone and providing new York and other stone where necessary over the conduits and mains, as required, during the three years next. Tenders by 25th inst. Full details in our advertisement columns.

Kingston-upon-Hull.—The Corporation invite tenders for the electric lighting installation and fittings for the Springhead pumping station, near Hull. Tenders by 23rd inst. Details in our advertisement columns.

Hapton.—Tenders are invited for the lighting of Hapton township with electricity from Sept. 1, 1900, to April 30, 1901. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, 16, Hammond-terrace, Padiham, by 31st inst. Full particulars on application.

Glasgow.—The Corporation invite tenders for the supply of concentric and single main cables, insulated with paper or fibre impregnated with oil, bitumen, or other substance impervious to moisture, or with vulcanised bitumen. Tenders by 26th inst. Full details in our advertisement columns.

Torquay.—The Corporation invite tenders for two water-tube boilers, with superheaters, two inductor alternators and Willans engines, pipework, surface condensers, etc., extension to high-tension switchboard, wattmeters, etc., and transformers. Tenders by Aug. 6. Full details in our advertisement columns.

Blackpool.—The Corporation invite tenders for the following works in connection with tramways extension: (Section A) trolley poles; (B) cables and trolley wires; (C) boosters and switchboards; (D) storage battery. Tenders will be received for any one or more sections, but not for part of a section. Tenders by July 23.

Madrid.—The Spanish Government invite tenders, not later than Aug. 18 for the concession of a system of electric tramway lines in Barcelona. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Russia.—Tenders are invited by the Russian Government not later than the 28th prox. for the telephone service of Warsaw, St. Petersburg, Moscow, Odessa, and Riga. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Grays.—The Urban District Council invite tenders for the supply, delivery, and erection of the following work in connection with the electric lighting of the district: (Section A) two Lancashire boilers and pipework; (B) two 100 kw. steam dynamos, with boosters and balancer; (C) fuel economiser; (D) switchboard; (E) battery; (F) travelling crane; (G) mains and street lamp fittings. Tenders by Aug. 9.

London, E.C.—Tenders are invited by the Pacific Cable Committee on behalf of her Majesty's Government and the Governments of Canada, New South Wales, Victoria, New Zealand, and Queensland for the manufacture and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cables between Vancouver and Fanning Island, Fanning Island and Fiji, Fiji and Norfolk Island, Norfolk Island and New Zealand, Norfolk Island and Queensland. It is proposed to divide the whole undertaking under three distinct contracts, for any one or more of which contractors may tender. Each of these contracts will include a clause under which the contractor guarantees the good electrical condition and working order of the cables for 30 consecutive days after the completion of the laying. A fourth contract is also proposed for surveying and sounding the whole route before the cables are laid. Forms of contract, specification, and tender may be obtained of Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street, E.C., at whose offices charts showing the proposed route of the cable and the positions where soundings are to be taken may be inspected. The last day for the reception of tenders is Aug. 14. They must be enclosed in sealed covers, marked "Tender for Pacific Cable," must be addressed to Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street, E.C., and must be delivered by 12 noon on that day.

RESULTS OF TENDERS.

Epsom.—The London County Council have accepted the tender of J. T. Mayfield and Co., of Queen Victoria-street, at £1,665, for the installation of telephones, tell-tale clocks, fire-alarms, and call bells at the Horton Asylum, Epsom.

Grimsby.—The Corporation have decided to accept the tender of Messrs. Chamberlain and Hookham for electricity meters, and to order 50 of the smallest size and 25 each of the next two sizes, and have also accepted the tender of Messrs. Mackenzie Bros., of Edinburgh, for lamp standards, at £613. 6s.

Stafford.—The Town Council have accepted the following tenders: Chloride Electrical Storage Syndicate, Limited, Chloride storage battery containing 224 cells, and for a switchboard with instruments and switches, at £1,699; Electric Construction Company, Limited, rewinding and converting the dynamos, at £287; Willans and Robinson, Rugby, 350-h.p. steam-engine, at £1 462; Messrs. Thomas Parker, Limited, Wolverhampton, 200-kw. dynamo, at £800.

Thorp Perrow (Yorks).—The following tenders have been received for an electric light installation at Thorp Perrow, Yorks, for Mr. H. C. Allfrey. Mr. Morgan Williams, C.E., consulting engineer:

J. C. Holmes and Co., Newcastle	£2,575
Ernest Scott and Mountain, Newcastle	2,504
Cox-Walkers, Darlington	2,400
Cox-Walkers, Darlington	2,280
Bland Bros., Newcastle	2 380
Walker and Hutton, Scarborough	2.250
Mavor and Coulson, Glasgow	2 051
Mavor and Coulson, Glasgow	2 030
Mavor and Coulson, Glasgow (accepted)	1,995

Digitized by Google

BUSINESS NOTES.

TRACTION.

Garston.—The Urban District Council have decided to oppose the Bill promoted by the Garston Tramways Company.

Southend.—Electric street trams are to be introduced by the Town Council at Southend-on-Sea. About 7½ miles of track are to be laid.

Central London Railway.—We notice that it is officially announced that the date of opening of this railway to the public is to be July 30.

Burnley.—The last ordinary meeting before the Corporation acquires the Burnley and District Tramways Company's undertaking was held last week. It was stated that the transfer would probably not take place until Dec. 31.

Moss Side.—The District Council have decided to apply for sanction to borrow £12,000 for relaying the tramlines in the district, so as to make them suitable for electric haulage, and a further sum of £3,000 for repairing the sides of the rails.

Halifax.—The Tramways Committee of the Corporation have decided to push on with all speed the work of extending the tramlines to Tuel-lane Top and to Causewayfoot. It is expected that both these extensions will be open for traffic during August.

Lancaster.—A scheme is being promoted by Mr. John Gardner, of Morecambe, for the provision of an electric tramway from Lancaster to the West-End of Morecambe. Tramways electrically propelled will, it is estimated, accomplish the journey in a quarter of an hour.

Barton.—At the last meeting of the Rural District Council the Clerk read a communication from Clifton Parish Council stating that they had passed a resolution that the Barton Rural District Council be requested to approach the Farnworth District Council asking that body to continue their electric tram system through Clifton. The clerk was instructed to reply that the Council now had the matter before them.

Southern Electric Tramways.—The Earl of Morley's Committee on Unopposed Bills in the Lords dealt last week with the Bill authorising the South-Eastern Metropolitan Tramways Company to equip electrically and operate on other than the overhead system their tramway running from Greenwich to Catford, and the Bill was passed as an unopposed measure after certain amendments had been inserted.

Bath.—The Rural and District Council having received a report from the Finance and General Purposes Committee on the subject of the proposed electric trams, the suggestion that macadam up to the rails would suffice, subject to the promise to lay wood pavement down if required by the Council from two years after construction, has been agreed to, and the report adopted.

Rhyl.—The town clerk has received a letter from the secretary to the Rhyl and Prestatyn Light Railway Company, relative to the proposed extension of the electric tramway through Rhyl. The letter states that the necessary notices have been issued, and that every effort is being made to hold the enquiry at an early date in order that the scheme can be completed and in working order by April 1, 1901. The contracts for the Rhyl electric light works have been signed and sealed.

Swansea.—At a meeting of the Tramways and Electric Lighting Committee of the Corporation last week, a proposal was made that the town clerk should make the necessary arrangements for securing witnesses in support of the application to be made shortly by the Corporation under the Light Railways Act for the extension of the tramway system. Some of the members questioned whether there would be any opposition, but the Mayor said Mr. Garoke had told him the tramway company would offer the very strongest possible opposition. The necessary authority was given.

Carlisle.—The new electric tramways met on Sunday with several accidents. Thus on Sunday night one of the trolley wires fell, and the cars stopped running. Two were left standing in Lowther-street and one in Caldewgate. The current was switched off until the wire was safely fixed. An accident of a somewhat serious nature also occurred on Sunday afternoon near Caldew Bridges. Two cars were running in opposite directions on the Caldewgate branch, and at the curve the drivers found it impossible to stop, a collision resulting, throwing one car off the line.

Yeadon.—At the monthly meeting of the Yeadon District Council last week a letter was read from the Leeds Corporation stating that the Tramways Committee could not recommend the Corporation to undertake the construction of a tramway to Yeadon and Guiseley, but were prepared to extend their system to the city boundary if the District Councils would undertake the service of their respective districts or arrange with a company to do so, so that there might be a point of connection between the district and the city tramways. It was decided to call a joint meeting of the Yeadon, Rawdon, and Horsforth Councils to discuss the question.

Dundee.—The Corporation electric tramways system, a section of which has now been completed, was on Thursday week inspected by Board of Trade officials, and there were also preliminary runs for the purpose of testing the working of the electric cars. The route which has been completed extends to 1¾ miles, and in the morning the first official run took place from the High-street to the west end of the town. These initial runs were carried through without mishap. Colonel Yorke, the Board of Trade inspector, expressed his satisfaction with the working of the cars. Thereafter the party proceeded to the generating station, and approval was given by the inspectors to the Dundee system, and the necessary permission authorising the opening of the tramways system for traffic last Friday was granted. The tramways were therefore opened to the public on that day.

Southport.—On Tuesday last Mr. Alexander P. Trotter, electric adviser to the Board of Trade, held an enquiry at the town hall, Southport, into the application of the Corporation for sanction to borrow £40,000 for the purpose of reconstructing the tramways recently purchased by the Corporation from the Birkdale and Southport Tramways Company. The Town Clerk informed the inspector that the present application was with regard only to the Birkdale and Southport tramway. The portions of this tramway within the borough, forming part of the company's undertaking, the Corporation had recently purchased, and the Board of Trade had sanctioned a loan for that purchase. It had, however, been decided, subject to obtaining the necessary sanction, to equip the line electrically, and for that purpose it was necessary to apply for further borrowing powers, and for permission to use electrical power, the present order providing only for the use of animal power. The present application accordingly was, first, for sanction to use electrical traction for these tramways; and, secondly, for sanction to borrow £40,000 for the purpose of reconstructing them and putting down the electrical equipment. The Corporation were in a position to equip the undertaking, and the overhead system would be adopted subject to the Board's approval.

London United Tramways.—The House of Lords Committee presided over by Earl Rosse has just completed its labours upon the London United (Tramway) Extensions Bill. This Bill had already been passed by a committee of the House of Commons, but was again opposed by the Middlesex County Council. The Bill proposed to remove the restriction which had been put upon the company as to working a portion of their system in Hammersmith by conduit instead of overhead electric traction, and after a contest extending over more than three years with the London County Council, the company have now secured overhead traction throughout the system. They have also obtained the whole of the extensions for which they applied to Parliament, and their system will now embrace some 40 miles of route, comprising the whole of the western suburbs of London. In several instances where the company's existing terms would expire in about 11 years they have secured extensions, so that the average period of life will be upwards of 23 years. In addition, most of the extensions will have to be bought up, if at all, not upon the Tramways Act terms, but at market value as a going concern. They are now engaged in the completion of the first section of their electric system, which they will open in a few months, and they will be able to make provision at their Chiswick power station for the working of the 40 miles.

LIGHTING AND GENERAL.

Brighton.—The electric light is to be installed in the clock tower at North-street Quadrant, Brighton.

Bradford.—The Town Council have decided to borrow a further sum of £140,000 for electric lighting purposes.

Paignton.—The District Council propose shortly to apply for a provisional order for lighting their district by electricity.

Kidderminster.—On Wednesday last the Town Council decided to obtain tenders for lighting the town hall and corn exchange by electricity.

Basingstoke.—The Mayor announced at the last meeting of the Town Council that their electric lighting provisional order had received the Royal assent.

Hampstead.—The Vestry last week decided to lay extra mains at a cost of £75, and that the engineer should obtain indicators and fuse-boxes at a cost of £86.

Dumbarton.—At the last meeting of the Town Council the question of an electric lighting and traction scheme was referred to the Lamps and Fires Committee.

Aberdeen.—On a question as to the method of charging for electricity, the Town Council have decided to continue to use the maximum-demand system, as hitherto.

Epsom.—In consequence of the increased prices in materials, etc., the Urban District Council have decided to have another scheme for their electric lighting prepared.

United River Plate Telephone Co.—We gather that allotment letters have been posted in respect to the whole issue offered of 23,361 5 per cent. cumulative preference shares.

British Insulated Wire Co.—Dividend warrants for the half-year ending June 30 on the preference shares at the rate of 6 per cent. per annum, less income tax, have been posted.

St. James's and Pall Mall Co.—The directors of this Company have declared a dividend for the half-year ending June 30 at the rate of 10 per cent. per annum on the ordinary shares.

Islington.—At last week's Vestry meeting the Clerk said that the sanction by the London County Council of the Vestry's electric lighting loans of £56,261 and £13,200 was now complete.

Kingstown.—Messrs. Porte, Sykes, and Co. have informed the Urban District Council of their intention to apply to the Board of Trade for an electric lighting provisional order for the township.

Sunbury.—The Twickenham and Teddington Electric Supply Company have given notice to the Urban District Council of their intention of applying for electric lighting powers in the district.

Richmond (Yorks).—The North British Electric Lighting Supply Company have announced to the Town Council their intention to apply for a provisional order to supply electric light in the district.

Digitized by Google

Wolverhampton.—The Town Council have sealed a contract with the St. Helens Cable Company for the supply of electric lighting cables.

Cannock.—The Urban District Council have received notice from the North British Electricity Supply Company of their intention to apply for a provisional order to supply electricity in the Council's area.

Channel Steamers.—We learn that the cross-Channel steamers of the Calais-Dover service are being fitted with electric search-lights, the first vessel on which an installation has been placed being "Le Nord."

Fulham.—The London County Council have approved of the Vestry securing a loan of £50,519 to meet the expenses for the introduction of electric lighting into the parish, and the erection of a dust destructor.

Inverness.—At a meeting of the Town Council last week the scheme for lighting the burgh with electric light, which has occupied the attention of the Council for a considerable time, was formally abandoned.

Carlisle.—The Town Council have resolved to extend the electric lighting cable along Botchergate to London-road at an estimated cost of £575, and along Warwick-road to St. Aidan's Church at an estimated cost of £330.

Leftus.—The Urban District Council have received a notice from the Northern Counties Electric Supply Company of their intention of applying for a provisional order for electric lighting purposes in the district.

Coatbridge.—The Scottish House-to-House Company are extending their high and low tension cables in various streets in the town. The Town Council have decided to light certain streets with arc and incandescent lamps.

Melton Mowbray.—The electric lighting company are about to commence laying their mains. The Urban District Council have decided to repair the roads afterwards, and charge the company with the cost of so doing.

City of London Co.—The transfer books of the preference shares of the City of London Electric Lighting Company will be closed until Aug. 2, inclusive, for the purpose of preparing the interim dividend warrants.

Dover.—The Rural District Council have received notice from Messrs. Simmons and Simmons, on behalf of Mr. E. H. Shaw, that he proposed to apply next November for powers to supply St. Margaret's with electricity.

British Electric Works Co.—This Company have, we learn, appointed Messrs. Gent and Co., Faraday Works, to be their agents in Newcastle and district, and have also appointed Mr. S. Haynes as agent at Nottingham.

Incandescent Electric Lamp Co., Limited.—The employés of the "Robertson" Lamp Works held their annual excursion on Saturday last, when a party of over 200, accompanied by the staff, had a most enjoyable day at Hastings.

Anglo-American Telegraph Co.—The directors of the Anglo-American Telegraph Company, Limited, announce an interim dividend of 15s. per cent. on the ordinary stock for the quarter ended 30th ult., carrying forward £8,700.

Gravesend.—With respect to a notice received from the United Electric Light and Traction Company of their intention to apply for a provisional order to light the town by electricity, the Town Council have decided to oppose the application.

Grimsby.—The Public Works Committee of the Town Council have accepted tenders for electricity meters and arc light standards. The committee have also accepted plans for lighting the electric light station, the cost being about £250.

Change of Address.—Messrs. Welch, Fry, and Skelton, electrical and hot-water engineers, have removed from 90, London-wall, to Salisbury House, in the same thoroughfare. The firm report an unprecedented increase in their business.

Wimborne.—The North British Electricity Supply Company and the Bournemouth and Poole Electricity Supply Company have informed the Urban District Council that they intend to apply for provisional orders authorising them to supply electrical energy in the Swanage district.

Morecambe.—The Urban District Council have received the sanction of the Local Government Board for the borrowing of a further sum of £20,000 for electric lighting purposes. The Council, however, have decided to only borrow £13,000 at present, leaving over the remaining £7,000.

Esher.—Notice having been given by the Twickenham and Teddington Electric Supply Company, Limited, and the United Electric Light and Traction Company, Limited, of their intention to apply for electric lighting provisional orders for the district, the Council have decided to refuse their consent.

Tettenhall.—With respect to a communication from the Midland Electric Corporation for Power Distribution, Limited, to the Urban District Council applying for leave to instal a system of electric lighting at Tettenhall, a committee has been formed to undertake the preliminary steps for obtaining their own provisional order.

Alnwick.—The Urban District Council have decided to discuss with representatives of two electricity supply companies on Tyneside as to supplying the district with electric power, these companies having informed the Council that they intend to apply to the Board of Trade for power to introduce electrical power into the town.

Wolverhampton.—The Corporation have given notice that from July 1 the price for electrical energy for lighting purposes has been fixed at 6d. per unit on a maximum demand for an average of 1½ hours per day during the winter months, and one hour per day during the summer months, and 3d. per unit for all energy consumed in excess thereof.

London County Council.—At the meeting of the London County Council on Tuesday, it was agreed to lend the Whitechapel District Board £30,500 for electric lighting purposes. It was also recommended by the Asylums Committee that a central station for the supply of electricity and water should be provided at Horton Manor Asylum, Epsom, at a cost of £39,000.

City of London Electric Lighting Co.—The directors of this Company have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ended 30th ult., payable 3rd prox. Royal assent has been given to the Bill of the City of London Electric Lighting Company. Under the measure the Company is relieved of the obligation to place substantial sums year by year to the various reserve funds.

Gainsborough.—At the meeting of the Urban District Council last Monday communications were read from the North British Electricity Supply Company and the United Electric Lighting and Traction Company, Limited, stating intention to apply for a provisional order for the supply of electric energy in the Gainsborough district. The matter was referred to the Gas Committee to take preliminary steps to promote an Act for lighting their own district.

Huddersfield.—The recommendations of the Electricity Committee of the Corporation that application should be made to the Postmaster-General for a 25 years' license to work municipal telephones dating from the present month, and also that the Council should be recommended to establish a municipal telephone exchange within the Huddersfield area, has been adopted by the Town Council. The proposed scheme is estimated to cost £30,000.

Dunstable.—The Town Council have received communications from the North British Electric Supply Company and from Messrs. F. T. A. Garrett and Co., giving notice that they intended to apply in the next session of Parliament under the Electric Lighting Act for a provisional order to introduce electric lighting into Dunstable. The Council have decided to appoint a committee in order to consider the question of obtaining a provisional order of their own.

New Company.—The Typewriting Telegraph Corporation, Limited, has been registered with a capital of £100,000 in £1 shares. The objects of the company are to adopt an agreement made between the Recording Telegraphs, Limited, and this company for the acquisition of certain patents, patent rights, and inventions, and to develop and turn to account the same, and generally to carry on in all or any of their respective branches the businesses of manufacturers of and dealers in lamps, wires, lines, and the general business of an electric light and power company.

Appointments Vacant.—The Huddersfield Town Council require an electrician-in-charge of the electric supply station.—The Hoylake and West Kirby Urban District Council require a competent electrical engineer to act as clerk of works, under the direction of their consulting electrical engineer, in carrying out the necessary works in connection with their electricity supply undertaking.—The Manchester Corporation require the services of a traffic superintendent.—The Bradford Corporation require a meter reader accustomed to direct-current meters. Full particulars of these vacancies appear in our advertisement columns.

Stock Exchange.—The Stock Exchange Committee have ordered to be quoted in the official list the Bournemouth and Poole Electricity Supply Company's £70,000 4½ per cent. debenture stock, and Robey and Co.'s 20,464 ordinary shares of £10 each, fully paid, Nos. 1 to 20,163, 20,174 to 20,198, 20,229 to 20,258, 20,269 to 20,402, 20,453 to 20,492, 20,503 to 20,527, 21,744 to 21,766, 21,781 to 21,802, and 21,816 to 21,817; 7,146 preference shares of £10 each, fully paid, Nos. 1 to 7,146; and £127,000 4½ per cent. first mortgage debentures of £100 each, Nos. 1 to 2,250; and have appointed July 26 as a special settling day for the first-named company's £70,000 4½ per cent. debenture stock. Application has been made to the committee to appoint a special settling day in and to grant a quotation to Callender's Cable and Construction Company's further issue of 20,000 5 per cent. cumulative preference shares of £5 each, fully paid.

Parliament.—Private Bills: In the House of Lords on Thursday week, the Plymouth, Stonehouse, and Devonport Tramways Bill, the Croydon Tramways and Improvements Bill and the London County Tramways (No. 1) Bill were read a second time, and the Wellingborough and District Tramroads Bill was read a third time. In the House of Commons the Rhymney Railway Bill was read a third time. In the House of Lords on Friday, the Bray and Inneskerry Railway and Newcastle-on-Tyne Electric Supply Bills were read a second time, and the South-Eastern Metropolitan Tramways Bill was read a third time. In the House of Commons the following Bills were read a third time: Donegal Railway, Great Southern and Western Railway, and South Staffordshire Tramways. In the House of Lords on Monday the Jarrow and Hebburn Electricity Supply, Hastings Tramways, and Belfast and County Down Railway Bills were read a third time and passed. In the House of Commons the following Bills were read a third time: Westgate and Birchington Water, County of Durham Electric Power, Lancashire Electric Power, and South Wales Electric Power; and the Caledonian Railway Bill and the South-Eastern and London, Chatham, and Dover Railways Bill were read a second time. In the House of Commons on Tuesday the South Metropolitan Electric Supply Bill was read a third time. In the House of Commons on Wednesday the Buenos Ayres and Rosario Railway Bill and the Costa Rica Railway Company, Limited, Bill were read a second time.

Digitized by Google

Worksop.—On Tuesday last Colonel Langton Coke, A.M.I.C.E., one of the Local Government Board's inspectors, held an enquiry at the Town Hall, Worksop, respecting the application of the Urban District Council for permission to raise a loan of £15,579 for the purposes of electric lighting.

Shilden.—At a meeting of the Urban District Council on Tuesday last the recommendation of the Highways Committee that application be made to the Board of Trade for a provisional order for electric lighting purposes in the Council's district was referred to the Lighting Committee.

Swindon.—Colonel J. T. Marsh, R.E., one of the Local Government Board's inspectors, recently held an enquiry into an application made by the New Swindon Urban District Council for power to borrow the sum of £7,866 for public and private street improvements, and £3,100 for electric light works.

Bishop's Stortford.—The Urban District Council have received notice of the intention of the North British Electricity Supply Company to make application to the Board of Trade for a provisional order to authorise the company to supply electrical energy for public or private purposes at Bishop's Stortford.

Bo'ness.—The North British Electricity Supply Company, South Shields, have informed the Police Commissioners that they intend to make application to the Board of Trade for a provisional order to authorise them to supply electrical energy for public or private purposes within the area of Bo'ness local authority.

Cork.—The electric lighting company having asked the Corporation to be allowed to run their lighting wires overhead to the suburban districts, the Public Works Committee last week considered the matter. Before replying definitely, they decided to ask the company where they intended to put the wires.

Cheshunt.—At the last meeting of the Urban District Council a formal letter was read from the Middlesex and Hertford Electric Lighting and Power Company, Limited, to the effect that application is to be made for powers to supply electricity for public and private purposes within the area of the District Council.

East Barnet.—The Middlesex and Hertfordshire Electrical Lighting and Power Company, Limited, have intimated to the East Barnet Valley Urban District Council, and also to the Barnet Urban District Council, that they intend to apply to the Board of Trade for a provisional order for supplying these districts.

Burton.—At the monthly meeting of the Town Council last week the Gas and Electric Light Committee reported that the manager's return showed that during the past month the quantity of electric light sold in Board of Trade units was 6,607, showing an increase of 3,181 on the corresponding month of last year.

Maidstone.—On the question of a combined electric lighting and refuse destructor scheme coming up before the Town Council last week, it was decided that the two schemes should be separate, and that application for a loan for electric lighting only should be made. The question of a refuse destructor being erected elsewhere is also being considered.

Holborn —At the last fortnightly meeting of the Guardians of Holborn Union, Mr. Putterill again raised the question of lighting the City-road Workhouse by electricity, his notice of motion being that the supply should be obtained from Shoreditch or the Brush Provincial Company, instead of generating on the premises. The proposition is to be discussed at the next meeting.

Ashton.—Messrs. Browett and Lindley, the makers of the engines, etc., complaining of the way in which the plant is being run and handled at the lighting station, Mr. Holmes, electric lighting engineer to the city of Liverpool, is to be called in to inspect the whole of the existing station plant, and report on the same to the Electricity Committee of the Town Council.

Finchley.—Notices have been received by the Urban District Council of intention to apply for provisional orders from the Middlesex and Hertford Electric Lighting and Power Company, Limited, and from the North Metropolitan Electrical Power Distribution Company, Limited. The Urban District Council have decided that the use of wireless telegraphy in connection with the fire brigade would be impracticable.

Warwick.—At a meeting of the Town Council last week, the General Purposes Committee stated that a communication had been considered by them from the British Electric Traction Company giving notice of their intention to apply for a provisional order to supply electric power for lighting and other purposes. It had been resolved to hold a special meeting to consider the question, and to invite the manager to attend and explain the views of the company.

Kilmarnock.—At a meeting of the Town Council last week it was intimated that the Secretary for Scotland had decided to hold a local enquiry with regard to the application by the Corporation for a provisional order for borrowing powers to the extent of £50,000, of which it was proposed to spend £30,000 on electric lighting and £20,000 on the extension of the gasworks. The Council resolved to withdrawn the present application for a provisional order, and to apply for a new provisional order in the autumn.

Horsham.—The Urban District Council have received a letter from the Local Government Board as to the application of the Council for sanction to borrow £15,000 for purposes of electric lighting, asking for plans and further particulars of the scheme. A letter was also received from Mr. Hawtayne, the consulting engineer, on the matter, and another communication from Mr. Hurst as to the terms and conditions for the sale of the land referred to was referred to the Electric Lighting Committee.

Burglary.—We regret to notice that on the 14th inst. the works of Mr. A. P. Lundberg, at 477, Liverpool-road, were broken into, this being the third time during the past six months. This time, however, more damage resulted than on previous occasions, as some valuable tools, etc., were taken. Mr. Lundberg has asked us to mention the matter in case clients should find their letters, remittances, or orders not receiving proper attention, and to enable them to give him particulars and avoid unnecessary delay.

Teddington.—At a meeting of the Urban District Council last week the clerk reported the receipt of notices of intention to apply for provisional orders for electric lighting in the district from the Richmond (Surrey) Electric Light Power Company, Limited, and the Twickenham and Teddington Electric Supply Company, Limited; also a letter from the Twickenham and Teddington Electric Supply Company, Limited, as to the supply of current to that and other districts. The letters were referred to the Electric Lighting Committee.

Yeadon.—At the monthly meeting of the District Council last week, a letter was read from the Board of Trade relative to the Yeadon Electric Lighting Order, 1894, stating that the Board were not aware that the Corporation of Leeds had any power to supply electricity within the Yeadon urban district, and as at present advised, the Board did not think they would be justified in further deferring the revocation of the order beyond the period referred to in their letter of Nov. 3 last (12 months). The consideration of this matter was deferred.

Nuneaton.—At a meeting of the Nuneaton and Chilvers Coton Urban Council last week a letter was read from the Local Government Board with reference to the application of the Council to borrow £16,000 for purposes of electric lighting, including the purchase of the Nuneaton Electric Company. The Board complied with the application to borrow £8,000 for the purchase of the undertaking. The Board deferred consideration of the remainder of the application until the Council had obtained the advice of an experienced electrical engineer as to the alteration of the works.

Cardiff.—At a meeting of the Electric Lighting Committee of the Corporation on Tuesday last the electrical engineer again brought forward the recommendations for extending the plant at the electric lighting station. The recommendations were part of the scheme agreed upon 18 months ago, when permission to borrow the money was obtained. The demand had increased to such an extent that by the time the new works could be obtained it would be absolutely necessary. The committee decided that steps should be taken to obtain the new machinery, and also to put in a coal conveyor.

Personal.—We are informed that Mr. W. G. Rhodes, M.Sc., M.I.E.E., has resigned his position as chief lecturer in electrical engineering at the Royal Technical Institute, Salford, in order to join Mr. T. M. Hewitt, formerly manager of Messrs. Mather and Platt, Limited, and now conducting business as consulting mechanical and electrical engineer at Tower-chambers, Brown-street, Manchester. In future this business will be carried on at the same address under the name of Hewitt and Rhodes.—Mr. A. E. Cramb has been appointed assistant electrical engineer to the Hampstead Vestry.

Edison and Swan Co., Limited.—The directors of this Company have determined to recommend the payment of a dividend in respect of the six months ending June 30, 1900, at the rate of 6 per cent. per annum on the A share capital of the Company as now paid up. This distribution, together with the interim dividend at the rate of 6 per cent. per annum, already paid in February in respect of the first half-year, will be equal to a dividend of 6 per cent. for the entire year. The dividend warrants will be posted on July 31, 1900, and the transfer books will be closed until the 31st inst.

Dorking.—A public meeting was held at Dorking last week to give the ratepayers an opportunity of protesting against the gas company in raising the price of gas 6d. per 1,000 cubic feet. This several of them did, and speeches were made in favour of leasing the provisional order granted to the Urban District Council to a company to proceed with the introduction of electric light, giving the local body the option to purchase the undertaking at a given period. The meeting passed a resolution expressing approval of the action of the Urban District Council in the proposal to make use of their provisional order in this way.

Dorchester.—In view of the fact that the North British Electricity Supply Company, the Urban Electricity Supply Company, Edmundson's Electricity Supply Corporation, and the Bournemouth and Poole Electricity Supply Company, have given notice of their intention to apply to the Board of Trade for provisional orders for supplying electrical energy within the borough, it was resolved to inform the companies that the Town Council reaffirmed their resolution of September last to apply for a provisional order themselves. Notice was given that at the next meeting a resolution would be moved that the Council take the necessary steps to obtain the provisional order.

Lichfield.—The City Council have received notices from the United Electric Light and Traction Company, Limited, and the North British Electricity Supply Company of their intention to apply under the provisions of the Electric Lighting Acts, 1882 to 1888, to the Board of Trade on or before Dec. 21 for a provisional order authorising the supply of electricity for public and private purposes within the area of the jurisdiction of the Council, and have decided that the Streets and Highways Committee shall report further on the subject of obtaining a provisional order on the part of the City Council, and of resisting the entry of these private companies to the district.

Oban.—The Town Council have decided to hold a special meeting on Aug. 14 to consider the question of introducing electric lighting

Digitized by Google

within the burgh, and if so agreed to resolve to apply to the Board of Trade for a provisional order in the ensuing session for the above purpose. A letter has been received by the Town Council from the North British Electricity Supply Company, South Shields, stating that application is intended to be made by them to the Board of Trade for a provisional order to authorise the company to supply electrical energy for public and private purposes in Oban. The Council, however, resolved that the company should be informed that the Council were proceeding with a scheme of their own.

National Telephone Co.—Replying to Mr. Henniker-Heaton in the House of Commons the other day, Mr. Hanbury stated that the amount paid by the National Telephone Company as royalty for the year ended March 31, 1900, was £134,115. The directors have recommended the following dividends for the half-year ending June 30 last, after charging £25,013 to revenue, being the special expenditure incurred in repairing damage caused by the snowstorm in February last: at the rate of 6 per cent. per annum on the first and second preference shares, at the rate of 5 per cent. per annum on the third preference shares, at the rate of 6 per cent. per annum on the ordinary shares, carrying £55,000 to reserve, and about £4,000 forward.

British Electric Traction Co.—We are informed that Mr. James Devonshire, having been appointed a member of the Committee for Associated Undertakings, has vacated the position of district superintendent for London and South Eastern district of this Company, and also that Mr. Daniel F. Sugrue has vacated the position of district superintendent for the Eastern Counties district, and will undertake certain supervisory duties for the management; that Mr. George Stevens has resigned the position of secretary, and has been appointed chief district superintendent with charge of the London and South-Eastern and Eastern Counties districts; that Mr. Charles H. Dade has been appointed secretary of the Company; and that Mr. Ernest Hopwood has been appointed districts secretary.

London Gazette.—A receiving order has been made out *re* L. Francis, 13, Corporation-street, Southwold, Suffolk, on creditors' petition. The first meeting in the estate of the above will be held on July 21 at 12.30, at official receiver's office, 8, King-street, Norwich, and the public examination on July 24 at 11 a.m., at town hall, Great Yarmouth.—Mr. L. J. Sharp, 174, Corporation-street, Birmingham, has been released from the trusteeship of T. Ford (trading as T. Ford and Co.), The Retreat, Selly Park, Worcestershire.—Mr. E. T. Pierson, 17, Hertford-street, Coventry, has been released from the trusteeship of H. J. Wimshurst, 4, Foleshill-terrace, Foleshill-road, Warwick.—An adjudication order has been made out *re* L. Francis, 13, Corporation-street, Southwold, Suffolk.

Manchester.—On Thursday week Mr. H. H. Law, Local Government Board inspector, held an enquiry relative to an application by the Corporation for sanction to borrow £189,890 for purposes of electric lighting, and £3,520 for the purchase of land for public walks and pleasure grounds. Mr. Hudson, deputy town clerk, explained that the sum which it was sought to borrow for electric lighting purposes formed part of an amount of £500,000 which it was decided by the City Council in March, 1899, to apply for. Mr. C. H. Wordingham, electrical engineer to the Corporation, gave evidence, and stated that there had been a great increase in the demand for the electric current. While the increased output in 1896 was at the rate of 31 per cent., in 1899 it was at the rate of 43 per cent. In the present year the percentage of increase was 24. With regard to the supply of electricity which would be needed for the purposes of the tramways, he mentioned that it was expected to have three sections of the tramways in operation towards the end of the present year.

Portsmouth.—The annual report of the electric light works, presented to the Town Council last week, showed that the year ending March 31 had not been so profitable as the previous one, owing to the increased expenditure for coal. During the year the committee had spent £5,616 for coal and sold 1,393,091 units of electricity, as against £3,798 spent for coal in the year before and 1,224 949 units sold. Another cause of the falling off in the net profit was that for some reason the current sold per lamp connected had decreased. This decrease of income, added to the increase in the price of coal, accounted for over £1,900. During the year they connected 7,090 lamps of 16 c.p., and although this was 192 less than the number connected during the previous year, more consumers had been connected, the figures being: 1898 9, 7,282 16 c.p. lamps connected and 413 consumers; 1899 1900, 7,090 lamps and 426 consumers. This was due to a greater proportion of domestic lighting having been reached. During the year the capital outlay had been increased by £20,277, which meant an increased contribution of £1,719 from the revenue for interest and sinking fund.

Walsall.—At the monthly meeting of the Town Council last week the Electric Lighting Committee reported that Messrs. John Russell and Co. had applied for the electric light to be extended to their works, and that the total cost would be £5,178. The committee had offered to comply with the request on a guarantee to take current to the amount of £300 a year, such guarantee being reduced annually by the amounts received from other consumers from the same main. The committee had received a communication from the Local Government Board that they would defer sanctioning the loan of £15,000 for the new transformer stations until the sites were actually decided upon, but they had pointed out to the Local Government Board that the sites could not be fixed until the points of demand were settled by the consumers, and that the work would be seriously interfered with if there were delay in carrying out the works. The report was adopted, and its recommendations were agreed to, the committee being empowered to carry out the extension work if their proposal were accepted. The Rural District Council have received a communication from the Midland Corporation for Power Distribution, Limited, announcing their intention to apply for a provisional order authorising them to supply electric power in the parish of Great Barr.

New Bromwich.—On Monday the foundation stone of some new and extensive electricity works at Black Lake, West Bromwich, was laid by the Mayor, Alderman S. Pitt, in the presence of a large company. The works are being built on the most modern principles, at an estimated cost of £30,000, and provision is being made for future extensions. This work is in the hands of Mr. R. C. Quin (electrical engineer), Mr. J. Mallin having charge of the building operations. The Mayor, in a speech at the luncheon, said they did not hold out any large promises to the ratepayers, and they must expect little or no profit from the undertaking for the first year or two, but he believed they would make a profit afterwards. In the negotiations between themselves and the tramway company they had detected a most remarkable opening for the supply of electricity, as no less than 300,000 units would be annually required to drive the trams in the borough. As their business increased they could extend the works without serious outlay. They intended not only to encourage small consumers, but to help the industries of the town. They had also obtained power to make regulations with regard to the wiring and fitting up of houses with electricity, and were determined to do all they could to protect the inhabitants from the serious dangers of bad workmanship.

Bath.—At a meeting of the Electric Lighting Committee, Mr. Metzger presented his report as to the best means of obtaining additional private consumers. His report read as follows: "The local authority to start a free wiring syndicate, consisting of local wiring contractors. The Electric Lighting Committee to employ a canvasser to get work and quote prices for wiring to consumers. The work to be sublet to local wiring contractors at a price which will pay for the canvasser's wages and expenses and still leave a fair margin of profit for the contractor. The Electric Lighting Committee to undertake canvassing and wiring, the prices for the work to leave only sufficient profit to pay for the canvasser's wages and expenses. The canvasser must be a combined wireman and business man. Local wiring contractors to have their business premises or private houses wired, and the contractor to have an amount deducted from his quarterly account equal to 1s for every 16-c.p. lamp which he has wired in private houses and connected to our mains during such quarter. Any balance in his favour to be carried forward and settled up annually; as an alternative the contractors to receive from us the same number of incandescent lamps as they have wired during the quarter returned to them for their own selling purposes. Any wiring contractor to engage a canvasser to be engaged in canvassing for electric lighting only, and we pay as a commission the sum of 1s. for every 16-c.p. lamp wired by such contractor and connected up by us in private houses during each quarter." Mr. Metzger said the idea of the first suggestion was that they should get the local wiring contractors to put their heads together and start a syndicate, as elsewhere, to wire houses free of charge, the consumer to pay back the cost either on a three years' basis or at the rate of an extra 1d. per unit. To carry out the third they would have to get powers for wiring, as they were not included in the order. Kingston-on-Thames had recently done so.

Southport.—At the monthly meeting of the Town Council the annual report of the electric lighting works was presented. This stated that Southport this year only occupied the eleventh position amongst the electricity works of the world, as against the third position last year; but it would be observed that the returns of the other towns were for last year, and when the returns for this year were made public Southport's position would be greatly improved, and would probably be the same as last year. Referring to the borrowing powers, the total amount sanctioned by the Council, including the £9,100 applied for the previous week, for feeders for the tramways, was £147,600. Of this amount, up to the end of the financial year, £100,136 had been spent; and about £20,000 would cover the expenditure up to the end of the next financial year. The estimated profit at the commencement of the year was £2,000, but the actual profit had only been £1,779. There were two or three primary causes for that reduction in the profit, the first being the great advance in the price of steam coal. The difference between the price in the estimates and what had had to be paid more than made up the difference between the estimated and the actual profits. In addition to that, a good deal of money had to be expended in making arrangements for the protection of the plant that was already running. At the commencement of the year the committee estimated that there would be an addition of about 200 consumers. The actual addition was 202. The estimated number of lamps to be connected during the year was 10,000; the actual number connected was 9,580. They also estimated an increased consumption of about 200,000 units, but the actual increase was only 106 000 units, the reason for which was that the connections which had been made were mostly in residential houses, whereas their estimates were based on the experience of the previous year, which was that the maximum required at residential houses was only about one quarter of the lamps installed. Before that the committee had always considered about one-half the lamps installed would be the maximum demand of the consumer. The Town Council have decided by 19 votes to 8 to introduce electric arc lamps into the main business streets of the town, instead of incandescent gas-burners, as at first proposed.

Digitized by Google

NOTTINGHAM ELECTRICITY ACCOUNTS.

From the accounts of the Nottingham Corporation electricity works for the year ended March 31, 1900, it appears that the total expenditure on capital account to date amounts to £166,097. 15s. 2d. Abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are appended:

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal	3,643	0	1
Oil, waste, and water	748	7	6
Wages at generating station	1,368	7	7
Repairs and maintenance—buildings, £8. 16s. 6d.; engines and boilers, £377. 16s.; dynamos, etc., £5. 1s. 4d.; other machinery, tools, etc., £71. 8s. 11d.; accumulators, etc., £158. 2s.	621	4	9
Distribution of Electricity.			
Wages	37	15	8
Repairs, maintenance, and renewal of mains	5	11	7
Repairs of meters and apparatus on consumers' premises	57	0	3
Public lamps—attending and repairs	74	5	5
Rents	50	2	6
Rates and taxes	226	17	3
Salaries	1,411	8	1
Stationery and printing	76	19	4
Establishment and other charges	318	7	5
Insurance	56	4	6
Consolidated stock, management charges, etc.	44	4	4
	8,739	16	3
Bad debts	6	9	0
	8,746	5	3
Balance carried to net revenue account	9,673	12	2
	£18,419	17	5

Cr.	£	s.	d.
Sale of current per meter	17,610	8	3
Public lighting	229	10	8
Rental of meters	382	11	6
Public lamps—attending and repairs	81	14	0
Connections to consumers' premises (net)	84	10	6
Stores	0	13	7
Discounts	30	8	11
	£18,419	17	5

BALANCE SHEET.

Liabilities.	£	s.	d.
Capital account: consolidated stock, £46,830. 2s. 10d.; less stock purchased and cancelled, £763. 18s. 9d.	46 066	4	1
Loans, £76,880; less loans repaid, £5,050	71,830	0	0
Cash due to bankers, £37,460. 3s. 8d.; less cash in hand, £3	37,457	3	8
Sundry creditors	3,879	1	7
General district rate account	2,000	0	0
Net revenue account—balance at credit thereof	151	15	0
Sinking fund account: amount set aside, £3 325; stock purchased and cancelled, £763. 18s. 9d.	4,088	18	9
Repayment of loans account: amount set aside, £4. 12s.; loans repaid, £5,050	5,054	12	0
Reserve fund account	7,531	18	6
	£178,059	13	7

Assets.	£	s.	d.
Discount on issue of consolidated stock, capitalised	1,614	9	6
Expenses of issue of consolidated stock, capitalised	215	13	4
Preliminary expenses	331	6	0
Lands	24,543	19	7
Buildings	39,721	16	4
Machinery	42,528	4	0
Accumulators	1,421	18	11
Mains and services	46,519	8	9
Meters	8,892	13	8
Electrical instruments	308	5	1
	166,097	15	2
Stores on hand: coal, £32. 15s. 5d.; oil, waste, etc., £40. 19s. 7d.; general, £701. 5s. 7d.	775	0	7
Sundry debtors for current supplied	7,861	17	10
Nottingham Corporation loans fund—proportion of sinking fund investments	3,325	0	0
	£178,059	13	7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units (estimated)		1,603,579
Quantity sold { Public lamps 20,904; Private consumers 1,470,280 }		1,491,184
Quantity used on works		16,180
Total quantity accounted for		1,507,364
Quantity not accounted for (estimated)		96,215
Number of public lamps		15
Total maximum supply demanded (kilowatts)		1,578

PROVISIONAL PATENTS, 1900.

JULY 9.

12388. Improvement in or relating to mechanical motive devices for the controlling drums or switches of electrically-propelled vehicles. Alfred Julius Boult, 111, Hatton-garden, London. (Edwin R. Gill, United States.)

12391. Improvements in electric traction. Gustavus Palmer Harding, 24, Southampton-buildings, Chancery-lane, London.

12392. Improvements in clamps for holding the ends of electrical fuses or links acting as electrical conductors. Callender's Cable and Construction Company, Limited, and John Charles Augustus Ward, 24, Southampton-buildings, Chancery-lane, London.

12393. An improved case or cover for electric switches, electric bell-pushes, and the like. Albert Groves, 2, Netley street, Hampstead-road, London.

JULY 10.

12404. Safety fender or lifeguard to attach to electric cars or other mechanically-propelled vehicles. Norman Edward Godson Little, 19, Bromwich-street, Bolton, Lancs.

12434. Improvements relating to the manufacture of conducting material for electrical and other purposes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Joseph Burke, Henry Andrew Kaufhold, and Thomas Russell, United States.) (Complete specification.)

12466. Improvements in the construction of rail-bonds for electric railways and in the mode of applying the same. George Gatton Melhuish Hardingham, Clun House, Surrey-street, Strand, London. (Felten und Guilleaume, Carlswerk, Actien-Gesellschaft, Germany.)

JULY 11.

12469. Improvements in vessels for containing fused salts during electrolysis. Sherard Cowper-Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

12531. Positive electrode for accumulators. Constantin von Sedneff 18, Buckingham-street, Strand, London.

12532. Improvements in switches for accumulator electrodes. Contantin von Sedneff, 18, Buckingham-street, Strand London.

12537. Improvements in and relating to accumulator plates. Paul Ferdinand Ribbe, 322, High Holborn, London. (Complete specification.)

JULY 12.

12554. Appliance for generating electricity to be utilised for propelling machinery and for other useful purposes. William Sunter, 8, Calton-hill, Edinburgh.

12591. Improved device for setting fuses or cut-outs in electric circuits. Carl Christian Theodor Sohrmann and Carl Moritz Oscar Feist, 111, Hatton-garden, London.

12598. Improvements relating to driving axles for electric and other vehicles. Camille Contal, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 6, 1900 being date of application in France.)

12603. Improvements in or relating to shades for incandescent electric lamps. Entwistle and Stephens, Limited, and Henry Joseph Stephens, 8, Quality-court, Chancery-lane, London.

12609. Improvements in testing sets for measuring insulation resistances. William Beckit Burnie, 24, Southampton-buildings, Chancery-lane, London.

JULY 13.

12624. The Parsons automatic storage battery switch. Ernest Medcalf Parsons, 10, Paragon-street, Hull.

12672. Improved manufacture of glass by electrical heating and apparatus therefor. August Voelker, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12673. An improvement in the manufacture of glass by electrical heating. August Voelker, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London (Complete specification.)

12702. Improvements in accumulators. Alexandre Antoine Riasse and Jean Joseph André Seugeisen, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12709. Improvements in electric arc lamps. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

JULY 14.

12716. Improvements in electric switches. William Bourne Dale, 17, Hanover-street, Keighley.

12733. Art of reducing attenuation of electrical waves, and apparatus therefor. Michael Idvorsky Pupin, 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883 Sec. 103, Dec. 14, 1899, being date of application in United States.) (Complete specification.

Digitized by Google

12735. Improved electrical railway fog and danger signal apparatus. Harry James Everatt, 142, Minet-avenue, Harlesden, London.

12739. An improved dynamo brush. Johannes Friedrich Peter Ringsdorff, 37, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on August 4.

1899.

12249. Telephone systems and apparatus therefor. Thomson and Warnford-Davis.

14250. Casings for electric light and similar cables. Arthur Hudson and Charles John Wightman.

14265. Automatic signalling apparatus for electric tramways. Wehner and Laube.

14489. Coin-controlled call-recording device for telephone systems. Gill.

14501. Electrical accumulator. Hills and Matthews.

14736. Winding for dynamos. Hurrell.

15166. Form of electrically-actuated railway signal. Langdon.

15551. Means for supporting electric incandescent lamps. Davidson.

16200. Holders for electric incandescent lamps. Oppenheimer. (Actiengesellschaft Mix und Genest.)

16600. Manufacture of earthenware troughs for carrying electric cables and analogous purposes. Nisbett.

17719. Variable-rate electric meters. Lorrain. (Macdonald.)

18335. Electrodes for arc lamps. Bremer.

18457. Guards for electric tramcars and other tramway vehicles. Tidswell.

18555. Splicing cars and terminals for overhead electric trolley wires employed on electric tramways. Slack.

18392. Electrical damping apparatus. Johnson. (Hartmann and Braun.)

20587. Electric railway conduit systems. Maxim.

1900.

559. Transformers. Wise. (Aktiengesellschaft Elektricitäts-werke, vorm. O. L. Kummer und Co.)

956. Telephone apparatus and induction coils for use therewith. Wilson.

2703. Process and apparatus for electrolytically treating ropes, hose, cork, asbestos, and textile fabrics of all kinds. Schlomann and de Castro.

3174. Long-distance telephony. Mengls.

8465. Electric motors. Boult. (Collins.)

9458. Space telegraphy. Eglin.

9730. Electric switches. Worsley and Green.

10137. Electric lamps. Krayn.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	July 14	753	686	+ 67	4,313	3,842
Birmingham Tramways Co.	,, 14	4,675	4,556	+ 119	119,517	112,612
Blackburn Corp'rat'n	,, 7	486	427	+ 59	10,063	11 535
Blackpool Corporatn.	,, 12	890	677	+ 213	9,030	7,058
Blackpool-Fleetwood	,, 14	948	913	+ 35	1,750	1,962
Bradford City Trams	,, 15	523	426	+ 97	7,415	5,882
Bristol Tramways Co.	,, 13	3,603	3 579	+ 24	—	—
City & South London	,, 15	1.436	861	+ 575	2,883	1 898
Cork E. T. and L. Co.	,, 12	526	462	+ 64	10 599	9,393
Dover Tramways	,, 14	272	258	+ 14	5,009	4,710
Dublin U.T., elec. cars	,, 13	3 849	1,216	+2,633	—	—
Dublin S.D. Electric	,, 13	1.144	1,022	+ 122	—	—
Halifax Corporation	,, 1	900	670	+ 230	9.615	6,786
Hull Corporat'n E.S.	,, 14	1,357	—	—	18.016a	—
Liverpool Corporat'n	,, 7b	8,439	7,235	+1,204	197,180	173,097
Liverpool Overhead	,, 15	1.755	1,593	+ 162	—	—
Sheffield Corporation	,, 15	2,534	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. b Partly electrical.

Summer Tours.—We have received a copy of the Great Eastern Railway Company's booklet, which gives particulars of new Continental tours, going by way of the Royal Mail, Harwich, and Hook of Holland route. The booklet is very nicely got up, the illustrations being printed in colours. The reading matter describes the various ways in which passengers can reach any particular point in Holland, and also deals with a portion of Germany. The booklet is well worth procuring by those intending to take a trip to the Continent this summer.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	⅛-¼
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	5½ 6¼ xd
—— 5 per cent. Mortgage Debentures	100	—	95½-100½
British Electric Works, Ordinary, 50,001-95,000	1	—	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	..	101-103
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	13-14
—— 5 per cent. Pref.	5	—	5¼-5¾
Crompton and Co.	3	—	3¾ 4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	2	—	2-2¼
—— 5 per cent. Debentures	5	—	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	91-93
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	..	3-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105 xd
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5¼-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-23
—— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	12	—	35-39
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	..	5¾-6
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	..	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅛ ¼
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6½-6¾
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5¾-6
Chelsea Electricity Supply	5	—	6½-7½
—— 4½ per cent. Debentures	100	—	107-110
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	100	—	122-127
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¾-5 xd
—— 4½ per cent. First Mort. Deb.	100	—	99-102 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	10-10½
London Electric, Ordinary	3	..	1-1½
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-100
Metropolitan, Ordinary	10	..	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1½-1¾
—— £5 Shares	5	..	7¼-7¾
—— £4½ Shares, New	4½	..	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	..	6-6½
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	—	85-95
South London, Ordinary	3	..	3¾-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	13¾-14½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	—	12 13
Electric Railways.—			
Central London, Ordinary	10	..	9¼ 9¾
—— Pref. Half-Shares	5	..	4¼ 4¾
—— ,, ,, deferred	5	..	4¼ 4¾
City and South London, Consolidated Ordinary	100	..	60-64
—— Ordinary	10	..	6-7
—— 4 per cent. Debenture Stock	100	—	123-128
—— 5 per cent. Pref. Stock '91	100	..	140 145
—— ,, ,, ,, '96	100	—	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	13¾-13¾
Waterloo and City, Ordinary	100	..	98 99
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17½-18½
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary, 1-30,000	10	..	14-15
—— 60,001-75,000	10	..	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	12-13
—— 5 per cent. Perpetual Debenture Stock	100	..	123-126
—— ,, ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¼-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	102 105
Isle of Man Electric Power, 1-95,000	1	..	⅛-3/16
—— 6 per cent. Preference, 100,001-170,000	1	..	⅛-3/16
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	—	3¼-3¾
—— 6 per cent. Cum. Pref.	5	..	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-18
—— 5 per cent. Cum. Pref.	10	..	10¾-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
Telephones.—			
National Telephone, Ordinary	5	..	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	..	13-15
—— 6 per cent. Cum. Second Pref.	10	—	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	97-100
Oriental Telephone and Electric Company	1	—	¾-1¼

Digitized by Google

NOTES.

"Album of Electricians."—Our Italian contemporary *Elettricità*, of 11, Via Cusani, Milan, will shortly publish their "Album of Electricians," a quarto volume, in French, containing the portraits of over 200 of the most eminent electricians of the world. The price will be 5fr., or 4s.

Electric Cooking.—We understand that an enterprising builder in New York has recently built a block of flats, in which the only provision he has made for cooking is by electric stoves. A remarkable saving of space is the result, as well as convenience. We are not told whether he has made any special terms with any of the electric lighting companies for the supply of cheap electricity for that purpose.

High-Voltage Railway Working.—The Ganz system for working electric railways by means of multiphase current has been successfully experimented with in Budapest. The system is now to be tried experimentally on the Valtelina stretch of the Italian State Railways. The length of this section of the line is about 65 miles, but we are not sure how much of it is to be equipped for the experiment.

Crystal Palace Engineering School.—We have received an invitation for Aug. 9 to inspect the various departments of the Crystal Palace School of Technical Engineering. On that day the list of certificates awarded by the examiners for the summer term will be ready, and the presentations will be made by Mr. A. T. Walmisley, the chief engineer to the Dover Harbour Board. The chair will be taken by Mr. Walmisley at noon prompt.

Electric Church Bells.—In the parish of Runwell, Essex, an apparatus has been lately erected by the rector for ringing the church bells by electricity. The origin of the invention is rather curious. The rector, finding a difficulty in obtaining bell-ringers, rung the bells for three months himself. In order to save the labour involved in performing this task, he invented the "automatic ringer," and erected the apparatus in the church tower. By connecting the machine with the electric current already in use for lighting the church and rectory, he succeeded in ringing the bells with perfect order and precision. The invention is in all respects an absolute success.

Standard Voltage.—Eight London electric lighting companies have sent a deputation, headed by Lord Suffield, to the Right Hon. C. T. Ritchie who wish to amend the Board of Trade regulation so that they could change from 100 to 200 volts by agreement with the consumer, or otherwise, by arbitration. The regulation at present says that no change shall be made in the pressure of the supply to any premises except with the consent of the consumer. The deputation consisted of the representatives of the following electric companies: the Westminster, the Metropolitan, the Chelsea, the City of London, the County of London and Brush Provincial, the Notting Hill, the Brompton and Kensington, and Kensington and Knightsbridge. The President of the Board of Trade admitted that it was a strong order for a few consumers to stand in the way of the application of the new system, but these people were within their rights, and if the Board assented to what the companies asked they would be over-riding the position which the former possessed. He would take the matter into consideration, but he urged the companies to use more conciliatory methods with their customers.

Electrical Laboratory Work.—In a paper read before the recent meeting of the Society for the Promotion of Electrical Engineering Education, of U.S.A., Prof. Aldrich maintained that training in handling electrical machinery is quite as essential as training in electrical measurements. If, he said, with all his familiarity with galvanometer work, the young electrical engineer is left to the mercy of the wireman or the operating engineer, his laboratory training has been incomplete. A knowledge of the behaviour of electrical machinery and confidence in handling electrical circuits is becoming more necessary with each widening use of electricity. The utilisation of alternating currents and the operation of alternating-current machinery constitute to-day a most interesting and important field, one with which the electrical student cannot become too familiar. It is the result of experience that students who have been given a course of electrical laboratory training involving study, inspection, illustration, and operation, have a better understanding of testing work than if they had been put at once into the latter without attention to the former. We are indebted to the *Electrical World* for the above abstract of Prof. Aldrich's paper.

The Franklin Institute "Journal."—We have received the July number of the *Journal* of the above institute, which contains an exceptionally large number of papers and reports on electrical subjects. Amongst these is a contribution by Prof. R A. Fessenden on electromagnetic mechanism, with special reference to telegraphic work. Mr. J. F. Stevens also read a paper before the institute recently on electrical measuring instruments, which paper is reproduced in the number of the *Journal* before us. The report of a special committee on an instrument known as the gramaphone grand announces that a certificate of merit of the institute has been awarded to its inventor, Mr. T. H. Macdonald. In this instrument, the chief advance on the ordinary phonograph is in the speed of the recording cylinder. The inventor claims that, by increasing the speed, the recording stylus has to cut much more gradual slopes, and hence is better able to reproduce the vibrations impressed on it. There is also an improvement made in the angle at which this stylus bears against the recording cylinder. This stylus makes an acute angle to the tangent at the point of contact. A further description of the instrument and of sound records generally is given in the *Journal* by Mr. P. Mauro.

New Cable.—The Canadian Government has at last decided to lay a cable from St. John's, Newfoundland, to Belle Isle. The work of establishing the telegraph line and laying the cable is, says the *Financial News*, arranged for at a cost of £14,000, though the Marconi system of wireless telegraphy was advocated. According to official reports the route recommended for the cable is from Pointe-aux-Esquimaux, the proposed terminus of the land line, out of the Strait to Belle Isle. Our contemporary remarks that a cable to Belle Isle is not all that is needed. Parallel lines of telegraphs along the north and south coasts of the Straits are also essential—indeed, on many grounds, are more so than the cable itself—and the Newfoundland Government has intimated its willingness to permit Canadian officials to set up the wires in the Colonial territory. The Colonial telegraphs do not now extend beyond Bonne Bay, which is 140 miles from the Straits. North of Bonne Bay the shore is practically unsettled, and it is only Canadian shipping which passes by or goes on the rocks. To Canada, therefore, the benefit would accrue of such a land line along the coast, which may be an actual fact in the near future. This land line would do quite as much to prevent shipwrecks and fatalities as the cable to Belle Isle.

St. Marylebone Lighting.—As mentioned in a recent issue, the St. Marylebone Vestry has entered into an

Digitized by Google

agreement with the Metropolitan Electric Light Company to buy that portion of the company's undertaking situated in the parish. One of the financial papers compliments the Vestry on the bargain it has made in buying this undertaking for half a million sterling. The transfer is to take place on Oct. 1, 1901, and the half million is to be paid over in 5½ per cent. vestry or borough council bonds. It would seem to us that this is equivalent to paying quite £750,000 for the undertaking. It is said by the Vestry's leaders that the income of the undertaking now shows 7 per cent. on the capital outlay. We do not know what capital outlay is here referred to, but we do know the local authority will have to spend a very large sum on an efficient generating station, and on alteration to mains, when they acquire the St. Marylebone portion of the Metropolitan Company's works. This extra expenditure, together with the purchase price, will make the capital charges heavy, and we are not sure that the district would not have been more cheaply supplied by the proposed Marylebone Lighting Company, whose Bill was recently thrown out. It will be remembered that at the expiration of the provisional order the local authority would have been able to purchase at the then value of the plant and mains only. We do not believe at the present time, if the plant and mains were taken over on these terms, they would fetch even half of the purchase price.

Proposed New Tramways.—The Highways Committee of the London County Council are at present considering what further extensions are desirable in connection with the tramways in the north and south of the Metropolis. They have arrived at a total of 28 lines, a list of which will be found in another column. They have consulted the solicitor, who says that the Council have power to promote such legislation, and have asked the Council to suspend Standing Orders so that their proposals may be considered. The length of these lines is over 28 miles—16 on the north and 12 on the south of the Thames. The estimated cost for the northern lines is about £469,700, in addition to £544,360 for street widening, while for the south it is £374,500, in addition to £449,400 for street widening, making a total of £1,837,960. It is proposed that those new lines connected with the Council's northern tramways (leased until 1910) shall, with the exception of that line in Archway-road, be constructed for horse traction, unless in the meantime effect shall have been given to the provisions in the company's lease relating to the conversion of the system from horse to electrical traction. The estimates provide for rails of sufficient weight to permit of their being used for electrical traction when that system shall have been adopted. The Archway-road line will probably be joined with the light railways which the Middlesex County Council propose to construct from that point to Finchley and beyond. A cartoon plan is in preparation showing the various proposals for the Council's consideration.

Extended Steam Trials.—It is usual nowadays to specify at least a six-hour run at full load on all steam dynamos before they are allowed to leave the manufacturer's works, and certain consulting engineers extend this run to as much as 12 hours. We notice that the consulting engineer to the Fulham Vestry has introduced a new departure in this respect, in that he has insisted on the makers of the exciter engines having one at work for a full fortnight before he would receive it. The trial, however, was not in any way comparable with the usual steam trial, and seems only to be intended to show the general performance of the engine. For instance, it was run at 80lb. steam pressure instead of at 140lb., and hence at only half load. Steam trials were not made, nor were the governors tested in the way specified, as, of course, full load could not be obtained. It seems, therefore, to us that the cost of supervising a fortnight's trial in the maker's works is out of all proportion to the information gained. When it is considered that all engines supplied to electric light stations are run on trial after erection in the central station until they have proved themselves up to specification, our objection to the extended trial in the engineer's works will be obvious. In cases where a new type of engine has to be used which is not known by the consulting engineer, it is always better for this gentleman to inspect an engine which has been doing regular work elsewhere before deciding to place the order. This inspection should give much more information than can be obtained from an expensive and inconclusive test such as referred to above.

Our Fighting Brethren.—We have recently given a few particulars of an engagement in South Africa at which a number of the Electrical Engineer Volunteers were unfortunately captured. This week a letter has arrived in London from Major Crompton which we have been privileged to see. From it a large number of details can be ascertained of the engagement, and of the defence which enabled the rest of the party to keep the Boers at bay until help arrived. The electrical engineers have been put to do ordinary civil engineering work at times when their services as lighting engineers are not required. At Vredefort they were employed on some crib reconstruction work, and it was while on this that an unexpected attack from the Boers took place and a detachment of the Electrical Engineers was captured. We understand that on of their number was sent back to the construction train to demand its immediate surrender. The message he took back from Major Crompton and the engineer in charge of the van invited the Boers to do their worst, with a hint as to their ultimate resting-place. It then became necessary to seize a ridge of rocks which was held by the Boers, and which would afford protection to the English engineers, who found the train quite untenable. The Boers retired before the bayonets could be got to work, but continued to molest the party all day. The temperature, which was several degrees below freezing point, made the situation far from a pleasant one. We are glad to be able to congratulate the parties on holding their own. After the excitement of such work as this, electrical contracting in England will hardly be appreciated by members of our Electrical Engineer Volunteers. We are sure from the tone of Major Crompton's letter that the skirmish up to the ridge and the defence of the same was thoroughly enjoyed by those who took part.

Electrostatic Lines of Force.—Mr. F. J. Rogers describes in the *Physical Review* an electrostatic needle to be used for the exploration of electrostatic lines of force. When teaching students electricity, it is always advisable to show them experiments which give a physical representation of the phenomenon which has to be mastered. For instance, with lines of magnetic force, the students can easily produce for themselves with paraffined paper and iron filings the contour of the lines of force round any system of magnets. In order to do the same thing with electrostatic lines of force, Mr. F. J. Rogers tried to suspend an elongated dielectric by means of a fibre in the field to be studied. He did not find this satisfactory, but prefers an electrostatic needle which consists of an aluminium wire equipped with a gilt pith ball at either end. The needle is mounted on an horizontal axis. By the aid of this needle it is easy to show the following characteristics of electrostatic fields: (1) that lines of force are normal to the surface of a

Digitized by Google

charged conductor (an elongated cylinder, for example); (3) that lines of force are not normal to the surface of a hard rubber rod, one end of which has been charged by friction; (3) that in the case of two oppositely-charged conductors placed near each other the lines of force issue from one conductor, curve over, and end on the other; (4) that in the case of two similarly-charged conductors the lines of force from each leave it normally and pass out into space, none of them passing from one conductor to the other. A much more useful form of electrostatic needle is constructed as follows: In place of the aluminium wire a small rod of hard rubber is used. It is mounted on a shaft and provided with pith balls, as in the first form. The pith balls are oppositely charged by contact with the poles of an electrical machine. While so charged, the electrostatic needle behaves in an electrostatic field just as a magnetic needle does in a magnetic field.

Unexplained Phenomena.—There have been for years certain actions of light on metallic surfaces which have not been explained on theoretical grounds. Amongst these are the actions of light noted by Moser from 60 years ago. We gather from the columns of *Nature* that Major-General J. Waterhouse, I.S.C., has during the last year been investigating the phenomena first recorded by Moser. From these investigations he confirms Moser's results as to the production of a change on the surface of metallic silver by exposure to light that can be demonstrated by the condensation of a vapour such as mercury upon it. But he has gone further, and demonstrated the change by the deposition of silver from solution, after the manner of the development of an exposed wet collodion photographic plate. By some half-hour's exposure in bright sunshine "printed out" images were obtained—that is, images visible without any subsequent application of a developer. General Waterhouse shows that these results are not due to pressure against the mask or stencil-plate used, nor to the emanation of vapours from it, nor to heat. Usually blue light gives a much stronger effect than red, but in one experiment, when the exposure was for three hours to bright sunshine, the effect was reversed, and the patches under red, orange, and yellow glasses were developable, while those under the blue and violet glasses were not. But when the silver plate was heated to redness, quenched in dilute sulphuric acid, washed and dried, and the cut-out design was also warmed before use, the effect produced by light was so small that it seems doubtful whether there was any effect at all. On the other hand, if the silver plate was exposed to the fumes of certain substances, especially nitric acid, it was rendered very much more sensitive. General Waterhouse, in his communication to the Royal Society, states that he hopes to continue the investigation this summer, and invites others to extend the observations that he has described.

Coal-Weighing.—The question of weighing the coal in the central station is of great importance, and can be looked at from two points of view. In the dealings between the central station and the coal merchant a check weighing is required when the coal is delivered, in order that the central-station authorities may get all the coal they pay for. We do not mean by this that contractors would go out of their way to defraud the consumers, as we know that such is not the case as a rule, but there is a distinct inducement for the contractors' servants to supply themselves with coal out of the quantity which should go to large contractors, who are not likely to miss small deficiencies. In order to weigh the coal which is coming into the station, an automatic recording machine can conveniently be used, so that both the weighing and the entering of the coal on the sheet is independent of manual labour or inaccuracies. When the coal has passed through this machine and is delivered, usually by means of a conveyor into the coal bunks, a new need for weighing occurs. It is exceedingly important that the engineer should know not only how much coal is used each week to keep his station running, but also how much coal is used each shift, so that comparisons can be made between the efficiency of the different members of the boiler-room staff and also of the calorific value of the coal. We notice in an agenda of one of the local authorities of London that their engineer proposes to instal only one weighing machine, with the first object mentioned above—*i.e.*, the checking of the coal as it comes into the works. We consider that the checking of the coal on to the boiler-room floor is, if anything, more important, and that an automatic recording weigher or coal measurer should be placed on each shoot from the bunks to the hoppers of the mechanical stokers. The quantity of coal used in the furnaces of any one boiler is then ascertainable, and gives after a year or so's experience a fair indication of the correct period of time at which to clean the same.

An Adjustable Capacity.—It is sometimes convenient, when experimenting on electrical phenomena, to have a condenser the capacity of which can be varied gradually over a wide range. This has usually been done to a limited extent by taking out connections from a number of the tinfoil sheets, and also dividing the condenser up into sections. The variation in this case cannot be made conveniently without interruptions to the experiment, which is sometimes most inconvenient. In the July number of the *Physical Review*, Mr. Lyman J. Briggs describes a new form of condenser which can be adjusted for capacity without the above objection. It consists of a number of sheets of brass which are curved with a radius of from 6in. to 8in.; in fact, the curvature which is always found in thin brass sheet from being rolled up is quite sufficient for the purpose. The insulation used between the sheets is mica. The brass sheets are so placed with the curvature first in one direction and then in another, that the air space between them can be varied very much by the pressure which is applied on the two surfaces of the pile. The brass sheets are held in the correct positions relative to each other by four rods, which pass through holes at the four corners of the condenser. The brass plates make connection with these rods. There are only two holes through each brass plate, which are of such a length that while they thread on to one pair of rods they leave a good clearance between the end of each plate and the other two rods. The range in capacity of these condensers can be gathered from the following figures: A small condenser, consisting of 13 plates on each side, the plates being about 2in. by 3½in., had a capacity in air of 0·055 of a microfarad when compressed, while its capacity was only 0·013 of the microfarad when the screw used to compress the plates was slacked back. This ratio, giving a variation of over 400 per cent., has been exceeded by other types made on the same general lines. The author also gives interesting curves which show the relation between the over-all thickness of the condenser and its capacity. It seems from this that the connection between the two is by no means a straight line, as might be expected.

Employers' Liability.—The *Western Electrician* comments on a curious lawsuit, in the States, in which a man brought action against an electric light company for damages for injury arising from being struck in the eye by a piece of carbon thrown by an employé of the company while the latter was engaged in the performance of his work. The case was recently reviewed by the Supreme Judicial Court of Massachusetts. The Court overruled the exceptions to a judgment for the plaintiff. The jury had been

Digitized by Google

instructed that if the carbon was thrown by the employé for the purpose of carrying out and performing his duty in his employment, the company was liable, and, on the other hand, if the carbon was thrown by the employé to carry out some whim of his own, in accordance with some impulse of his own, and not for the purpose of carrying out or accomplishing the purpose for which he was then and there employed, the company would not be liable. This, it is held by the Court of last resort, correctly stated the law on the subject. That the carbon was thrown by the employé in the performance of the work he was hired to perform there was ample evidence, the Court thinks, in that it was shown that he was hired to remove the remains of the four carbons left in the lamp in question during the preceding night; that he testified that he ordinarily dropped the discarded pieces near the base of the lamp-post, or, if there was any reason why he could not drop them there, tossed them out into the street, intending to be careful not to drop them on a passer-by or to strike any horse in the street; that on this occasion the cart which he used was left standing at the foot of the pole on which he was at work, and that the man was struck as he was driving by, just outside of the cart mentioned. Nor does the Court consider that the situation was changed by the fact that the employé testified that he threw the piece of carbon at the man's team because he wanted to attract his attention, so as to speak to him, and did not throw it for any purpose connected with the business he was engaged in, not for any business of the company. It says that it would be strange if the jury were not at liberty to disbelieve the testimony of one employed by the company as to his mental processes. It also says that it was proper for the jury to take into consideration the fact that not only was the witness at the time of the trial in the employment of the company, but also that he had been taken back into its employment only two weeks before the trial. Besides, it says that the jury may have also believed that, from the terms in which his testimony was couched, it was evident that the witness had a particular knowledge of what the law required to exonerate the company from liability.

Electric Ore Transporters.—The *Electrical World* of New York publishes an interesting article on the application of motors in the Ohio Works of the National Steel Company at Youngstown. Amongst the electrical features of this yard are two enormous travelling bridges, which can be moved alongside of the works over a large space devoted to the storing of ore. On these travelling bridges run transporters, which take the ore from the trains and drop it on to the storage ground. The freezing up of the great lakes in winter renders this storage most necessary, as throughout the winter the works are dependent on the reserve ore accumulated throughout the summer. There are two of these mammoth bridges now in operation, and a third is to be constructed; all to operate over the same yard, which will easily hold 1,500,000 tons of ore. Each ore bridge is operated by two 130-h.p. General Electric motors geared together and to the various friction drives, which throw in or out the drums for moving the bridge cars or for hoisting the scoop bucket, or giving its carriage a cross travel, or the bridge itself a longitudinal travel up or down the stock-yard. These two motors are compound-wound, with but a light shunt coil—*i.e.*, they are practically series motors with comparatively weak shunt coils, the shunt coils having one-half the ampere-turns of the series coils, these shunt coils being intended to prevent the motors from running away when all the clutches are off. Under this condition the motors run up to a speed of 920 revolutions per minute. The motors are controlled by a G. E. L-14 controller, no reversing arrangement being needed, the L-type being used instead of the K-type. With compound-wound motors this short-circuit would pull a heavy current through the series coil to balance the magnetising effect of the shunt coil, retarding the motion of the motors severely on the transposition points, causing sparking, flashing, and other troubles The electrical motors used to drive these bridges and transporters are supplied at 250 volts. The ore comes from the ports on Lake Erie in the usual ore cars; each of these is separately pulled by a dolly car to a dump, in which the body of the car is firmly gripped, and the whole car, trucks and all, is then turned over, delivering its contents into what are termed "bridge" cars, four of which are mounted on a transfer car. These transfer cars, carrying four bridge cars each, are then hauled by a steam locomotive down under the end of the ore bridge, which takes the bridge cars, one at a time, from the transfer car and runs them out on the bridge and dumps them over the stock-yard. Each ore bridge is designed to carry 100 of these bridge cars, holding 17½ tons each, per day of 10 hours. Powerful searchlights are fitted so that the ore bridges can be worked night and day when necessary. Our contemporary gives the full details of the equipment and methods of control.

Municipal Trading.—Some interesting contributions have been made to the evidence on municipal trading during the past week. Amongst the witnesses called before the Committee on Municipal Trading was Mr. George Livesey, of the South Metropolitan Gas Company. With respect to the municipalisation of gas, Mr. Livesey advocated that if this were done, the supply should be given at cost price. With respect to the breaking up of the streets, and the consequent public inconvenience, Mr. Livesey showed that corporations were, as a rule, more lax than companies in the management of their men, and hence that the streets were likely to be longer open than if the work was being done by a local authority. With respect to the monopoly question, Mr. Livesey's opinion is that there is no more tyrannical monopoly than a corporation department which fears no man except trade unionist voters. This too great subserviency to the trades unions has been repeatedly shown n the history of m unicipal trading as far as electrical lighting is concerned. The other objections to municipal trading which Mr. Livesey clearly puts before the committee are the inability of a municipal committee to recognise and a disinclination to adequately reward merit in the higher ranks of their officers, a lack of enterprise in taking up and developing new system, and a grasping at profits to be used for the reduction of rates. These views by a successful organiser of a large company ought to carry great weight both with the committee and with the House of Commons when considering the committee's report. Unfortunately, to echo the gist of one of Mr. Livesey's expressions, the committee members, and also the members of Parliament, fear no man, but they have to meet their voters shortly, and amongst these voters there are 10,000 trade unionists for every successful organiser as represented by Mr. Livesey. Lord Avebury's views on this subjects are given in the *Contemporary Review*, showing many objections to which not a few of the proposals of widening the scope of municipal enterprise are open. He reminds us that the old school of Radicals were strongly opposed to any form of trading by governments and municipalities, which principle the new Radicals have deserted. Among the varied businesses Lord Avebury suggests that municipalities should undertake, he mentions the manufacture of electrical fittings and of the residual products of gas. He concludes with three suggestions: (1) that no extension of municipal

Digitized by Google

trading for purposes not yet sanctioned should be permitted, except after full notice and special parliamentary enquiry; (2) that as regards water, lighting, tramways, and telephones, fresh undertakings by municipalities should only be sanctioned if it can be shown that there are special reasons why they should be carried on by the municipality rather than by private enterprise; (3) that any ratepayers objecting should have a right to be heard, and give their reasons for opposing the Bill. These suggestions will not be appreciated by the megalomaniacs and collectivists; but it is high time that the public should be made to hear both sides of the question, and we welcome Lord Avebury's contribution to their enlightenment.

The Theory of the Coherer.—Messrs. K. E. Guthe and A. Trowbridge contribute a valuable article on the above subject to the July number of the *Physical Review*. After giving a brief *résumé* of work done by other experimenters and also of past theories on the subject, the authors proceed to describe their own original investigations and to analyse them by means of curves. Their conclusions on the subject, in which they attribute the high original resistance of the coherer to the film on the surface of the metallic particles, are as follows: "Dorn has shown that very little or no coherer action takes place between surfaces of the noble metals when they have been heated in a vacuum so as to expel as far as possible the surface film. He also found a decided decrease of resistance for other metals. Aschkinass, on the other hand, tried to remove the surface film from the filing particles in a tube by exhausting and heating, but did not observe any change in the behaviour of the coherer. He admits himself, however, that this can hardly be considered a decisive test. The fact mentioned above, that metallic surfaces after thorough cleaning do not show a high contact resistance, is also in favour of our supposition, and we believe that Auerbach's results can easily be explained by the rubbing away of the films by mechanical action. The films must form a sort of protecting layer on the metal surface, as the following experiment shows: Two coherers, consisting of one contact each, were put in parallel and the circuit closed through them. The resistance of each was measured before and after lowering, and it was found that coherer action took place in one only. After standing a day this one was always oxidised, while the other showed a bright surface where the balls had been in contact. The coherer action had apparently destroyed the protecting film of the one in which it took place. Aschkinass mentions his interesting results with coherers consisting of PbO_2 or CuS particles as a proof against Lodge's theory. They behave in the opposite way from the ordinary coherer. We would suggest, in view of the similarity with polarisation, that the compounds are in this case broken up into two components, one of which conducts well and the other poorly. No actual metallic contact need then occur, and the S or O mould would play a decided *rôle* in the increase of the resistance. It seems that particles of any conducting substance may form a coherer—among others, carbon. This suggests an interesting question in connection with the electric arc. Ayrton and Perry found that the difference of potential between the two carbons of an arc lamp was independent of the current strength, provided the distance between them was kept constant—*i.e.*, the apparent resistance of the arc was inversely as the current. Does this correspond to the horizontal line of our curves, and does cohesion play any part in the starting of the arc? We offer the foregoing considerations merely as a tentative explanation of this little understood phenomenon, being well aware that some of our assumptions are somewhat crude, but hoping, nevertheless, that they may lead to a fuller understanding of the subject, since they seem to furnish a satisfactory hypothesis."

St. Pancras Lighting.—We had in a recent issue to seriously complain of the way in which the *Journal of Gas Lighting, Water Supply, etc.*, commented upon the electric lighting undertaking by the St. Pancras Vestry. We find it exceedingly difficult to believe even in the good faith of our contemporary, and if we grant it good faith, we have at the same time to credit it with gross stupidity and an utter want of reasoning power. We should not have again referred to the matter but for the fact that in the issue of July 24 further remarks are made. In this, a further criticism of the St. Pancras undertaking, the cost per unit for generation is stated to be 2·66d, whereas the cost of coal per unit was 0·92d. Our contemporary adds: "This fact ought to be enough to explain to silly persons in technical colleges and on local authorities why dearer coal does not hit the electric lighting business so hard as it does gas manufacture." If our contemporary wishes to be sarcastic, it should guard itself against throwing stones without laying itself open to a serious counter-charge. We quite grant that in St. Pancras the cost of coal is only about two-fifths of the total cost of generation, but this ratio is not so exceedingly different from what is found from gas undertakings. We have taken the trouble to look up the accounts of the South Metropolitan Gas Company for the past half-year. In these we see that the whole cost of generation, including coal, oil, labour, and repairs, was £512,000. Of this total coal cost £343,800, which would seem to prove our contemporary's view of the case. Looking, however, on the other side of the balance-sheet, it will be seen that the residual products obtained from the carbonising of the coal brought in about £247,000. The labour for working up these residuals is included in the cost of generation. It is obviously unfair not to consider these residuals, and our view of the case is that the difference between the cost of the coal and the income from the residuals gives the item corresponding to the cost of fuel with an electric lighting undertaking. This cost in the case of the South Metropolitan Gas Company is, roughly, equal to £97,000. In the same way, deducting the income from the residuals from the total cost of generation, we obtain an approximate sum of £265,000 as the total cost of producing the gas. It will then be seen that the ratio of this figure, which corresponds exactly to the cost of generation in an electric lighting station to the net cost of fuel, is practically the same as that which applies in the figures from the St. Pancras electricity works. Our contemporary may answer that the cost of gas residuals will not go up with the increased cost of coal. These costs are, however, increasing, and even if the increase is not as rapid as that in the case of coal, it is likely to be also slower in coming down afterwards. It is, of course, too much to expect our gas contemporaries to take an outsider's view of the problem, and the matter is one which can well be left in the hands of the gas consumers. Our contemporary justifies the gas companies in the large increases they are making in the price of gas, and it will be amusing to read its justification of the same directors a year or so hence when they advocate decreased prices and decreased dividends in order to prevent gas businesses falling off. Reverting to the St. Pancras figures and the criticisms thereon by our contemporary, we would advise it to get the office boy to repeat to its editorial staff the above sentence at half-hourly intervals. "A municipal undertaking which serves ratepayers at cost price is a failure." It will be observed that Mr. Livesey does not hold these views.

Digitized by Google

SOUTHPORT ELECTRIC TRAMWAYS.

A brief notice of the official opening of the Southport electric tramways appeared in our issue of July 20. We now propose to give some further details of the scheme. It is about 27 years ago since the first tramways were started in Southport, the line of the Southport Tramways Company from Birkdale to Churchtown being opened about that time. Subsequently another company, the Birkdale and Southport Tramways Company, was formed to construct a line to Kew Gardens, and this was opened about 19 years since. New districts have since sprung up, and the tramways inaugurated last week are the practical outcome of a commendable policy on the part of the Southport Corporation to supply the same with a better service of trams than the older districts. Blowick, the district served by the new electric tramways, is of modern growth, having been a detached hamlet 19 years ago. To give an idea of the Corporation's previous connection with the tramways of the town, it may be mentioned that in 1896 they purchased the lines of the Southport Tramways Company within the borough, together with the buildings, and the cars in connection with the same, for £17,000, at the same time granting the company a lease for 21 years at a rental of £2,700 per year. In January of the current year the Corporation bought the lines of the Birkdale and Southport Tramways Company within the borough, with their cars, sheds, stables, and other property, for £12,000. No lease was, however, granted the company in this case. As reported in our issue of July 20, a Board of Trade enquiry was held last week into the application of the Corporation for sanction to borrow £40,000 required for the reconstruction and electrical equipment of these newly-acquired lines. It is intended to lose no time in getting on with the work when once the permission is forthcoming.

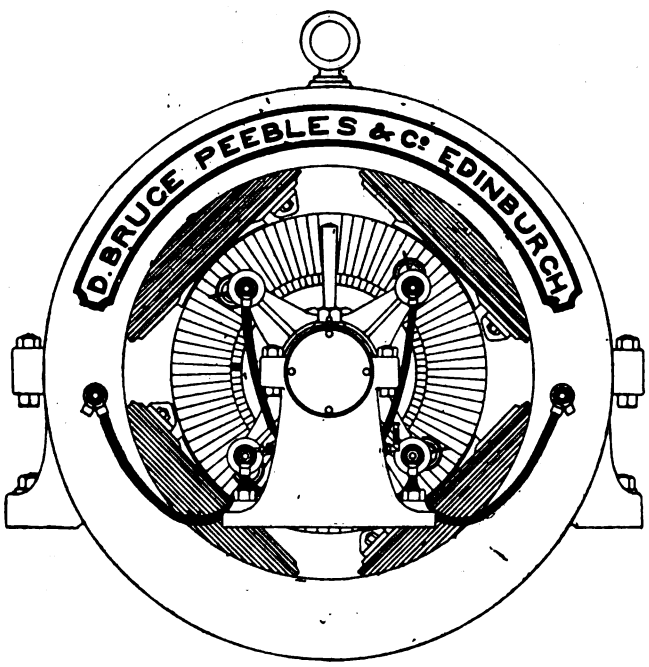


FIG. 1.—Traction Type Generator, Southport Tramways.

The new lines serving Blowick, with which we are now concerned, were first mooted in 1897. At that time Councillor Hulme was chairman of the Tramways Committee, and that gentleman, together with Councillor Travis (the present chairman of the committee) were deputed to report upon suitable roads for tramways and the best means of working the same. Subsequent to the appointment of Councillor Travis as chairman of the Tramways Committee, the report of the sub committee recommending to the Council the construction of the lines opened last week was duly carried. It was not, however, until 1899, after a great waste of valuable time, that the provisional order consenting to these lines was finally confirmed by Parliament. No time was subsequently lost in proceeding with the work. The order was confirmed in October, 1899, and contracts were signed in December of the same year, the actual work being started in January of the current year. Hence, the new lines, having a length equivalent to six miles of single track, have taken about six months to construct and fully equip. There are yet one or two small link lines to construct in connection with these tramways, besides which the Bill before Parliament this year provides for the construction of another three miles or so of track. In addition, there are already about nine miles of horse lines within the borough, including the lines to be converted for electric traction, so that eventually Southport will be in possession of about 18 miles of tramways, which gives one mile to every 2,900 inhabitants.

The power for working the new lines is obtained from the electricity works, which supply the town with current for lighting purposes. These works are situated in a central position relative to the various termini, but the generating plant installed for lighting purposes being of the alternating-current type, it has been necessary to put put down separate plant for the tramways. This special traction plant consists at present of two generators of the type shown in Figs. 1 and 2. They are of Messrs. D. Bruce Peebles and Co.'s standard No. 19A size. Each generator is capable of developing 380 amperes at 500 to 550 volts terminal potential when running at 350 revolutions per minute. As will be seen from the accompanying illustrations, the machines are of the multipolar slot-wound drum-armature type, fitted up on spiders of rigid design and ventilated throughout, and the field magnets are compound wound. The poles are of best annealed cast steel, fitted with the makers' patent "P. P. P." pole-tips for ensuring sparkless reversal at all loads. Special attention has been paid to the mechanical and electrical design of the machines to enable them to run with a minimum of attention during the widest variations of load. The efficiency of each combined set at full load (200 kw. at 350 revolutions) is over 89 per cent. The engines, to which the generators are directly coupled, are of Messrs. Belliss and Morcom's E C /12 size, capable of giving 375 b.h.p. with a pressure of 130lb. per square inch at the engine stop-valve, condensing at a speed of 350 revolutions per minute. The steam consumption of each set per kilowatt-hour, with 130lb. steam pressure 100deg. superheat, is 28·b. Steam is provided from the adjoining boiler-house through the range, which feeds the rest of the plant in the station. A special feature of the set is the exceedingly compact arrangement of the combination, the size of engine and dynamo being exceedingly well proportioned. As one of the 200-kw. sets was standing by the side of a horizontal compound engine, direct-coupled to a flywheel alternator running at a speed of 90 revolutions per minute, with an output of 125 kw., it was of interest to note that the 200 kw.

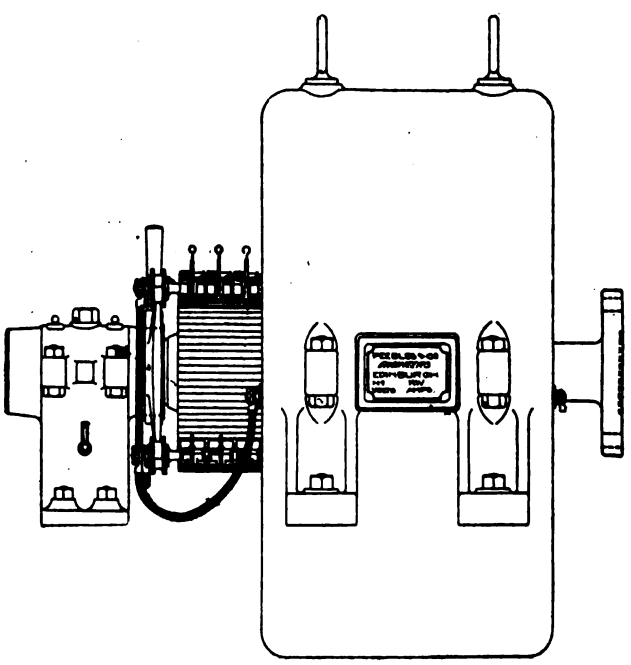


FIG. 2.—Traction Type Generator, Southport Tramways.

Digitized by Google

took up rather less than one-third floor space of the slow-speed plant with half the output. Three sets will ultimately be installed.

The switchboard, a view and diagram of the connections of which are shown in Figs. 3 and 4 respectively, was supplied by Messrs. Dorman and Smith, Salford, Manchester. It consists of 11 panels, three of them being generator panels, four feeder panels, two negative panels, one works panel, and a Board of Trade panel. On each generator panel is an ammeter and a voltmeter, together with equalising positive and negative switches. Each feeder panel is provided with an ammeter, automatic circuit breaker, main switch, lightning arrester, choking coil, and a recording wattmeter, which registers the number of units used on its circuit. In addition to the meters on the feeder panels there is a wattmeter on one of the negative panels which registers the whole current generated by the dynamos. Counting from left to right, panels 1, 2, and 3 are for the generators, 4 and 5 the earth return panels, 6 the works panel, 7 the Board of Trade panel, and 8 to 11 the feeder panels. There was insufficient room to get the board in a straight line, so an angular form was adopted, as shown, the effect being pleasing. The circuit breakers are of the latest Dorman and Smith pattern, and the main switches on the feeders are two-way, so that the feeders may be boosted up when required.

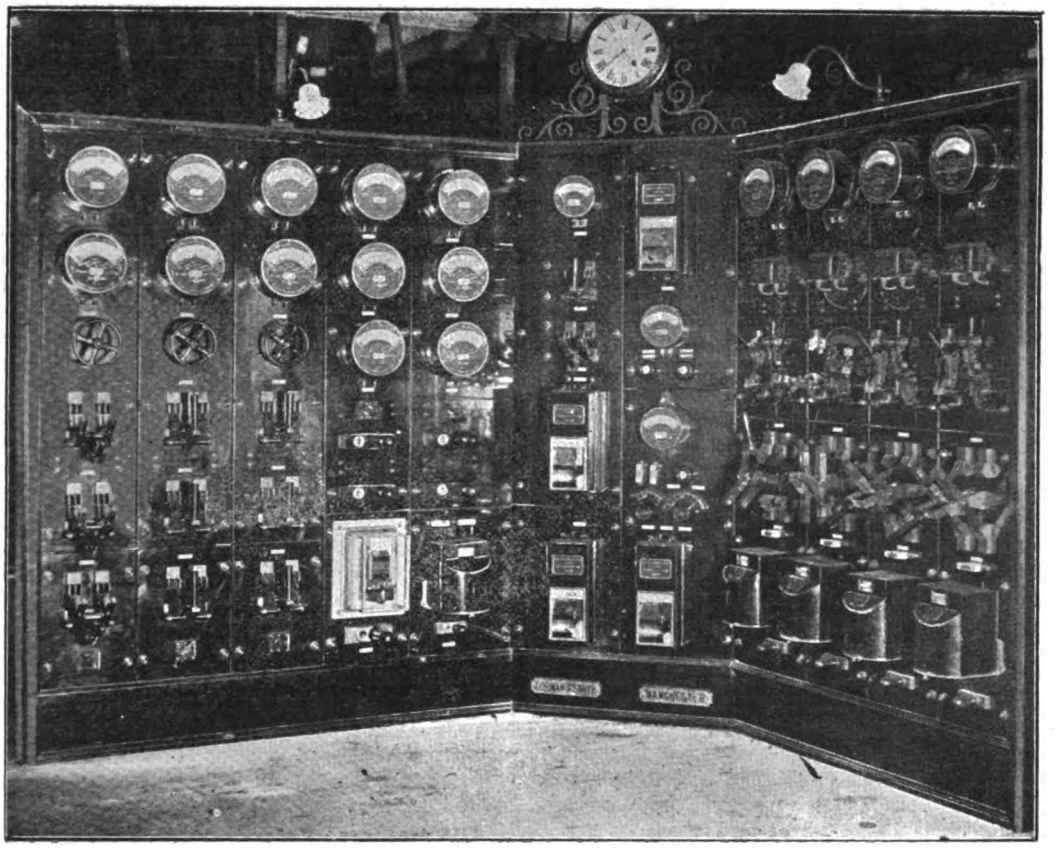


FIG. 3.—Traction Switchboard, Southport Tramways.

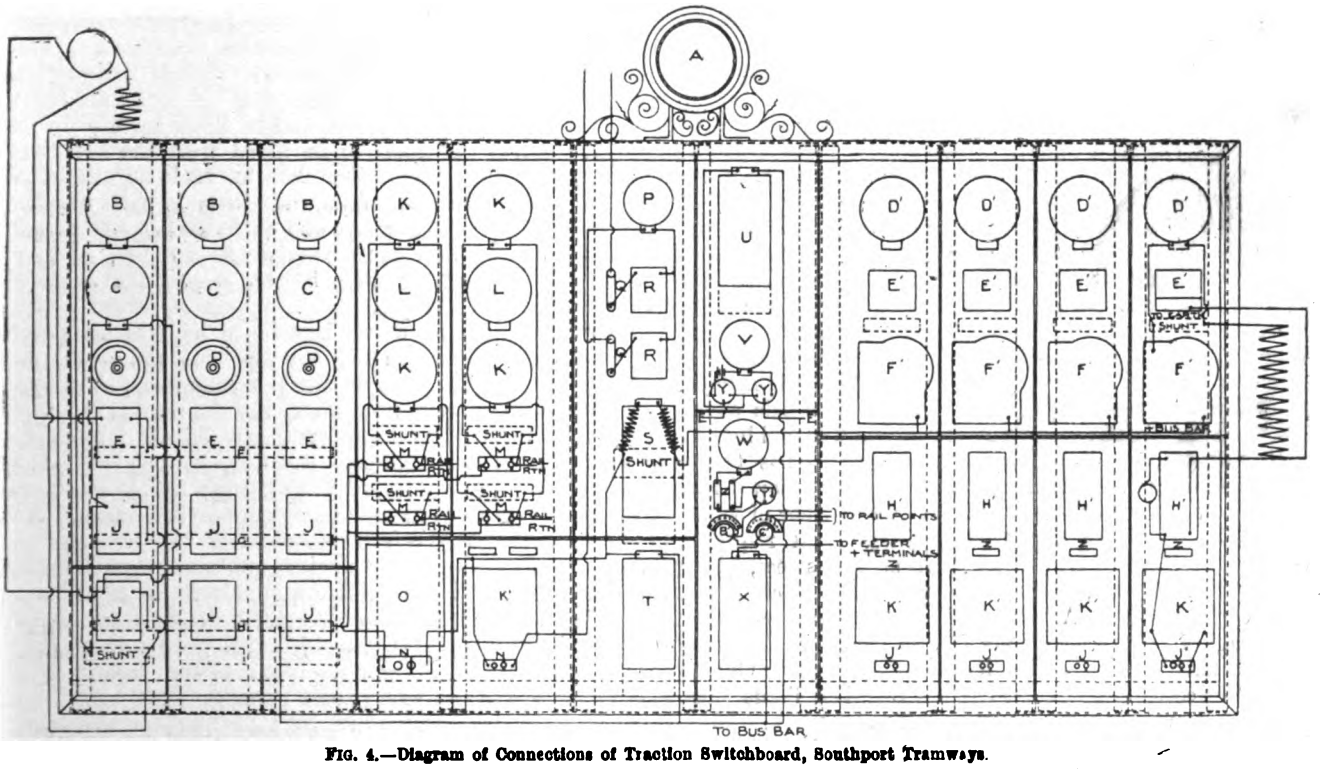


FIG. 4.—Diagram of Connections of Traction Switchboard, Southport Tramways.

Now we come to the outside work, and a few notes may be given concerning the permanent way. This portion of

Digitized by Google

the work, like the other sections, has been executed in a most thorough manner, and great praise is due to the Corporation staff, with the borough surveyor (Mr. R. P. Hirst) at its head, for the excellent manner in which the foundations for the track, which is probably equal in every way to any in the country, has been laid. All the concreting, paving, and excavating has been done by the Corporation's own men. The rails and accessories were, however, furnished by Messrs. Dick, Kerr, and Co., Limited, and some 800 tons of steel girder rails of their No. 75 section have been employed. These rails weigh 87lb. to the yard, are made up in 40ft. lengths, and nearly 1,600 pairs of this firm's well-known "Dicker" patent joint were used in the construction of the line. The gauge is the standard 4ft. 8½in.

Overhead Construction.—The contract for the overhead construction was placed with Messrs. Macartney, McElroy, and Co., Limited, of Westminster, on Dec. 11, 1899. As the contract was accepted on a strict premium and penalty basis, the contractors commenced operations in the early part of January, some time before the Corporation had commenced to lay the permanent way. The side bracket type of construction is employed throughout, the poles being 31ft. in height, and weighing approximately 1,200lb. each. The latter were designed specially by the company's engineers, and met with the approval of the Corporation. The trolley wire is 00 B. & S. gauge, and is double over the single track. The insulators are of the Macartney type, and designed by him several years ago for American use. With the exception of the Sussex-road section, the hangers are attached direct to the brackets; on the Sussex-road they are attached to a flexible arrangement, which is probably a superior method. The line is divided into half-mile sections, and fed from standard section pillars. The complete six miles of overhead equipment was practically completed within three months of signing the contract, which reflects great ability on the part of the contractors to execute work in quick time, since the material was designed, delivered, and erected in practically 90 working days. There have been, of course, a few changes due to the line of the permanent way, and especially its curves, not being exactly where they were anticipated by the overhead contractors, nor of the same radii. These changes, however, did not prevent the successful operation of the trams well within the stipulated time for completion.

During the inspection of the lines last week we noticed what appeared an unusually large number of anchor wires, but have since found that these were put up in compliance with the wish of the Corporation to have their trolley wire hauled up tight for the opening ceremony, which took place in the hottest weather. These anchor wires will serve to prevent breakage of the line when cooler weather and consequent contraction of the wire succeeds.

Cable Work.—A short description of the cable work may now be given. The whole of the feeder and rail return cables, together with the Board of Trade pilot cables, have been manufactured and laid by Callender's Cable and Construction Company, Limited. The feeders consist of ·4 square inch vulcanised-bitumen cables, laid in earthenware conduits and run in solid with pure Trinidad bitumen, the whole main being protected with a hard tile cover. The feeder leaves the generating station, and is laid by way of Peel-street, Sussex-road, and Ash-street to the feeder pillar near the rail-head in that street. It is looped into and out of three section pillars *en route*, either of which pillars can be used for feeding purposes if required. A subsidiary feeder is continued from Ash-street, along Scarisbrick New-road, which will eventually be carried as far as Chapel-street. A lead-sheathed and armoured cable, consisting of three cores each $^{7}/_{23}$, is laid direct in the ground alongside the entire length of feeders. One of these three-cores is to be used as the Board of Trade wire, and the other two for telephonic communication. They are also introduced into every section pillar, where suitable terminals are provided. The rail returns are laid solid, similar in all respects to the feeders, but consist of two cables each ·75 square inch. They follow the same route as the feeders till the corner of Tithebarn-road and Sussex-road, whence they are continued by themselves to the rails at the junction of St. Luke's-road and Sussex-road. A single-core $^{7}/_{22}$ lead-sheathed and armoured pilot cable is laid alongside the two rail returns the whole length of their route. The return cables are bonded on to the rails with flexible copper bonds, which are tee'd off the vulcanised-bitumen cable. The earthenware conduits for the feeders and the whole of the tile coverings were supplied to Messrs. Callender by the Stonite Patent Conduit Company, of Liverpool, the troughs for the rail returns being made by Messrs. Doulton and Co. The Stonite conduits are provided with a self-interlocking socket joint, which prevents any vertical and horizontal displacement of any conduit with reference to its fellow or adjacent conduit. In the event of ground subsiding beneath these self-locking joints, no strain is thrown on the cable contained therein. The whole of this cable work has been carried out under the supervision of Mr. F. A Pocklington, who has been laying cables for Messrs. Callender for 12 years in the North-Western district.

Rolling-Stock.—The rolling-stock for the present consists of nine double-decked cars, but there are also six single-decked cars on order. Messrs. Dick, Kerr, and Co., Limited, were the contractors for both these types of car. The cars now running were manufactured for them at the Electric Railway and Tramway Carriage Works at Preston, and are of the reversed stairway type, which, while affording complete protection to the passengers from the danger of falling when ascending and descending the stairways, also allows an increased seating capacity of something like 12 per cent. The cars are well designed, of handsome appearance, and thoroughly well constructed throughout. They are mounted on Brill 21 E. trucks, and are lighted electrically, having eight lamps in the interior, and also headlights and platform lamps. The electrical equipments were designed by Prof. Short, and are of the same type as those supplied by the contractors to Liverpool, Bolton, Dover, Sunderland, and other corporations. Two standard type motors, each having a capacity of 25 h.p., are fitted to each car, the controllers being of the solenoid blow-out pattern. Each car carries 22 passengers inside and 34 outside. The six single-deck cars on order are combination open and enclosed cars, seating 16 passengers inside and 16 outside. The electrical equipments of these cars are entirely of British manufacture (like the cars themselves), having been constructed at the works of the English Manufacturing Company Limited, at Preston, which were opened last month, and a description of which has already appeared in these pages, as our readers will doubtless remember. These new works are situate opposite the Electric Railway and Tramway Carriage Works, where the car bodies are made and consequently these car bodies have merely to be shipped across the road to be fitted with the necessary equipments. Final tests can then be made on the actual spot of manufacture, and small disparities in parts rectified without involving the delays and expenses inevitable when the car factory and equipment works are not, as here, practically on the same site. In this respect the works in question are quite unique.

Car Depôt.—A few words remain to be said about the car depôt, which is situated not far from the generating station buildings. Though not yet completed, the depôt was in a sufficiently advanced stage at the time of our visit to judge of its ultimate appearance. This will be exceptionally fine and a credit to the Corporation's able staff, who are here again concerned, the designs for the buildings having been got out in the borough surveyor's offices. The style may be termed a free treatment of the Renaissance. The front elevation shows a centre gable with a smaller one on either side, and is built of Accrington brick, the ornamentations being of dressed stone. The side walls are also of brick, but the back is of wood, the object being to enable extension to be more readily made. The roof is of iron in three bays, and is covered with patent glazing. The interior of the building measures 122ft. by 150ft., and of this space some two-thirds is available for the accommodation of cars. The remaining third is fitted for painting and repairing work and offices. The interior is well finished, being lined with brick, with a dado of salt glazing. The cost of the building is estimated at about £6,000, exclusive of foundations. The cars will enter through three doors, and each

Digitized by Google

rail inside has a cleaning pit of about 50ft. in length. Accommodation will be afforded for 32 cars.

The borough electrical engineer, Mr. Charles D. Taite, has been responsible for the electrical equipment of the new lines throughout, no assistance having been called in from outside. Mr. Taite has also large extensions to the lighting section of the electricity works on hand. The capacity of the plant already installed, including the traction generators, amounts to about 3,000 h.p., and the new extensions provide accommodation for a further 6,000 h.p., making 9,000 h.p. in all. A very fine and commodious new engine-room, opening into the older room, has already been erected. Electric lighting is making rapid headway in Southport, as the above figures would suggest. Several important additions to the lighting plant have been made since the station started supply, the most recent of these being a 600-kw. Ferranti copper-type alternator, which was installed less than a year since. When the extensions now in progress are complete, Southport will have a very fine station indeed. In conclusion, we have to express our thanks to the several contractors concerned for most of the information given above.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 87.)

The electrical plant in the Government dockyard at Kiel is much more scattered, consisting virtually of a number of independent installations of varying capacity. The first of these installations was put down in the early eighties, since when numerous additions have been made, but according to no systematic plan. Hence a number of independent plants have been put down, each designed to serve the requirements of a limited area of distribution in its immediate proximity. All the generators are of the continuous-current type, their distribution between the several departments of the establishment being as follows:

Shipbuilding yard proper	100 h.p.	—2 × 120 volts
Engine-building shops	500 ,,	—2 × 120 ,,
Carpenters' shop	30 ,,	65 ,,
Smithy	16 ,,	65 ,,
Foundry	40 ,,	65 ,,
Torpedo factory	20 ,,	110 ,,
Torpedo-mounting shop	15 ,,	65 ,,
Torpedo-repairing shop	30 ,,	110 ,,
Seven series-wound machines for general lighting purposes, each of 10 h.p. (on three sites)	70 ,,	550 ,,
Total	821 h.p.	

Of the several machines enumerated above, the latter seven each supply current to a separate circuit of from eight to ten arc lamps, arranged in series and serving for the general lighting of the yard. All of the 110 and 65 volt generators serve small individual areas of consumption.

On the other hand, the 100-h.p. and 500-h.p. machines constitute a combined direct-current plant, which feeds into an extensive three-wire distributing network of mains. The machines are situated about 1,310ft. apart, but may be paralleled together from either station. The 100-h.p. set consists of two separate compound-wound dynamos coupled direct to a compound steam-engine, while the 500-h.p. set consists of two compound wound generating machines, coupled direct to a marine type triple-expansion engine taken out of an old torpedo boat.

Amongst other purposes, electricity is employed in the dockyard for lighting the wharves, workshops, offices, and ships under construction and repair, transmitting power to motors driving countershafting, cranes, lifts, pumps, large and small machine tools, and portable drills employed during the construction and repair of ships, electro-plating, charging accumulators, and tests. Throughout the dockyard there are about 2,550 16-c.p. incandescent lamps at present installed; 360 arc lamps, consuming eight amperes each; 82 motors, aggregating about 500 h.p.; one continuous-current transformer, two stationary batteries of accumulators, and one accumulator boat. As in the Germania (Krupp) Werft, already described, the use of electricity is also to be largely extended in the Government dockyard, and especially in connection with the large new docks in course of construction. The two main pumps, it may be mentioned, representing about 875 h.p., are to be driven by electric motors, besides the apparatus for moving and pumping out the pontoons. The new power-house, which has already been erected, is to be equipped with a multiphase plant to generate current at a pressure of 1,000 volts for transmission to the various centres of consumption. No reduction of pressure, other than that represented by the loss in the leads, is to be made to the large motors, which will be wound for the full initial pressure of 1,000 volts. For the small motors and any others that may be situated in a damp position, the current will be transformed down to 110 volts, while the lighting circuits will also be supplied at the lower voltage. Plant having an aggregate capacity of 1,000 h.p. is to constitute the first instalment, but it is intended to gradually concentrate the whole of the generating plant serving the requirements of the dockyard on the one site. So far as can be at present foreseen, a total of about 3,000 h.p. will be required to meet the maximum demand. A combined multiphase direct-current system with motor transformers is to be adopted, since direct currents cannot be dispensed with for certain purposes. It is estimated that the rearrangement of plant entailed by the extensions will be completed by 1905.

There are other works installations, etc., in Kiel too numerous to mention in detail, but illustrating incidentally the extensive and varied application of electricity to industrial purposes in Germany. At the works of the Baltische Electricitäts Aktien-Gesellschaft, for example, electricity provides the exclusive power employed, some of the machines being driven separately by its means, while others are grouped. Of the electrically-worked tramways in Kiel little need be said; they are company-owned, and were opened for traffic in 1896. There are at present three lines in operation, having a total length of 12¾ miles single track. The heaviest gradient is 1 in 15. The motorcars are of a small single-deck type, and 41 in number. Each is equipped with two motors. There are no features in regard to the power-house which call for particular mention beyond that its equipment comprises three vertical compound engines, capable of each developing a maximum effective output of 200 h.p. To these are coupled in pairs six traction-type generators capable of having an aggregate output of 410 kw. at 500 volts terminal potential. The lines are equipped on the overhead trolley system. A five minutes' service of cars is in operation over the whole system, the receiver-box method of payment, without conductors, being employed, with a uniform fare of 10 pfennige—the equivalent of about 1½d. Tickets are also issued in bulk at reduced prices. In 1899 1,040,000 car miles were run, and about 4,000,000 paying passengers carried. There are five stations at which passengers may change from one line to another without extra payment. Further lines are are in course of construction, which are destined to provide a means of communication between Kiel and the township lying on the opposite side of the harbour. This extension will have a length of 6 miles, and a separate generating plant will be put down to work it, consisting of two dynamos of an aggregate capacity of 440 kw., with a terminal potential of 550, coupled direct to as many compound engines capable of each developing a maximum effective output of 330 h.p. There will also be installed a buffer battery of 270 elements and 198 ampere-hours capacity. As in the case of the already existing power station, steam will be supplied to the engines by water-tube boilers. These will be two in number, each having a heating surface of 2,280 square feet.

So much for the actual and prospective electrical attractions of Kiel. I may now return to the proceedings of the Verband, in which connection it must not be forgotten to mention that Herr Hartmann, of the well-known firm of Hartmann and Braun, Frankfort-on-Maine, was elected president in succession to Herr von Siemens, whose term of office had just expired. It transpired during the further business of the meeting that an under-

Digitized by Google

standing was in sight between the Government and the Verband relative to the periodical inspection of electrical installations, and that an association having for its aim the promotion of this important question in Berlin was in course of formation. Several new commissions, besides those already mentioned, were appointed, amongst other things, to consider in what direction, if any, an improvement could be effected in the existing patent laws, and to test and specify the insulation of wires and cables.

I have already referred to several papers read at the meeting, but there were various others of an interesting nature contributed, brief reference to which may be made. Dr. Hans Goldschmidt, of Essen, dealt in a highly-appreciated paper with the question of rail-welding by the process of obtaining high temperatures with the aid of aluminium. The discovery made by the author in this direction will be fresh in the minds of the reader. It attracted considerable attention at the time, and has since been turned to practical account with considerable success. Dr. Goldschmidt, in his introductory remarks, briefly described the process. While hitherto temperatures of 3,000deg. Celsius have been attainable only with the aid of the electric current and the bulky apparatus thereby involved, Dr. Goldschmidt has discovered a mixture of aluminium and oxygen termed "Korund," which developes this temperature upon simple ignition, thereby enabling thick steel plates and massive iron bars to be bored through in a few minutes. The process also serves to reduce metals to a fluid state which are otherwise difficult to melt, such as chromium, manganese, titanium, etc., all of which obtain extensive employment in the steel and copper industries. But, in addition to this phase of utility, Dr. Goldschmidt has adapted his discovery for welding purposes, the practical outcome of which is to be seen in Essen and Braunschweig, where long stretches of tramlines have already been welded together by the new process. Berlin, Hanover, and other towns have also decided to adopt the system. Dr. Goldschmidt made some practical demonstrations with the process before the meeting. He first of all showed its application to tube welding, for which purpose it is now employed in a large number of factories, one great advantage being that the work may be executed on the spot, besides being cheaper than the ordinary process. In executing the experiment, an assistant placed some of the Korund mixture in a crucible and thereupon ignited it, subsequently adding metal with a spoon. An interesting point in connection with the process is that the calories generated may be exactly predetermined. During the course of the demonstration the assistant had his eyes protected by smoked glasses from the intensely brilliant light developed by the melting process. After a very short time the glowing mass was ready for pouring into the mould, which held the ends of the tubes to be welded together in a horizontal position. The operation was accomplished by hand, for, in spite of the tremendous generation of heat, the crucible remained cold outwardly. Melting of the iron pipes is prevented by a protecting film formed by the Korund upon the surface of the same. Thin iron plates also remain unaffected in this way for the same reason. Two vertically-arranged pipes were next dealt with, and finally the method of welding rails by the new process was shown. Air is not admitted to the joint during the welding process, care being taken to exclude all oxygen. By this means the weld is rendered of excellent quality. It would certainly appear from what was shown that the process has a future before it. The advantages pertaining to a good system of welding rails are obvious. In the first place, the unevenness of the track at rail joints is avoided, whereby more even wear is ensured, and, secondly, trouble through vagabond currents is practically overcome.

One of the Art Galleries at Paris.

(*To be continued.*)

THE PARIS EXHIBITION.

[BY OUR OWN CORRESPONDENT.]

(*Continued from page 59.*)

Another English exhibit which was not in working order at the time of my visit was the dynamo of the well-known firm of Mather and Platt, Limited, of Manchester. This machine is coupled to an engine made by Messrs. Galloway. The general arrangement of the combined set can be seen from Fig. 1. The dynamo is one of Mather and Platt's standard multipolar machines, designed for use on lighting or power circuits. It is of substantial design, and all details with regard to accessibility and compactness have been carefully considered. The machine is shunt-wound, and has an output of 220 to 250 volts and 1,400 amperes at 105 revolutions per minute. It is, however, capable of carrying a temporary overload up to 1,600 amperes, and is arranged to run in parallel with other generators in the Exhibition. It is of the 12-pole type, the yoke ring

Digitized by Google

and magnet cores are of cast steel, and arrangements are made so that the lower half of the ring can be lowered into the foundations, enabling any magnet winding to be taken off or to be easily inspected if necessary. The armature is central hung, being mounted upon the crank-shaft between the two bearings. It is not keyed to the shaft, but bolted direct to the heavy flywheel with which the engine is provided; this method of attachment ensures all flywheel effect being transmitted direct to the armature, no keys are subjected to an unnecessary strain, and a very stiff job is ensured. The armature is of the slotted type, the bars being laid in insulating tubes, and entirely embedded in the iron of the core, which is the usual practice in generators of this type, and efficiently protects the windings from damage. Special attention has been paid to the question of efficient ventilation both of the armature and the commutator, and the machine can consequently carry on the full load for long periods with but a small rise in temperature. The commutator is of large diameter and width, and of a design and construction up to the highest standard of modern practice. The current is collected by carbon brushes mounted in special holders, which admit of the contact pressure being adjusted as may be required, and each holder is fitted with "hold off" attachment. The efficiency of the generator is approximately 94 per cent., which with an engine efficiency of 91 per cent. gives a combined efficiency of 85·5 per cent. The engine, which is of the compound inverted type, is by Galloways, Limited, and is capable of developing up to 680 i.h.p. with high economy when provided with steam at 140lb., and going at 105 revolutions per minute. The high-pressure cylinder is 18in. diameter and the low-pressure 34in., both being arranged for a stroke of 3ft.; the cylinders are erected on standards of an enclosed type, the flywheel and dynamo being between. The distribution of steam to both high and low pressure cylinders is effected by Corliss valves having separate chests for steam and exhaust, both sets of valves deriving their motion from eccentric fitted on crankshafts driven from the end of the main crank pins. The whole of the valve gear is arranged on the outer sides of standards, and thus, owing to its accessibility, admits of ready adjustment at any time from the outside of the engine, and further, in conjunction with the enclosed design of the standards, avoids the risk of any oil, steam, or water being splashed upon the dynamo. The governor, which is of the high-speed centre-weight type, is positively driven from the valve shaft, and it automatically controls the expansion of steam in the high-pressure cylinder. Provision is also made for the adjustment of speed by hand while the engine is running. A neat and substantial platform is erected for access to the whole of the cylinder parts, valves, etc., and this is designed so as to give light to and convenience for lifting the dynamo parts. A system of forced lubrication is adopted, and the steam is superheated between high and low pressure cylinders. As is now generally the case in central-station installations, the condenser, which is of the ejector type, is fitted with an independently-driven water-pump. The engine throughout is of massive and substantial construction, and gives the French engineers a good idea of engineering work as done by our best firms.

View from the Balcony of the English Restaurant, showing the Globe Celestial.

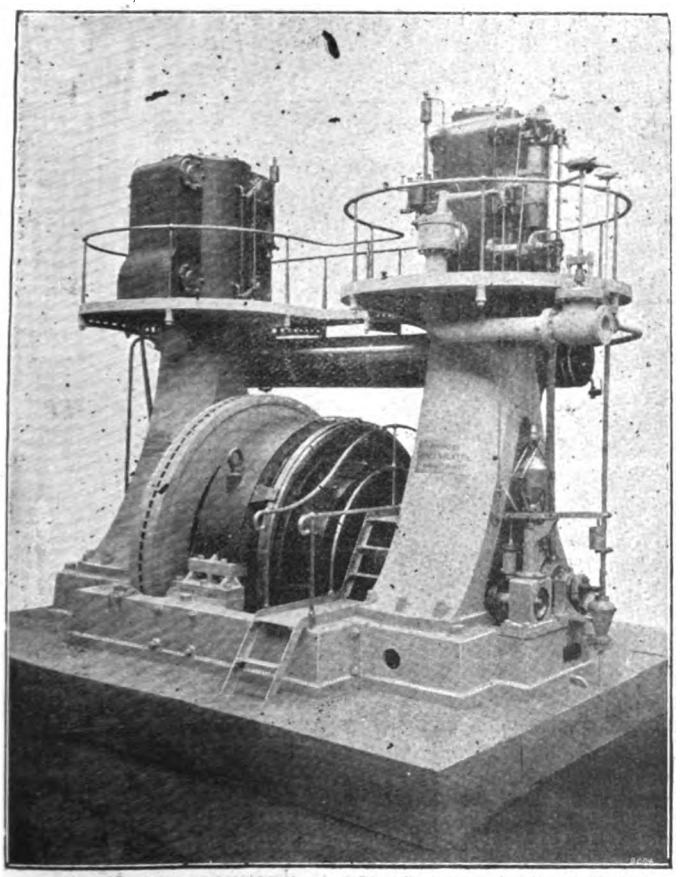


Fig. 1.—View of the Mather and Platt Dynamo and Galloway Engine.

Digitized by Google

The Exhibit of Messrs. Kolben and Co., of Prague.—To give the above firm its full name I should have called it the Elektricitäts Actien-Gesellschaft, vormals Kolben und Co. The personal interest that I feel for this firm is due to a friendship with its originator, Mr. Emile Kolben, and to an appreciation of the good work in electrical design which Mr. Kolben did both in America and Germany for prominent firms of electrical engineers before he commenced business on his own account in Austria. The works of the firm are particularly interesting from the fact that they are laid out for the construction of alternators of large size. In order that this may be conveniently done, Mr. Kolben has not laid down large tools to handle the large castings, which are inevitable with these multipolar machines and alternators. Instead of them, he provides a number of portable tools, which can be conveniently moved round the work. The result is that a great saving is effected both in first cost of equipping the works and, what is more important, in the speed with which such work can be put through the shops. An illustration of these tools is to be seen in Fig. 2, in which they are operating on the star wheel of one of the large alternators in the course of machining. Fig. 3 is a view in the same workshop to show how the cores of this Paris machine were built up and wound with wire. I understand that the first large electrical generating unit which was able to supply power to the exhibition was this three-phase steam alternator of Messrs. Kolben and Co. It was started at May 2, and both engine and dynamo were so well tested beforehand in the factory, and so well fitted in place, that at the very day of starting it was able to furnish current for the lighting of "Vieux Paris." The plant in question is situated in the Belgian section of the gallery devoted to the electric service of the Exhibition. It is placed at the foot of the large staircase coming down from the "Palais de l'Electricité" into the "Galerie des Machines." It consists of horizontal tandem compound steam-engine making 94 revolutions per minute, of the firm Carels frères, of Ghent, driving the flywheel-type three-phase alternator. This alternator is designed to give 1,100 effective

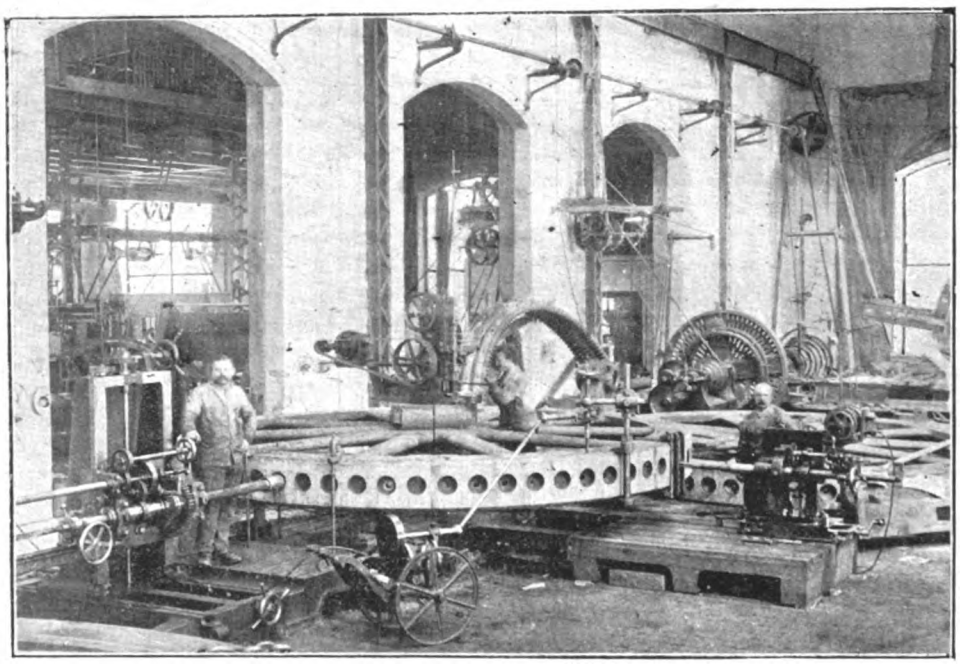


FIG. 2.—View in the Workshop of Messrs. Kolben and Co., showing Paris Alternator in course of Construction.

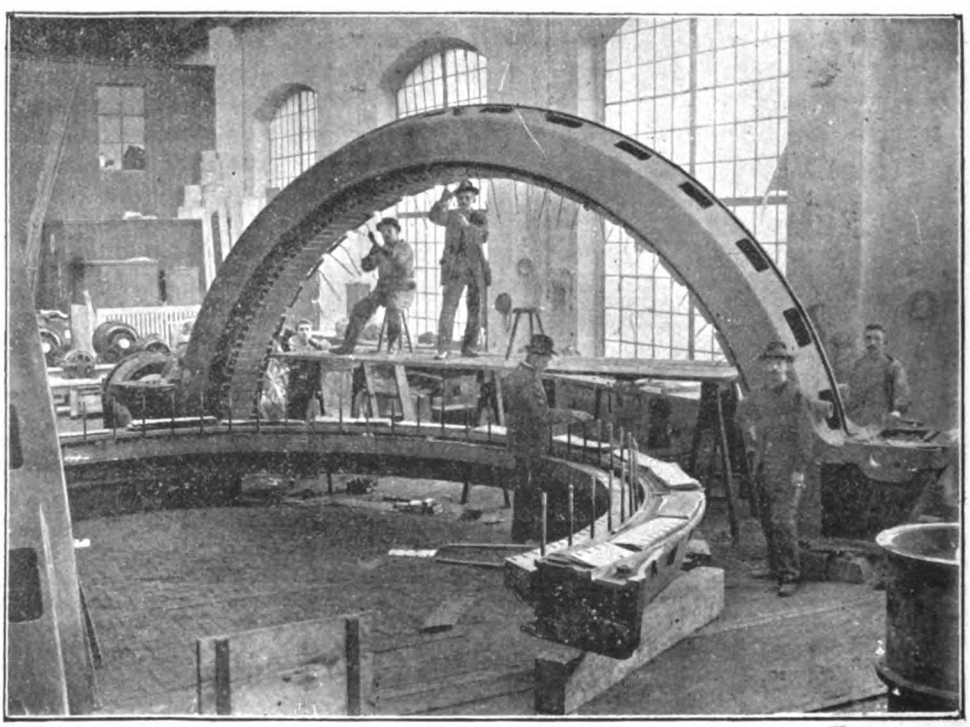


FIG. 3.—Building up and Winding the Armature Core of the Kolben Alternator.

Digitized by Google

horse-power for driving induction motors, furnishing 825 kw. at a compound pressure of 3,000 volts. The magnet wheel has 64 poles, thus generating at 94 revolutions per minute a periodicity of $64/2 \times 94/60 = 50$ cycles per second. The magnet wheel is made in two halves, and consists of a heavy cast-iron flywheel carried by 10 double arms, in the rim of which are fitted the magnet poles of cast steel. The rim has a weight sufficient to reduce the irregularity of the angular velocity to 1/200, having an inertia of $G D^2 = 600{,}000$ square metre-kilos, where G is the weight in kilos and D the average diameter in metres of the flying masses. The 64 magnet steel cores have an oval cross-section, and have cylindrical projections which fit exactly in corresponding holes in the flywheel rim, thus

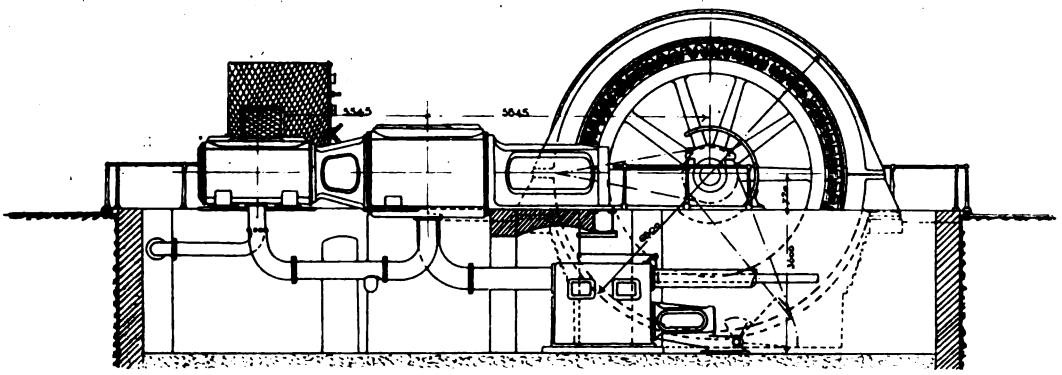


FIG. 4.—Side Elevation of the Kolben Alternator and Engine.

reducing the magnetic reluctance between steel and cast iron in correspondence with the different magnetic properties of steel and cast iron. The poles of the cores are made of iron laminations, which are cast into the steel cores. The core winding is made of copper band of 5mm. by 25mm., wound on edge. The adjacent layers are insulated from each other by means of parchment paper punchings. The magnet windings thus formed are hydraulically pressed together. The rim velocity of the wheel is 5,400ft. per minute, the external diameter of the wheel being 18ft. 3in. The stator which carries the high-pressure winding has a laminated iron core with deep slots, which are insulated by micanite troughs. The high-pressure winding consists of 96 coils, which 96 coils are laid in the slots and solidly fastened therein. The whole is carried by a strong cast-iron frame,

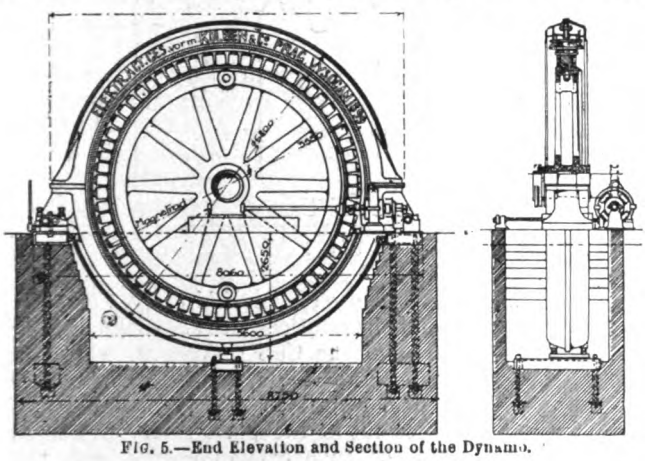


FIG. 5.—End Elevation and Section of the Dynamo.

which can be shifted axially, so that single armature coils as well as magnet coils can be easily replaced. The stator frame is also adjustable in the vertical direction by means of heavy adjusting bolts resting upon the cast-iron sole-plates. The magnetic proportions of the alternator, as well as the windings, are so calculated that at varying loads only very small pressure variations are noticeable. The dynamo is therefore designed with a high air-gap induction, strong iron saturations, small armature leakage and reactance, having a good pressure characteristic at no load, and a favourable short-circuit curve. The full-load current is reached with the short-circuited armature windings at an excitation corresponding to one-third of the normal voltage. The dynamo works at full and even at 25 per cent. overload very quietly without humming. The total weight of the dynamo, excluding exciter, is 62 tons. A general idea of the alternator and engine can be obtained from Figs. 4 and 5.

The exciter for the alternator is a six-pole continuous-current dynamo, whose armature is keyed directly on to the main engine shaft. It makes, therefore, only 94 revolutions per minute, and generates a current of 100 volts and 80 to 100 amperes. The whole energy required for the excitation is, therefore, about 1 per cent. only of the useful output. From the terminals of the alternator three high-pressure main cables are led to the distribution switch-board, which carries all controlling safety and measuring apparatus. The high-pressure switches of the board are so designed that their manipulation is perfectly without danger; they are handled by the machinist standing upon an elevated platform. The three-phase current generated by the Kolben three-phase alternator is used for feeding the high-pressure distribution network of the Exhibition. In the village "Old Paris" there are installed seven Kolben three-phase transformers, which transform the high pressure of 3,000 volts down to 110 volts, which is being used for lighting by arc and incandescent lamps. It may be remarked that the alternator exhibited by the Kolben Company carries the number "1,000," it being the one-thousandth dynamo manufactured by the firm. Five alternators of exactly the same size and output as the one exhibited are working at the three-phase central station of Prague, where they are used for generating current for the public and private lighting and power, and for the electric tramway service.

(To be continued.)

STANDARDS OF E.M.F.

BY JOHN HENDERSON, D.SC., F.R.S.E., A.I.E.E.

The practical unit of E.M.F., the volt, is legally defined as "that electrical pressure which if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere," the ohm and the ampere being carefully defined quite independently of any measurement of electrical pressure. For practical purposes, however, the above definition does not supply a very ready means of reproducing the standard of E.M.F., assuming, as it does, the possession of a standard ohm and the means of measuring current in terms of the legal definition—viz., by means of a silver voltameter. The accurate manipulation of this latter apparatus involves much practice and a considerable expenditure of time, so that comparatively few measurements could be made in a day, and rapid measurements would be out of the question.

Recognising this fact, a supplementary definition of the volt is given, in which it is stated to be a certain fraction of the E.M.F. (at a definite temperature) of a primary battery which has been constructed in a specified manner. If, then, the E.M.F. unit is to be expressed in terms of the potential difference of a primary battery, it is obvious that we should possess the fullest knowledge of the behaviour of that cell under varying conditions, and also that the cell should fulfil all the requirements of a standard of measurement.

Before we examine the behaviour of various cells that have been suggested as possible standards, and in particular of that form chosen in the definition of the volt, it will be as well

Digitized by Google

to specify the conditions to be fulfilled by any satisfactory standard; these are as follows: (1) the standard cell must be easily made and reproduced; (2) the E.M.F. of such a cell must remain constant under constant physical conditions; (3) the nature of the alteration of the E.M.F. of such a cell with altered physical conditions must be accurately known; (4) the E.M.F. must return to its original value when the original conditions are reproduced; (5) all impurities likely to occur in the materials of which the cell is composed should produce a negligible effect on the E.M.F.

In order to determine whether or not a cell fulfils these requirements, the following measurements must be made: (*a*) the measurement of the E.M.F. of the cell under known conditions; (*b*) the measurement of E.M.F. with various added impurities likely to occur in "commercial" samples of the materials of which the cell is composed; (*c*) the measurement of the variation of E.M.F. with temperature; (*d*) the behaviour of the cell when supplying a current, with special reference to the rate of recovery of the E.M.F. from the effects of polarisation.

In what follows it is proposed to consider the construction and behaviour of several of the more important cells that have been suggested from time to time for use as standards, and to see in how far they fulfil the above conditions and requirements.

The Standard Daniell Cell.—In all primary batteries the chief cause of variation of E.M.F. is due to polarisation, and the majority of cells that have been invented represent more or less satisfactory attempts to reduce or entirely remove this trouble. There are three principal methods of doing this: (1) the mechanical method, in which the polarising hydrogen is brushed or otherwise mechanically removed from the surface of the negative plate; (2) the chemical method, in which the hydrogen is removed by the aid of some oxidising substance—this method is employed in the majority of cells such as the Bunsen, Leclanché, Bichromate, etc.; and (3) the electro-chemical method as represented in the Daniell cell, in which the hydrogen of a sulphuric acid molecule is made to replace the copper in a copper sulphate molecule, and deposit the copper on the negative copper plate.

As far as regards its use as a standard of E.M.F., we need only consider one form of this cell—viz., that devised by Dr. Fleming, who has carefully investigated the best conditions under which the Daniell cell can be used, and the E.M.F. of the cell under varying conditions. The cell is set up in a glass U-tube, to the upper ends of the limbs of which are attached small glass reservoirs communicating with the U-tube through glass taps. The tube is filled with copper sulphate and zinc sulphate solutions, so that there is a sharp interface between the two near the level of the small escape tap fused into the U-tube near the bottom of one of the limbs, and by opening which and running out a little of the liquid the sharpness of the interface may be restored should it become blurred by gradual diffusion. The reservoirs contain stores of zinc sulphate and copper sulphate solutions respectively, which can be drawn upon as the level of the liquid in the U-tube falls. Into the side of the U-tube containing the copper sulphate solution is placed a rod of pure copper, whilst into the zinc sulphate solution is placed a rod of pure amalgamated zinc. The whole apparatus is mounted on a wooden stand (see Fig. 1), small glass side tubes being provided to hold the copper and zinc rods when the cell is not in use.

As regards the value of the E.M.F. of the cell, Dr. Fleming has shown that it depends to a large extent on the strength of the solutions and on the condition of the copper and zinc rods. The copper rod should be made from a thin copper wire 4in. long, on which copper is electrolytically deposited until it attains a thickness of ¼in., and whenever the cell is to be used after having stood idle for some time a fresh layer of copper should first be deposited on the rod. The zinc rod is of the same dimensions, and consists of double-distilled zinc carefully amalgamated with pure mercury. The solutions employed may be of two strengths: (*a*) equi-dense solutions of specific gravity, 1·2 at 15deg. C., or (*b*) $ZnSO_4$ solution of specific gravity 1·4, and $CuSO_4$ solution of specific gravity 1·1, both at 15deg. C. Of these, solutions (*a*) are made by dissolving 28·25 parts by weight of pure $CuSO_4$ in 71·75 parts of distilled water, and 32 parts by weight of $ZnSO_4$ in 68 parts of distilled water; whilst solutions (*b*) consist of 55·5 parts by weight of $ZnSO_4$ in 44·5 parts distilled water and 16·5 parts by weight $CuSO_4$ in 83·5 parts distilled water. Under the above conditions the E.M.F.'s of the cell are: with solutions (*a*) 1·102 volts; with solutions (*b*) 1·072 volts.

The effect of temperature on the E.M.F. may be neglected, since it only falls by ·00015 volt per degree centigrade rise of temperature. One of the most serious defects of this cell is that it is not portable, and thus can only be employed as a laboratory standard. The E.M.F. is found to rise by about ·003 volt after standing for some time, also the purity of the rods greatly affects the E.M.F. If the copper rod is sandpapered instead of being copper-plated, the E.M.F. is increased by 0·6 per cent., whilst oxidation of the copper rod raises the E.M.F. by variable amounts. Oxidation of the zinc rod, on the other hand, lowers the E.M.F., and the smallest deposit of copper on the zinc rod, such as is very liable to occur should any of the $CuSO_4$ solution find its way to the zinc, at once lowers the E.M.F. by 2 or 3 per cent. The strengths of the solutions also affect the E.M.F. An increase in density of the $CuSO_4$ raises it, whilst an increase in density of the $ZnSO_4$ lowers it. Another drawback to this particular form of cell is the liability of the $CuSO_4$ to crystallise out in the glass reservoir, and so choke up the tap in the tube communicating with the U-tube.

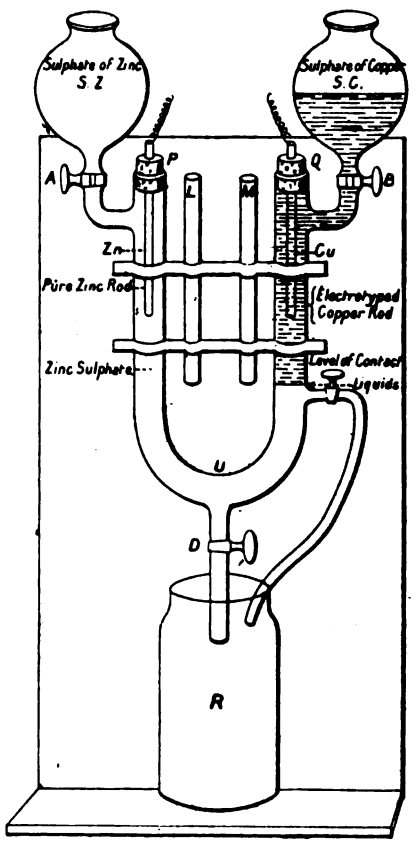


Fig. 1.

In cases where great accuracy is not required, an ordinary porous pot Daniell cell may be simply and rapidly made up with $CuSO_4$ solution saturated at 15deg. C. and acidified with sulphuric acid, the amalgamated zinc rod dipping into dilute sulphuric acid instead of zinc sulphate solution. The following table gives the results of measurements made by the author on such a cell, 15 minutes after having been made up.

Electrolyte round copper plate.	Electrolyte round zinc rod.	E.M.F. Volts.
100 c.c. $CuSO_4$ + 0·5 c.c. H_2SO_4	100 c.c. H_2O + 0·5 c.c. H_2SO_4	1·142
,, + 1 ,,	,, + 1 ,,	1·140
,, + 2 ,,	,, + 2 ,,	1·128
,, + 5 ,,	,, + 5 ,,	1·114
,, + 10 ,,	,, + 10 ,,	1·106
,, + 15 ,,	,, + 15 ,,	1·099
,, + 20 ,,	,, + 20 ,,	1·094

Digitized by Google

The H_2SO_4 was ordinary strong sulphuric acid, and the H_2O tap water. If the above voltages are plotted out against the volume of H_2SO_4, it will be seen that the best conditions obtain between 10 cubic centimetres and 20 cubic centimetres of H_2SO_4 to 100 cubic centimetres H_2O, as the E.M.F. changes least rapidly then with a given change in the amount of the acid added. The Daniell cell, on account of the trouble in preparing it, and from its not being portable, is not much used now as a standard of E.M.F.

The Clark Cell.—The most important of all the primary cells in use at the present time for standard purposes is undoubtedly one or other modification of the cell originally proposed by Mr. Latimer Clark. This is partly due to the large amount of accurate information possessed regarding its behaviour, and partly to the fact of its having been chosen by the Board of Trade as their standard cell. The particular form of this cell, mentioned in their specification, is known usually as the Board of Trade or B.O.T. Clark cell, and differs somewhat from the original form. As, however, there are a great many modifications of this cell, and more especially as some of the most accurate information we have on Clark cells was obtained from some of these other forms, it will be necessary to describe some of the more important modifications, and to discuss their relative merits and deficiencies.

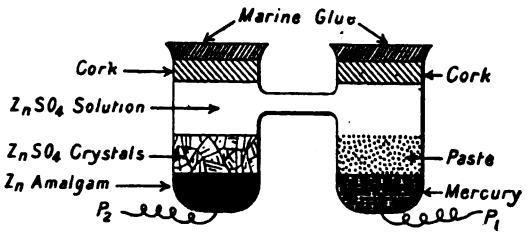


FIG. 2.

The Rayleigh H-Type of Clark Cell.—This modification was adopted by Lord Rayleigh after long and careful investigation. It consists of an H-shaped glass vessel (see Fig. 2). In one limb is placed some mercury which has been purified by distilling *in vacuo*, and to which contact is made by means of the platinum wire, P_1, fused through the glass. On the top of the mercury is placed a layer of paste composed of mercury, mercurous sulphate (Hg_2SO_4), and zinc sulphate ($ZnSO_4$). In the other limb is placed zinc amalgam (1 Zn to 9 Hg), a platinum wire, P_2, fused through the glass making contact with it. A few crystals of $ZnSO_4$ are placed on the top of the amalgam, and the remainder of the glass vessel is filled up with a solution of zinc sulphate saturated at 30deg. C. The open ends of the vessel are closed with corks and marine glue. Slight modifications on the Rayleigh pattern of cell have been made by Kahle and Cooper, the form due to the latter being specially adapted for immersion in a water-bath.

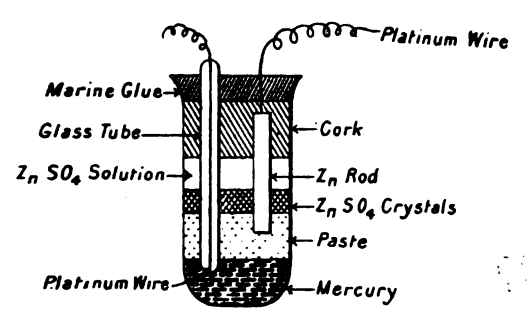


FIG. 3.

The Board of Trade Clark Cell—The shape and construction of the Board of Trade form of Clark cell is designed with a view to making the cell more portable than the Rayleigh form. The cell is made up in a glass tube (see Fig. 3). Pure redistilled mercury is placed at the bottom of the tube, contact being made to it by means of a platinum wire, the upper part of which is insulated from the rest of the cell by a glass tube. The paste above the mercury is similar in composition to that in the Rayleigh cell, the zinc sulphate solution also being saturated at 30deg. C. The negative electrode, however, consists of pure unamalgamated zinc, which passes through the solution and enters a little way into the paste. The cell is sealed up with a cork and marine glue. A few additional hints on fitting up these cells have been given by Mr. Glazebrook, who advises the addition of a little zinc carbonate to the $ZnSO_4$ solution to neutralise any free acid, and also the addition of $ZnSO_4$ solution to the mercurous sulphate paste, this latter being made up of Hg_2SO_4, "purchased as pure," and washed with distilled water, some pure mercury being added to the paste to "preserve the basicity of the salt, which is of the utmost importance." Also, in a cell made up in accordance with Glazebrook's suggestions, the zinc rod does not penetrate into the paste, although apparently there is nothing to prevent the paste coming in contact with the zinc should the cell be shaken. Clark cells of the Board of Trade pattern are stated to have an E.M.F. which will not vary more than 0·001 volt from 1·434 volts at 15deg. C.

The Carhart-Clark Cell.—This form was introduced by Prof. Carhart to overcome some of the objectionable features

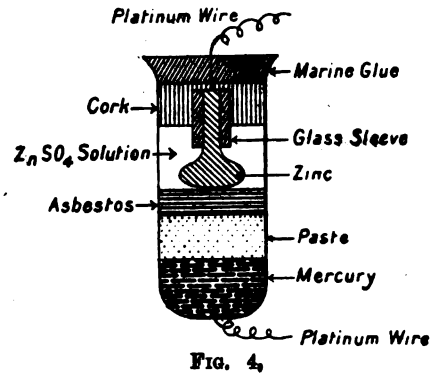


FIG. 4.

met with in the Board of Trade Clark cell. The arrangement of materials is shown in Fig. 4. The pure mercury at the bottom of the glass tube has contact made to it by the platinum wire fused through the glass. On the top of the mercury is a layer of paste, as in the Board of Trade cell, but separating the paste from the zinc rod is a layer of asbestos, which prevents the paste coming into contact with the zinc. The zinc rod is flattened out at the lower end to increase its active surface, whilst the upper part of the rod is protected by a glass sleeve. Contact is made to the zinc by a platinum wire in the usual manner. The zinc sulphate solution in the cell is saturated at 0deg. C. instead of at 30deg. C., as in the Board of Trade cell, and in consequence of this the E.M.F. is about 0·4 per cent. higher, being 1·438 volts at 15deg. C.

Callendar's Crystal Clark Cell.—This is a modification of the Board of Trade cell introduced by Prof. Callendar, in which the zinc sulphate solution is replaced by moist crystals of $ZnSO_4$ packed closely round the zinc rod. The glass containing tube is smaller in bore and considerably longer than in the Board of Trade form, thus admitting of the complete immersion of the active parts of the cell in a water-bath, and the more rapid attainment by the cell of the temperature of the water-bath than is possible in cells having a larger thermal capacity. There are various other modifications of Clark cells of more or less importance, the modifications mostly being in the structural arrangements of the cells. Of these we can only mention one—Muirhead's form of Clark cell, in which an amalgamated platinum spiral (formed by plunging red-hot platinum into mercury) replaces the mercury in the ordinary form, the advantage claimed being greater portability.

Defects of Clark Cells.—One of the chief criticisms levelled against Clark cells in general, and the Board of Trade form in particular, during recent years refers to the inconstancy of the E.M.F. This may be experienced in two ways: (*a*) cells made up by different people with chemicals emanating from different sources are found to differ in their E.M.F.'s; and (*b*) cells made up by the same individual, which agree amongst themselves when new, are found to differ, in some cases very considerably, after

Digitized by Google

having been in use for some time. That the first want of agreement should exist is not very surprising, and points to the presence of impurities in the materials of which the cells are composed, the words "chemically pure" being capable of very wide interpretation. This cause of difference, nevertheless, is a very serious one, since not only is it impossible for all who wish to construct standard cells to obtain their chemicals from the same source, but there is no real assurance that the same standard of purity will be maintained for any lengthened period by the same manufacturer; thus, for instance, various manufacturers will supply, say, Hg_2SO_4, which they describe as being "chemically pure," and which may be so in so far that no other metal than mercury is present, yet the various samples will differ enormously in acidity; one sample may give no acid reaction, whilst another is strongly acid. This difference in acidity of the materials may in many cases account for the peculiar behaviour of the cells which are made up from them. The causes of the irregularities of E.M.F. in the second case are, if anything, still more serious on account of the difficulty of localising and removing them. In particular, it has been found that specimens of the Board of Trade cell cannot be relied upon to agree amongt themselves more closely than one part in 1,000 when freshly made up, and that after standing some time, even this agreement was not maintained, Cooper having found that cells which a week after construction had a mean error of 1 in 7,000, after 3½ years differed by 1 in 700, which is considerably more than the limit permitted in the Board of Trade specification. One of the causes of inconstancy in the Board of Trade cell which has been pointed out by Carhart is that the mercury is apt to come into contact with the zinc rod, which is not amalgamated, and thus alter the E.M.F. Local action may also occur where the zinc enters the paste, resulting in the amalgamation of the zinc. Another defect is that in consequence of the zinc sulphate solution being saturated at 30deg. C., ordinary fluctuations of temperature produce crystallisations and re-solutions of the $ZnSO_4$, thus setting up differences in density in the liquid at different levels, and in this way affecting the E.M.F. and favouring local action at the zinc rod. To overcome this latter difficulty Carhart introduced the Carhart-Clark cell, in which an asbestos plug separates the mercury salt from the zinc rod, whilst the $ZnSO_4$ solution is saturated at 0deg. C., so that at all ordinary temperatures there should be no $ZnSO_4$ crystals present in the cell, and consequently fluctuations in temperature will not cause differences in density in the solution. An objection to this modification has, however, been pointed out recently by Messrs. Spiers, Twyman, and Waters, who have shown that if an error of a few one-tenths of a degree be made in the temperature of saturation of the zinc sulphate solution, there will be a corresponding error of several parts in 10,000 in the value of the E.M.F. of the cell, and also that every time a current is taken from the cell a small quantity of zinc is dissolved, thus gradually increasing the strength of the $ZnSO_4$ solution. Another cause of variation in the Clark cell has been investigated by W. Jaeger. The normal $ZnSO_4$ crystal has the composition $ZnSO_4 + 7H_2O$; it, however, loses a molecule of water at 39deg.C., and becomes $ZnSO_4 + 6H_2O$. These two forms of $ZnSO_4$ possess different solubilities, and two cells made up each with a different form would have different E.M.F.'s. He also showed that if $ZnSO_4 + 6H_2O$ solution is allowed to cool slowly, it will not return to its original form, unless in contact with a crystal of the original form $ZnSO_4 + 7H_2O$. At 150deg. C. the difference in the E.M.F.'s of two such cells would amount to as much as 7 parts in 10,000, that cell made up from the $ZnSO_4 + 6H_2O$ crystals giving the lower E.M.F.

Temperature Coefficient.—In all forms of Clark cell the E.M.F. varies considerably with temperature, consequently not only is an accurate knowledge of the temperature coefficient necessary, but also an accurate knowledge of the temperature of the cell. The temperature in the ordinary forms of standard cell as supplied by instrument makers, is registered by a thermometer placed alongside the cell in the brass containing case. These thermometers are of two forms: a straight thermometer tube which projects up through the top case of the cell, and is, therefore, very liable to fracture; and the bent form, in which the tube is bent through 90deg. and lies along the top of the case cap. The great objection to this latter form is the tendency the mercury column has to break at the bend in the tube, and the great difficulty in getting it to join again. The position of the bulb inside the case is also open to criticism, since, on account of the difference in thermal capacity of cell and thermometer bulb, the former will not follow fluctuations of temperature anything like so rapidly as the latter, and there will always be uncertainty as to whether the thermometer really indicates the temperature of the cell or not, unless the cell has been kept at a constant temperature for at least half an hour before it is used. In the Rayleigh H-type of cell the temperature coefficient has been carefully measured by Lord Rayleigh for a number of different cells, and from the mean of the results the following correction for temperature has been obtained:

$$E_{t^\circ} = 1{\cdot}4345\ \{1 - {\cdot}00077\ (t^\circ - 15^\circ)\}.$$

Thus an error in reading the temperature amounting to 1deg. C. would correspond to an error ·08 per cent. in the E.M.F. In the Carhart-Clark cell the temperature coefficient is about one half of the above, the correction given by Prof. Carhart being

$$E_{t^\circ} = 1{\cdot}438\ \{1 - {\cdot}000387\ (t^\circ - 15)\},$$

the cause of the difference being the saturation of the zinc sulphate at 0deg. C. instead of 30deg. C. In the Board of Trade cell Ayrton states that, after having been set up for some time, the mercurous sulphate settles down, leaving a clear solution above, and should the zinc rod dip only into this clear solution and not into the paste, the temperature coefficient will be about half its normal value. Small alterations in the temperature of saturation of the $ZnSO_4$ solution also affect the temperature coefficient considerably. The Callendar crystal cell has a temperature coefficient practically the same as that of the Board of Trade cell.

(To be continued.)

GLOUCESTER ELECTRICITY WORKS.

On Thursday last week we attended, by invitation, the opening ceremony of the electricity works. The success of this opening was only marred by the great heat which was experienced on that day. The opening ceremony was held in the engine-room; the distinguished guests of the Electricity Committee and of Mr. Hammond took their position on the switch gallery. A number of speeches were then delivered, which we listened to until we heard Mr. Hammond descanting on the advantages from an architectural point of view of the temporary end of the engine-room. The temperature inside the engine-room inspired us with the desire to inspect the site for the extensions, and we finally found a cool corner on the top of the main flue. We learn from a local journal that the opening ceremony proceeded despite our absence. Thus after the Rev. Canon James had opened the proceedings with prayer, the chairman of the Electricity Supply Committee extended a hearty welcome to all those present. He proceeded to detail the history of the electric light undertaking, and called upon Mr. Hammond to give a description of the works. In this description Mr. Hammond explained his own capabilities of spending money, in which he was assisted by the inhabitants of Gloucester. The demand was so great that before the works were completed 15,000 lights had been applied for, and they had had to go before the Local Government Board for additional borrowing powers before all their first loan had been utilised. We gather that it is doubtful whether the extension of plant will not be actually running before the Local Government Board have "duly considered and granted" the application for additional capital. Mr. Clutterbuck then called on the Mayor to switch on the light, and, this having been done, the Mayor declared the works open. He expressed the hope that the electric lighting undertaking would be a great boon and blessing, being conferred on the whole of the

Digitized by Google

citizens. He trusted that the citizens would ever look upon the electric light as a mark of the progress and prosperity of the city of which they were all so proud. The opening proceedings concluded by a vote of thanks and tea, after which the visitors from London went into the crypt of the Gloucester Cathedral to get cool.

In the evening a banquet was held in the Guildhall, the host being Mr. Councillor Clutterbuck, the chairman of the Electricity Supply Committee; Mr. Robert Hammond, the consulting engineer; Mr. Harry A. Dancy, the architect; and the various contractors who supplied the plant, etc. A full toast list followed an excellent dinner, the Mayor, proposing success to the electricity undertaking, presented a gold watch to Mr. Clutterbuck as a token of the Council's appreciation of the valuable services rendered by that gentleman in his capacity as chairman of the Electrical Supply Committee. The Mayor also made the joke of the evening by suggesting that while Mr. Hammond had spent their money most economically, he did not think he had provided quite so many arc lamps as the guests would see on their way home that night. The electric lighting of the Guildhall, in which the banquet was held, was exceedingly brilliant, but the arrangement of the lights was not all that could be desired.

THE TELAUTOGRAPH.

We have this week seen, by invitation, at the offices of the British Telautograph Company the working of the above-mentioned instrument. We are, however, debarred at present by its inventor, Mr. Foster Ritchie, from publishing a technical description of the instrument, owing to the fact that patents for details have not yet been completed in certain countries abroad. The two illustrations we give herewith indicate in some way what results can be obtained by means of the instrument. Thus Fig. 1 is a record as written at the transmitting end, and Fig. 2 is the record received at the further end. Although we are not allowed to describe in detail the way in which the machine works, the following information will give a general idea of its principle. If an earth return is employed, two line wires are required between the sending and receiving station. The current in each of these line wires is varied by means of a rheostat, which is in series with the line wire and sending battery. The resistance of the rheostat is connected at frequent intervals to the small sections of a commutator in the form of a quadrant, and connection is made between this quadrant and the line wire by means of a fine brush. In connection with the pencil which is used to write the message to be transmitted are two connecting levers, which alter by a suitable mechanism the position of the two brushes bearing on the two quadrants or commutators. The levers which link up the pen to the brush gear are so devised that for any one position of the pencil of the paper, only one combination of positions of the two brushes on the two commutators is possible. In the receiving station the gear for recording is practically a duplicate of that for sending, except that the circular motion of the brushes on the commutator is reproduced by means of a moving needle of an enlarged D'Arsonval galvanometer. The position of one of the brushes on its commutator, of course, determines the current in the line wire connected with the same. Again, the angular position of the needle of the receiving galvanometer is determined by the current of the line wire, so that the linkwork on the receiving station exactly reproduces the motion of the linkwork connected to the pencil. At the point on the linkwork at the receiving station which corresponds to the pencil a recording pen is placed, which traces the message on the paper. It is very interesting to watch the movements of the pen when the operator, not used to sending on the machine, is considering what he will write. The success of these instruments is due to the perfection in detail. Thus the large-type D'Arsonval galvanometers used to move the recording pen are wonderfully dead-beat, and have little inertia in their moving parts considering the comparatively large force which they are capable of exerting.

The advantages of the telautograph are many, but the instrument is not intended in any way to replace the telegraph. It is rather a machine by which written instructions can be given to an agent at a distance, and for important communications involving an expenditure of money is decidedly to be preferred to the telephone. For instance, it renders it quite possible to prove the authenticity of the message from the fact that actual handwriting is reproduced, or, if need be, a clerk could be detailed to do the writing, and a member of the firm could sign the message as correct. Again, from the sender's point of view, a written record is kept of the instructions given, by which any tampering with the message afterwards could be prevented; also, all movements of the receiver being controlled by the sender of the message, it is not necessary that anyone be present at the receiving end, and if secrecy is required, the machine may be in a lock-fast cabinet. A list of the uses to which the machine could be put would be exceedingly tedious to our readers, but we are assured by the company that the orders already booked for the machines include a very wide range of commercial life. The company has secured a license from the Postmaster-General to use the machines on private lines erected by the Post Office or to be erected by that authority, but up to the present it has not the right to use the telautograph in connection with the exchange system of the National Telephone Company. We cannot up to the present obtain information as to the terms on which the instruments can be obtained, but we believe that at a very early date this will be forthcoming at the offices of the company, 97, Gresham-street, E.C.

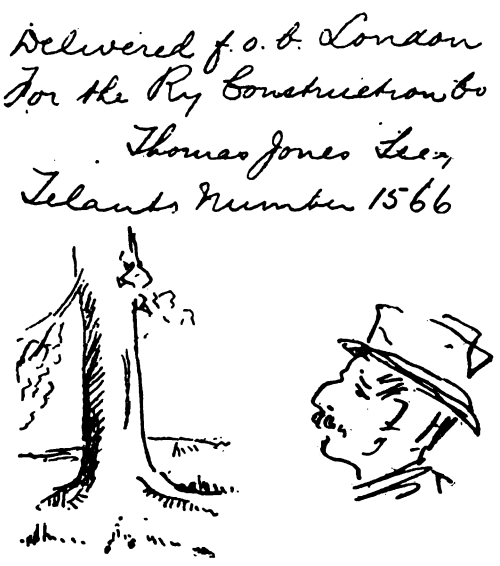


FIG. 1.—Writing and Sketch as Despatched.

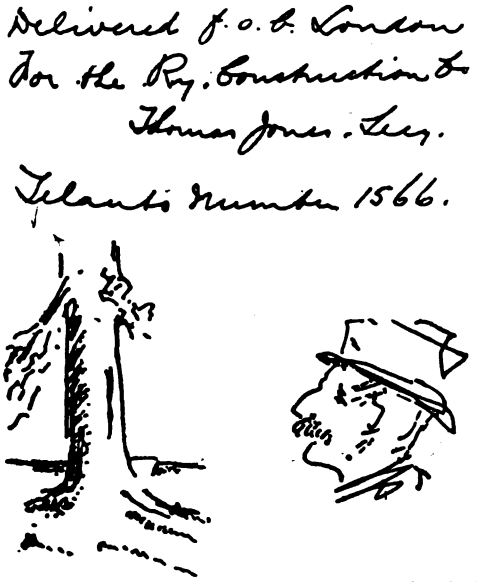


FIG. 2.—The Writing and Sketch as Recorded at the end of the line by the Telautograph.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

39-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	109	Alternating-Current Induction Motors	129
Southport Electric Tramways	114	Light Railways from a County Surveyor's Point of View	132
The Verband Deutscher Elektrotechniker	117	Legal Intelligence	135
The Paris Exhibition	118	Companies' Meetings and Reports	135
Standards of E.M.F.	121	Contracts for Electrical Supplies	138
Gloucester Electricity Works	124	Traction Notes	139
The Telautograph	125	Lighting Notes	140
Behind the Scenes	126	Hampstead Electricity Works	142
Correspondence	127	Hastings Electricity Works	142
The Power Bills	127	Provisional Patents	143
Some Notes on Enquiries for Engines	127	Traffic Returns	144
Questions and Answers	134	Companies' Stock and Share List	144
Proposed New London County Council Tramways	134		

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

BEHIND THE SCENES.

It is a little rough upon English business men to have it continually drummed into their ears that they do not know how to conduct business properly, that they must go to school again and learn from America, Belgium, Germany, and France how to do it. The fact is the speakers and writers who so harp upon our commercial position are of two kinds—first, those possessed of ignorance and credulity; second, those who have particular fads to run or fish to fry. The credulous folk accept the latest statement, whatever that may be, without a particle of doubt or any attempt to analyse in order to obtain the true conditions prevailing generally over the whole industry, their conclusions depending possibly upon those prevailing in one case alone. When, again, you hear a man condemning this, that, and the other, it is well to ask why. If he is an interested party, then enquire of the other side, and accept the truth as somewhere between the two extremes. Let us take a simple concrete example, interesting to many firms, and causing a wide divergence in tendering for this particular work. Because the amounts of tenders vary largely, surely till the matter is fully examined no one is justified in saying the heads of the various firms do not understand their business. The example we refer to is the capital cost of mains. So far as the cost of manufacture of cables is concerned, no doubt the various manufacturers know the cost of any particular cable to the fraction of a penny per yard; but what the contractors do not know, and what fluctuates almost beyond ordinary comprehension, is the cost of opening up and making good the paths and streets in the laying. According to our advices, the local authorities who usually "make good" and send in the bill to the contractors do not all act upon one system. In some cases, indeed, they expect and do make a profit. Now, the common-sense view of the question is that the local authority ought not to make a profit. They have to protect the interests of the ratepayers, and as the exigencies of installing the electric light include the breaking up of streets, it becomes their duty to see that the streets are left in quite as good a condition when the work is finished as they were before the work was commenced. No one who has not had experience in cable-laying can realise the varying cost per yard under the varying conditions, and the cost in the case of coterminous authorities when the conditions seem to be similar is often very different. It is hardly too much to say that the most experienced contractors for mains are compelled in their tenders to put down a sum for this purpose that is arrived at by rule of thumb. Sometimes they come out on the wrong side after making all allowances. Such, then, is this particular phase of business, and we contend that examination will often show that in other cases orders lost or gained are lost and gained by chance, and that the gain does not necessarily imply a profitable transaction, nor does it imply ignorance or inexperience on the part of those who are engaged in that particular industry or particular phase of an industry. We had

Digitized by Google

intended to discuss this question from one or two other standpoints, but perhaps we have said enough.

CORRESPONDENCE

"One man's word is no man's word,
Justice needs that both be heard."

THE RIVER TRIP.

SIR,—I have recently received from the Institution of Electrical Engineers a circular announcing the proposed arrangements for the entertainment of the members of the American Institute of Electrical Engineers who will be visiting this country during August.

It is with the deepest regret and concern that I note that the first item on the programme is a trip up the Thames on *Sunday*, Aug. 12! The hope is expressed that a large number of members and ladies will take part in the proceedings, in order that a "true British welcome" may be given to the guests!

Nominally, at any rate, this is a Christian country, and those who profess Christianity are supposed to at least adhere to the fundamentals of their religion. To keep the Sabbath Day is not only one of the most sacred obligations of Christianity, but it is quite foreign to all the traditions of this country for a public or a scientific society to give an entertainment upon that day.

Under the circumstances, therefore, it will scarcely be possible to give our American guests a "*true* British welcome." Fidelity to principle will, no doubt, keep many away, while probably some conscientious qualms may overtake a section of those who go.

I sincerely trust, however, that steps will be taken at once to remedy the matter, as, besides the foregoing reasons, it would be a deplorable precedent for the rest of the scientific societies, and it would undoubtedly cast a stigma upon the whole profession, in addition to bringing dishonour upon the country and involving our American *confrères* in the wrong-doing.—Yours, etc.,

A CHRISTIAN BRITON.

[While not wishing to start a discussion on religious subjects in our columns, we feel bound to give space to the letter above. The writer is a member of the Institution, and as such has the right to be heard on matters connected with the Institution with which he personally disagrees. As a number of the members will doubtless hold similar views respecting the keeping of the Sabbath, it is a great question whether the Council of the Institution of Electrical Engineers should not at least have made the Sunday excursion up the Thames a private function. At it is, they are offering our American guests hospitality in a way which is displeasing to a certain number of would-be hosts, and perhaps even some of the invited guests will abstain from the function for that reason. It is a matter on which the private opinions of every man are entitled to respect, and hence one in which unanimity is hardly to be obtained in any institution.—ED. *E. E.*]

THE POWER BILLS.

The consideration of the County of Durham, the Lancashire, and the Shannon Water and Electric Power Bills was entered upon on Wednesday by the committee of the House of Lords presided over by the Duke of Argyll. The Bills have already passed through all the stages in the House of Commons.

Mr. Balfour Browne, Q.C., Mr. Worsley-Taylor, Q.C., and Mr. Moon represented the promoters of the County of Durham Bill, which was taken first; and Mr. Fitzgerald, Q.C., and Mr. Lloyd appeared for the District Councils of Felling and Hebburn, who were the only opponents.

Mr. BALFOUR BROWNE explained to the committee the exhaustive character of the enquiry which had been held by Sir James Kitson's committee into the provisions of the Bills, and referred to the fact that the most important clauses which were introduced for the protection of the public and the local authorities were framed by the Government draftsman and put upon the several promoters by the House of Commons committee. He therefore asked their lordships to pass the Bill exactly as it left the other House.

Mr. FITZGERALD urged that the districts of Felling and Hebburn should be struck out of the proposed area of supply.

The DUKE OF ARGYLL, in announcing the decision of the committee, said they were of opinion that the Bill might proceed, with the exception of the clauses including Felling and Hebburn in the area of supply. Those clauses should be altered so that only wayleaves through those districts should be allowed. The Lancashire Electric Power Bill was then considered.

Mr. Worsley Taylor, Q.C., Mr. Pollock, Q.C., and Mr. Shaw appeared for the promoters of the Lancashire Bill. The opponents were the Corporations of Manchester, Liverpool, Bootle, Salford, Southport, and Bolton.

The learned counsel having explained the object and scope of the Bill, referred to the clauses which had been put upon the promoters for the protection of the public and of the local authorities by Sir James Kitson's committee. He urged that these clauses afforded every reasonable protection to the municipalities who were now petitioning against the Bill, and that they should not be allowed to refuse wayleaves to the company through their districts if and when it was desired to reach places beyond.

The consideration of the Bill was then adjourned till Thursday.

SOME NOTES ON ENQUIRIES FOR ENGINES.*

BY J. A. SEAGER, STUDENT.

The following are a few suggestions for guidance in enquiring for an engine, which will be found to obviate much unnecessary correspondence, and facilitate the delivery of a satisfactory steam unit. It is remarkable how many omissions can be made in a single enquiry, apparently due, not so much to carelessness, as to a misunderstanding of the requirements of the engine-builder. It would add greatly to the quality of the work done, besides cheapening the price and reducing the time of completion of work, if the requirements of the customer could be made to agree more closely with the standard practice of the engineers. The present notes are limited to main engines, such as those used for mill machinery, electric power plants, steamship propulsion, etc.

Horse-Power.—It seems almost unnecessary to say that the horse-power of the engine should be stated. The brake horse-power should preferably be specified. In arranging for belt or rope driving, as a percentage of power is lost in transmission, a 5 per cent. increase should be made to the calculated brake horse-power of the engine for short single drives, longer drives or multiple drives, of course, involving a greater percentage loss. It should be mentioned whether the driving is to be by rope pulley, belt pulley, or half-coupling for direct driving.

Steam Pressure.—I have seen a few enquiries for engines from which the boiler pressure has been omitted, although it is obvious that an engine cannot give the same power with low as with high pressure steam. If no boiler has as yet been installed, the engine-makers should be asked to state the most suitable boiler pressure. If the boiler is already laid down, its working pressure, less the loss of pressure along the steam-pipes (which may be from 5lb. in short, well-designed lengths, to as much as 15lb. in long or crooked arrangements), should be stated in the enquiry.

Speed.—The question of speed has an important influence, not only on the size of the engine, but often on the type also. For example, high-speed engines—*i.e.*, from, say, 350 to 600 revolutions per minute—are now usually built vertical, and often with their cranks, connecting rods, valve motion, etc., enclosed. With slower speeds, however, horizontal engines with large cylinders and unenclosed mechanisms are employed, or in situations where ground

* Paper read before the Institution of Electrical Engineers (Students' Section).

Digitized by Google

space is begrudged (as on shipboard and valuable ground), these open-type engines are built vertically. It is not always possible to give the engine-maker much latitude as to speed at which he may run his engine, but wherever possible he should be allowed to select his own, or, at the very least, be given some slight range to choose from, in order that he may put in a standard, and, therefore, cheap, size which will run economically.

Condensing.—Although an economy can be effected by the use of a condenser, an engine should not be changed over from an atmospheric exhaust to a condenser without one is sure that it is mechanically strong enough to stand the strains due to increased difference of pressure on the faces of the piston, and the greater mechanical force transmitted at the same speed. For this reason the engine-maker should always be informed whether a condenser is to be used or not. Two other reasons may be cited: The distributing valves would be set differently for the two conditions, and possibly a smaller engine could be put in if it were to run condensing. With large-sized engines it is often advisable to have a separate condensing plant for each engine, the pumps for which could either be worked by the main engine or by small auxiliary engines. It is preferable, however, to leave this point to the engine-maker's discretion.

Description of Site, etc.—It would be disappointing if, after the engine was delivered, it was found to be too large in one of its dimensions for the space provided for it. The client should therefore either send a dimensioned sketch of his foundations, if supplied, or of the site, and also the height to roof, travelling crane, or other obstruction; or he should ask the engine-maker to send an outline drawing giving the main dimensions of the engine when tendering. If the engine is to be erected inside a building, it would be well to make sure that there is a door or other convenient opening large enough to admit the engine when it arrives. A description of the site should always be sent. For example, it is of interest to the engine-maker to know whether his engine is to be placed on board ship or on a concrete foundation, for in the latter case only will foundation bolts and plates be required. If the engine is to be erected by the engine people above or below ground level, this must be mentioned, as special lifting or lowering tackle will have to be provided. Details should be given as to the nature of the approach to the site—whether by land or water. In the former case it should be stated whether there is a road suitable for heavy traffic leading to the site; in the latter, whether there is a craneage wharf handy, and in both cases whether there is a travelling crane or other suitable means for handling the engine on site.

Erection.—In the matter of erection, however, the client has the choice of three alternatives: (A) giving the engine-maker the order to erect the plant complete on foundations to be supplied by the client if they are requisite, and giving the above information in full detail; (B) asking the engine-maker to quote only for skilled labour in erecting, the client himself providing all rough labour, cartage, etc.; (C) the client undertaking to erect the engine on site himself, in which case he should ask for quotations f.o.r. or f.o.b. at the nearest railway station or dock. The first method is the most costly, but usually ensures good work. The last is perhaps cheap, and the result may be good or bad according to circumstances. It should be understood that only under exceptional circumstances and by special arrangement will engine-makers allow in their price for building foundations for the engines, or for any masonry, builder, or joiner's work required, or for any excavating, cutting away, or making good again. If such work is required, it must be definitely mentioned in the enquiry, and care should be taken to see that the engineer has bound himself to do the work.

Combined Plants.—For many purposes where small powers and high speeds are required, such as centrifugal pumps, fans, electric dynamos, etc., it is customary to supply a direct-coupled set mounted on a common bed-plate, thereby cheapening the cost of erection. In such cases the engine-maker will supply the base-plate with his engine, and will, if requested, receive the apparatus to be fitted at his works, couple the same to his engine, and deliver the complete set ready for erection on the foundations. As a matter of fact, he will often undertake to supply the combined plant complete, fitting his engine to suit the needs of the fan or dynamo to be supplied on receiving particulars of the work to be done by the plant. This method of ordering is recommended to non-expert purchasers, as it saves trouble for the client, and throws the onus of failure or defect entirely on the engine-builder.

Tools, Accessories, and Spares.—A clause should be included in the enquiry calling for all necessary tools, accessories, and spares. A firm of good reputation will put in a suitable set without further information, but as a check the following items (though not forming a complete list) should be looked for: a complete set of spanners on rack, to be kept on rack except when being used on the engine, and any special tools required; spare springs and rings for pistons, and, if needed, valves; set of main brasses and smaller brasses; eccentric strap and governor springs if required; barring gear, tachometer, steam pressure and (if running condensing) vacuum gauges, etc. Cans, tanks, and filters for oil are not usually supplied by engine-makers. It should be specially stated whether steam and exhaust stop valves are required with the engine, or whether they will be supplied with the pipework. Engine-makers cannot be expected to connect their engine to steam, exhaust, or drain pipes unless this was arranged before signing the order, and if connecting pipes or bends have to be placed between engine and main pipes, the position of the flanges on the latter with relation to the engine should be indicated when asking for a tender.

Nature of Load.—Different types of engines, equally high class in workmanship, are designed with varying intent. Some are meant to withstand severe shock, such as is experienced in rolling mills; others, such as are used in cotton mills and electric generating stations, are required to give very uniform speeds under varying loads; others, again, where fuel and water are expensive, are designed to give extremely low water consumption and high efficiency; still others, destined to be placed in populous localities or on slight foundations, necessitate a careful balancing of moving weights to reduce vibration. If any such special conditions exist they should be stated, so that the engineer may form an opinion as to whether heavy framework, Corliss valve gear, three-cranked shaft, etc., are applicable. It should be carefully stated whether the direction of rotation of the engine is to be reversible or not, unless the particulars given of the work to be done imply one or other of these conditions as essential. If the engine is always to turn in one direction, it should be clearly stated which direction would be preferable, as "the engine to run clockwise (or counter-clockwise), as seen from the end of the crankshaft next the coupling or pulley."

Steam Consumption and Efficiency.—Where steam consumption and efficiency are important, makers should be asked to state a guaranteed value for these in their tender at, say, full and half load. These values should be tested when the engine is built, either at the engine-maker's works or on site. In the former case the client is at liberty to see the tests carried out and verify the results himself, or he can have a signed certificate of tested results. In the former case it almost goes without saying the travelling expenses of the client are not included in the engine estimate, and it would be a breach of courtesy at least to claim from the engine-maker any sums spent in this way. If the tests are conducted on site, all fuel and water required for the test should be supplied by the client. It should be noted that the efficiency of an engine when new is generally some 5 per cent. less than when it has been running a short time, as the piston rings and bearings have not then come to a proper bearing surface.

Speed Regulation.—A point respecting speed regulation should be explained for the benefit of those who require very good governing. It is customary to test the action of the governor by suddenly throwing the full load off the engine, and expressing the increase in speed as a percentage of the original speed. This percentage will be guaranteed by the builder if required, and in good engines will not be above 3 per cent. But it is an instant or two before the governers will "get hold" of the engine after the load goes off, and the speed flies up possibly over 10 per cent. above normal. This excess of speed, though lasting only

Digitized by Google

a short time (at most 10 seconds with good governors), would be sufficient to burn out a high-efficiency electric lamp if the engine were driving a dynamo, or break the threads in a spinning machine if the engine were running a mill. For this reason, the percentage of instantaneous, as well as permanent speed variation, should be asked for, if there is good reason for so doing.

Time of Delivery. — An engine-builder cannot keep a stock of engines, except possibly in small sizes, so that a period must be allowed him to complete his order. Since time is money, the client should ask in his enquiry for a guaranteed time of completion of work, which will obviate any misunderstanding as to what constitutes a reasonable time of delivery, and will enable him to discriminate between a maker whose shops are already too full of work and one who can supply the necessary power, labour, and room to get the work through quickly. Such guarantees are, of course, given subject to delay due to strikes, lock-outs, accidents, or other causes not under the control of the engine-maker.

Although the above considerations by no means exhaust the points which have to be remembered in ordering an engine—it would be unfortunate for the consulting engineer if they did—yet if those mentioned were attended to, the confusion of ideas which is apparent in many enquiries would be lessened, and the chances of getting a satisfactory engine much increased.

ALTERNATING-CURRENT INDUCTION MOTORS.*

BY A. C. EBORALL, ASSOCIATE.

(*Continued from page 89.*)

Several firms, notably the Oerlikon Company, avoid the squirrel-cage construction altogether by winding the rotor with closed coils. In this case the rotor winding may either consist of a regular wave winding, taken all the way round either once or else several times and finally short-circuited, or better, of a number of coils, or groups of coils, separately short-circuited. Such wire-wound rotors are naturally more expensive than either of the forms described above, and are frequently difficult to wind, on account of the trouble experienced in handling the heavy conductors.

The employment of wound rotors and non-inductive starting resistances is, as already indicated, always preferable for motors of any size. Here the rotors are invariably wound with a three-phase star-connected drum winding, which may be carried out either with overlapping (rectangular) coils, or with two or four bars per hole or slot, arranged as a cylinder wave winding. The common junction to the three phases of such a winding is frequently the ironwork of the rotor. This is very convenient with motors of considerable size, where the conductors are usually massive. Star-connected bar windings of this character are always unsymmetrical, and "false connections" have to be made in each phase. A point to be remembered when designing wound rotors for high-tension motors is the fact that the rotor volts per phase—that is, the voltage between any two slip-rings at normal stator pressure when the brushes are lifted off and the motor is at rest—must be kept down to a safe value: this is because at starting, with all resistances in, the voltage across each resistances (and the corresponding two rings) may be sufficiently large to be a source of danger to the attendant, if the turns in the winding have not been kept down; moreover, there is some risk of arcing taking place. On the other hand, in no case must the number of rotor conductors in series be too few, especially if the motor is of large size, else the cost of the starting box becomes excessive, and, if this latter is mounted on a switchboard, the three heavy cables coming to the latter may become inconvenient to arrange for; moreover, the contacts on the box may give trouble. It may sometimes happen that it is desirable to regulate the speed of a polyphase motor (by means of the rotor resistance) at a point situated a considerable distance away from the motor. In such a case, and if the motor is for a low voltage, it may pay to arrange the rotor windings to transform up, as it were, in order to effect a saving on the cost of the three cables coming from the rings to the starting box, but this must not be pushed too far.

Although it is the standard practice with one or two firms to build the starting resistance within the rotor itself, instead of employing a separate starting box and slip rings, it would seem that the latter practice is the better. The advantage of doing away with the external arrangement consists, of course, in getting rid of the sliding contacts. On the other hand, it is easy for the short-circuiting device (whether operated by hand through the hollow shaft or automatically) to get out of order, inspection of the contacts is difficult, and, above all, the motor is brought up to speed abruptly because a sub-divided resistance is practically out of the question; consequently, the effect on the pressure regulation of starting a motor so fitted under heavy load is bound to be greater than if the motor had been fitted with an external graduated resistance, permitting of easy and gradual starting. However, several firms are now engaged in studying this detail, and considerable improvements may be expected shortly in the electrical and mechanical design of internal starting gear.

(C) *Notes on Performance and Design.*—An analysis of the guaranteed performance of a given line of open or semi-enclosed induction motors between 2 b.h.p. and 100 b.h.p. built by any of the best Continental or American makers, and whose construction is on the lines indicated above, may be set forth as follows:

1. No-load Current. Expressed as a percentage of the full-load current, the values for this will be as under:

	Poly-phasers. Per cent.	Single-phasers. Per cent.
For motors between 2-5 b.h.p. inclusive.....	30	40
,, ,, 7½-20 ,, ...	25	30
,, ,, 25-100 ,, ...	20	25

2. Overload Capacity. This is sensibly the same for all sizes with a given line of motors run at constant stator pressure, and will be as follows:

	Polyphasers.	Single-phasers.
For one hour*	50 per cent.	Varies considerably, but generally small.
Before falling out of step...	90 ,,	

3. Full-Load Drop of Speed (Slip). At constant pressure on the stator terminals this will be:

For induction motors between 2-5 b.h.p. inclusive, 7 per cent.
,, ,, ,, ,, 7½-15 ,, 5 ,,
,, ,, ,, ,, 20-40 ,, 4 ,,
,, ,, ,, ,, 50-100 ,, 3 ,,

4. Heating. The final temperature rise after a long continuous run at full load will not exceed 40deg. C. for semi-enclosed motors having outputs between 2 b.h.p and 25 b.h.p., and 300deg. C. for larger sizes.

5. Full-load Efficiency. For semi-enclosed motors with hot windings the values for five representative sizes will be as follows:

	2 b.h.p. Per cent.	5 b.h.p. Per cent.	10 b.h.p. Per cent.	25 b.h.p. Per cent.	50 b.h.p. Per cent.
Polyphase motors ...	75	79	85	87	90
Single-phase motors.	73	77	83	86	89

6. Full-load Power Factor. The values for this quantity for five such representative motors will be:

	2 b.h.p. Per cent.	5 b.h.p. Per cent.	10 b.h.p. Per cent.	25 b.h.p. Per cent.	50 b.h.p. Per cent.
Polyphase motors ...	78	80	85	87	88
Single-phase motors.	72	75	80	83	85

7. Weight per Brake Horse-power. The net weight per brake horse-power—that is, not including the weight of the rails, pulley, and starting resistance, if any—of the five representative motors designed and constructed on the above lines will not come out much below the following values:

	2 b.h.p.	5 b.h.p.	10 b.h.p.	25 b.h.p.	50 b.h.p.
Polyphase motors ...	80	58	56	40	40lb.
Single-phase motors.	115	88	66	62	62

NOTE.—The values given in Nos. 1 to 7 above are for 50-cycle motors at voltages of 110, 220, 440, or 500 volts, having the following number of stator poles per phase:

All motors between 2-7½ b.h.p. inclusive, four poles.
,, ,, ,, 10-30 ,, six ,,
,, ,, ,, 40-100 ,, eight ,,

The various values, however, for 40 and 60 cycle motors having the same number of poles are practically the same as those given above.

A standard line of induction motors constructed on the lines already indicated, and to which the above figures relating to performance apply, would have the following general technical data:

1. Peripheral Speeds. 4,000ft. to 7,000ft. per minute, according to the size of the motor.

2. Ampere-conductors per inch of stator (inner) periphery at full load.

B.H.P.	Ampere-conductors per inch.
2 to 7·5	250
10 to 30	330
40 to 100	430
100 to 150	570
Above 200	600

* Paper read before the Institution of Electrical Engineers,

* The temperature rise not exceeding 70deg. C. for semi-enclosed motors, and less for open-type motors.

Digitized by Google

3. Flux Densities per square inch. In the stator teeth :

B.H.P.	Maximum value of B.
2 to 7·5	65,000
10 to 30	70,000
40 to 100	80,000
Above 100	85,000

In the rotor teeth :

B.H.P.	Maximum value of B.
2 to 7·5	80,000
10 to 30	85,000
40 to 100	90,000
Above 100	100,000

In the air-gap the flux density should never exceed 30,000 lines per square inch. The flux density in the stator core is determined solely by the permissible loss, and does not otherwise affect the performance of the motor. The above figures give very good results for 50 ~ motors having partly closed slots for both rotor and stator. With motors for higher frequency, and for hole-wound stators and rotors, smaller values must be taken.

4. Current Densities per Square Inch. With low and medium pressure semi-enclosed motors the amperes per square inch in the stator windings at full load will be between 1,500 and 1,100, according to size, while in the rotor bars the current density will be about 15 per cent. higher. With high-pressure motors, somewhat smaller values must be taken in the stator on account of the relatively larger space taken up by insulation.

5. Length of Air-gap. This is always to be made as small as possible, and is determined wholly by mechanical considerations. Usual values for the length of air-gap—that is, the distance from iron to iron—are :

Rotor diameter.	Air-gap length.
Up to 4in. inclusive	1-100in.
Between 5in. and 8in. inclusive	1-75in.
,, 9in. and 12in. ,,	1-50in.
,, 15in. and 20in. ,,	1-32in.
,, 24in. and 32in. ,,	1-16in.
,, 40in. and 60in. ,,	1-8in.

Although the above figures relating to the design of induction motors have been taken wholly from practice, it is perhaps necessary to point out that it is not possible to apply hard-and-fast rules and constants when designing such motors—experience in designing and a large quantity of experimental data for the type in question are absolutely necessary if the best results are to be obtained.

Part II.—Starting Devices for Single-Phase Induction Motors and some Notes on Recent Developments.

It is not too much to say that more attention has been given to the question of starting devices for single-phase induction motors than to any other problem connected with single-phase working. The first difficulty was to get such motors to start at all ; then, after this was overcome, there came the question of reducing the heavy starting current ; finally, it was sought to so improve the starting device as to permit of the motor starting against load, still with a moderate current consumption. In the six years during which the subject has been before electrical engineers, successive improvements have taken place, and it is to the latest development in single-phase motors that the author wishes more particularly to refer in this part of his paper—namely, the new motor of Mr. Alex. Heyland. Before doing so, however, it may perhaps not be out of place to consider very briefly the underlying principles of all single-phase induction motors, although, of course, there is nothing new to be said on the subject in these days.

It has already been stated that a single-phase induction motor is nothing more than a polyphase motor running on one phase. Let, for instance, a two-pole two-phase motor be running from two-phase mains without load. Neglecting (as may quite well be done) the trifling power current required to make up the motor losses (under these circumstances practically only iron, ventilation, and friction), the current read on an ampere-meter in each phase is the "magnetising current" of that phase of the motor—that is, it is the wattless current required for driving the magnetic flux through the magnetic circuits of the motor ; further, the speed is synchronous. Now let one phase be switched out. The motor will go on running as a single-phaser at practically the same speed, but the ampere-meter in the remaining phase will read approximately twice the current that it did before—that is, the magnetising current in this phase has doubled. What has happened is briefly as follows : The magnetic flux originally provided by the switched-out phase is now replaced by a flux of approximately the same value and relative position furnished by a magnetising current in the rotor. Magnetising currents are called into being in the rotor, induced by the magnetic flux of the phase still connected to the mains, and in quadrature with this flux with regard to time, and these currents are carried round nearly 90deg. in space by the practically synchronous rotation before reaching their maximum. Thus the cross-flux produced by them has very nearly the same effect as that formerly produced by the switched-out phase. The magnetising current in the rotor has, of course, to be balanced by a corresponding stator current, so that the ampere-meter reads the magnetising amperes of phase 1, plus the magnetising amperes of the rotor transferred to the winding of phase 1. Hence the magnetising current in the latter approximately doubles.

With this perfect motor running at synchronous speed, it would be found that a voltmeter connected to the terminals of the switched-out phase would give a reading equal to the pressure on the mains from which phase 1 is running. This E.M.F. is that induced by the cross-magnetisation of the rotor magnetising currents, and is in quadrature with the impressed E.M.F. of phase 1, as already stated. In commercial motors the E.M.F. of phase 2, measured in this way, is not quite equal to that of phase 1. The magnitude of the difference between the two voltages is a measure of the quality of the design of the motor. It has been said above that the motor continued to run as a single-phaser at practically the same speed. In reality the speed is a trifle less, the difference being too small to detect on a counter, owing to the fact that the rotor currents cause a slight slip, so that even a single-phase motor without friction and ventilation losses (unlike the polyphase motor) cannot run at a synchronous speed at no load.

Of course, as the rotor is loaded, the rotor power currents called into being by the load are magnetically balanced by corresponding stator currents (when the rotor and stator coils are coaxial, or approximately so), and the slip increases—that is, the speed departs more and more from synchronism. Owing to this latter circumstance the induced rotor magnetising currents are carried round in space less than 90deg. ; the cross-magnetisation produced by them is accordingly shifted from the most effective position, until with continually-increasing load there comes a point at which the torque due to the cross-field and the rotor load currents attains a maximum value—if this value is exceeded the motor pulls up. When the rotor is stationary the cross-magnetisation is reduced to zero ; there remains now only the one flux of the phase connected to the mains (phase 1), and this flux cannot possibly produce a torque—that is, the motor cannot start—because its axis (that is, the axis of the exciting coils of phase 1) coincides with the axis of the current-carrying coils of the rotor.

In order, therefore, to enable a single-phase induction motor to start at all, an auxiliary starting field must be created that will do exactly the same thing as the rotor magnetising currents do at synchronous speed—that is, with regard to space, a magnetic flux must be established in quadrature with the principal flux inducing the rotor currents ; and with regard to time, this auxiliary flux must coincide with the rotor load current—that is to say, it must be approximately 180deg. behind the corresponding stator current. Every single-phase induction motor must, therefore, be provided with a device to produce a suitable cross-flux in the air-gap, and the amount of starting torque available will depend purely upon the value of this cross-flux, and upon the effectiveness of its time relations as stated above.

All single-phase induction motors are provided with starting coils wound in the useless winding space of the stator. They rarely occupy more than one-third of the total stator winding space, and frequently less ; moreover, these coils are invariably so arranged that the magnetic axis of each coil is in quadrature to the magnetic axis of the corresponding running coil—a disposition exactly fulfilling the "space" requirement stated above. A notable exception to this disposition is the arrangement that has been used for many years by the Swedish firm of Wenström for their small single-phase motors, which have the starting coils "staggered" from the position indicated here. The difference existing between the various starting devices lies mainly in the various methods of producing the requisite phase relation of the cross-magnetisation.

With the exception of the Heyland motor, all the devices employed for producing this requisite phase difference are external to the motor, and they have all been devised at one time or another by Mr. C. E. L. Brown, and have gradually been adopted by all other single-phase motor builders. These external starting devices take the special form of arranging that the self-induction of the current, including the starting coils, has a much higher value than that of the circuit containing the running coils, this being attained by suitable winding proportions in conjunction with choking coils or non-inductive resistances or condensers, or any two of these in one or other of the stator circuits. The choice of such apparatus is governed by the relative value of the turns in the starting and running coils, and by the particular connections used at starting.

The starting torque given by motors arranged in this way is inconsiderable, barely sufficient, in fact, to run the motor up to speed against the load of belt and loose pulley. Moreover, unless the motor is very carefully designed—particularly from the magnetic leakage point of view—the starting current at this small torque will be excessive. With the above-named exception, the very best single-phase induction motors of the present day working under the most favourable conditions

Digitized by Google

require a current at starting at least equal to the full-load current in order to run them up to speed without the load, while against the full load they will not start at all, whatever the value of the starting current.

The principal reasons for these comparatively indifferent results are, that the phase difference at starting produced by the above-mentioned means is small, and that the cross-flux produced by the starting coils does not attain a high value. As with independent alternating-current circuits a large phase difference will be produced by increasing the self-induction of the circuit, it might be thought that this could also be obtained in a motor by arranging the starting device and starting coils on these lines. But it must be remembered that the stator circuits of an induction motor are not really independent, on account of the action of the rotor currents. These behave

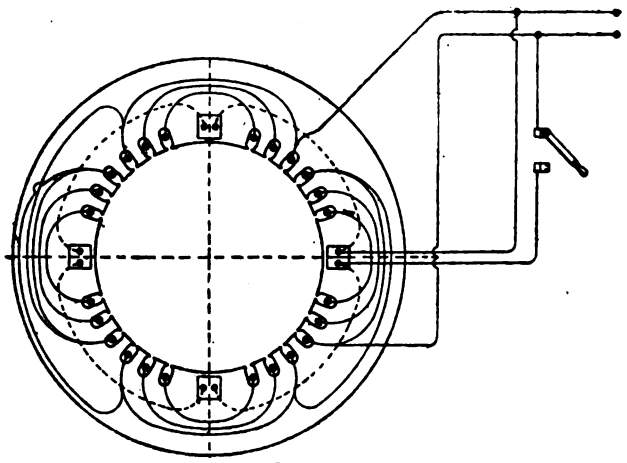


FIG. 7.

with regard to the stator currents just as the loaded secondary of a transformer behaves with regard to the primary—that is to say, the self-induction of the stator windings is more or less completely wiped out by the mutual induction of rotor and stator. It follows from this that better results will be obtained if the number of turns of the starting coils is kept low, and the increase of self-induction produced by an external choking coil, or equivalent device involving magnetic leakage. This point was recognised at an early stage by motor builders, and an external choking coil (to produce as much phase difference as possible) is a leading feature of several modern starting devices.

But this increase of self-induction, whether produced externally in this way, or by winding the starting coils with a large number of turns, effectually prevents the starting field of the motor—that is, the field in quadrature position to that of the stator running coils—from attaining that high value already shown to be absolutely necessary if a large starting torque is required. Where the self-induction is increased by increasing the turns of the starting coils, the strength of the cross-flux falls off inversely as the square root of the self-induction. If the choking coil is used, the strength of the cross-flux is diminished by an amount equivalent to the leakage flux of the coil, consequently it is evidently a clear fundamental point that to obtain a large starting torque the self-induction of the starting coils should be kept down as much as possible.

It has been hitherto generally held that the design of starting devices for single-phase induction motors should be such that the starting conditions should approximate as nearly as possible to the starting conditions of polyphase motors—that is, designers have aimed at the production of a rotary field at starting. Not only this, but every effort has been made to make this field as uniform as possible, by so proportioning the windings of starting and running coils as to produce two equal magnetic fluxes, and the production of a larger field by one or the other winding has been particularly avoided.

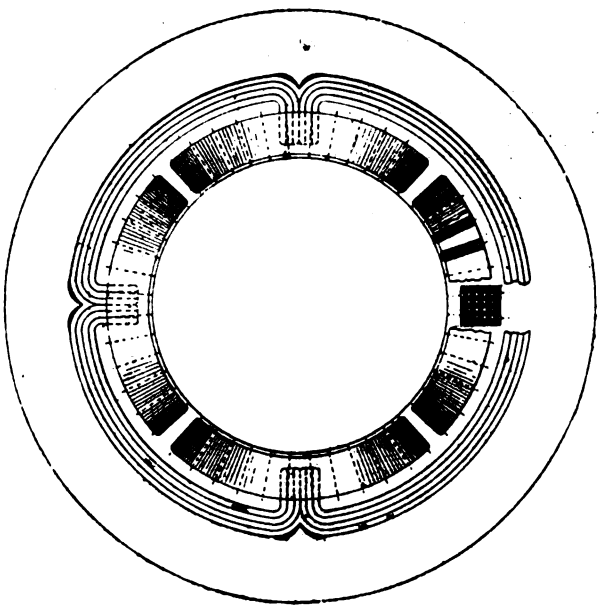


FIG. 8.

Mr. Heyland's motor, which is shown here to-night, and described below, is designed with regard to the starting device on exactly opposite lines to these. Briefly, there is no external phase-shifting device, the starting winding being put straight on the mains, and this winding has comparatively few turns, and is so arranged that under all circumstances its self-induction is less than that of the running coils—that is, the winding carrying the current of greater phase difference is made to have the smaller self-induction. As a result of the small self-induction of the starting coils, a cross magnetic flux of great strength is available, and this cross-flux is made to have the proper time relation by a special arrangement of the magnetic circuit of the stator. The production of a rotary field at starting is not aimed at, the whole idea of the starting device being to produce a powerful alternating magnetisation having the proper phase relation, in a direction (considering the two-pole case) at right angles to the axis of the running coils. The result is, that the Heyland single-phase motors will all start against full load quite easily, without an excessive current consumption, and it will be therefore readily admitted that an important advance has been made in single-phase motor work.

Apart from the design and arrangement of the starting device,

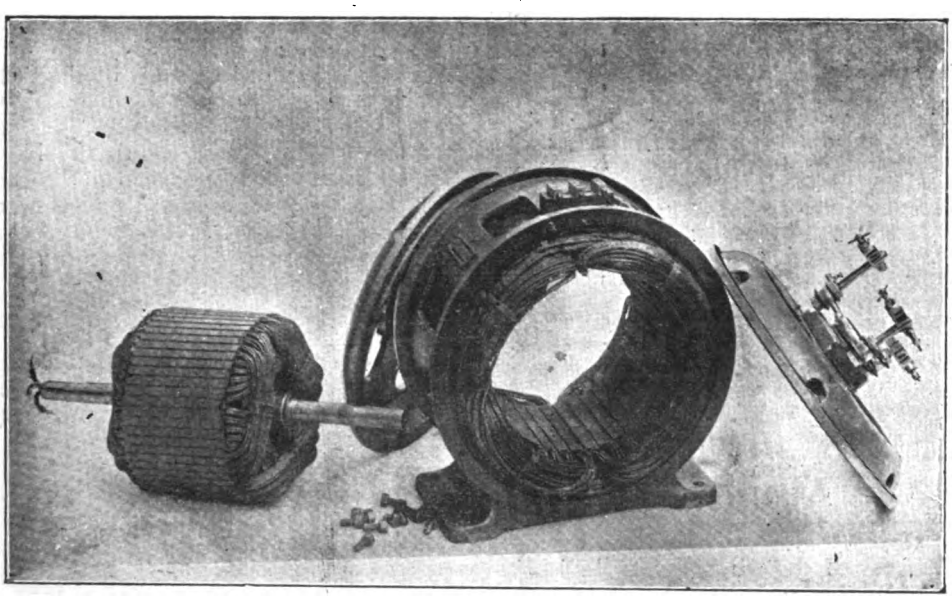


FIG. 9

Digitized by Google

the Heyland motors differ but little from other well-designed motors of the induction type. The stator running winding consists of a number of rectangular coils wound in half-closed slots in such a manner that magnetic leakage is as small as possible, while the rotor is wound with a regular three-phase star-connected winding, with its three free ends connected to slip-rings on the shaft, for the insertion of a starting resistance. A squirrel-cage rotor, or one of its modifications, could be easily used, but it has been found that the reduction of the starting current (for a given torque) brought about by the use of the resistance well repays its use, even for motors as small as 1 h.p.

Fig. 7 illustrates diagrammatically the stator windings of the Heyland single-phase motors, the figure illustrating a four-pole motor. The running coils are shown by the full lines and the starting coils by the dotted lines. These latter coils are wound in rectangular holes in order to obtain the necessary large phase difference of the current in them; the flux produced by these coils link very unfavourably with the rotor windings, which has the effect of reducing the mutual induction of the circuits in question, with the result that the current in the starting winding lags considerably, sometimes as much as 50deg.

Figs. 8 and 9 show clearly the arrangement of the stator running and starting coils as actually carried out for a four-pole motor, while the form of the rotor winding can be seen from the latter figure also. The motor is started as follows: all the rotor resistance being in circuit, the stator windings (both running and starting) are switched directly on the mains; the motor will immediately start up with great torque, and the rotor resistance and starting coils are to be cut out as it does so. The exact moment at which the latter are cut out affects only the starting current: if the motor is starting light, the single-pole switch can be opened when the arms of the rotor resistance are on the second contact; if it is starting against full load, the starting coils require to be left somewhat longer in circuit—that is, they are to be cut out, for instance, on the fourth or fifth contact of the starting resistance. The earlier Heyland motors were all furnished for use with a single-pole switch in the starting circuit. This has now been done away away with, however, by combining it with the starting resistance box (see Fig. 10), so that the operation of starting up is as simple as that with a shunt-wound direct-current motor.

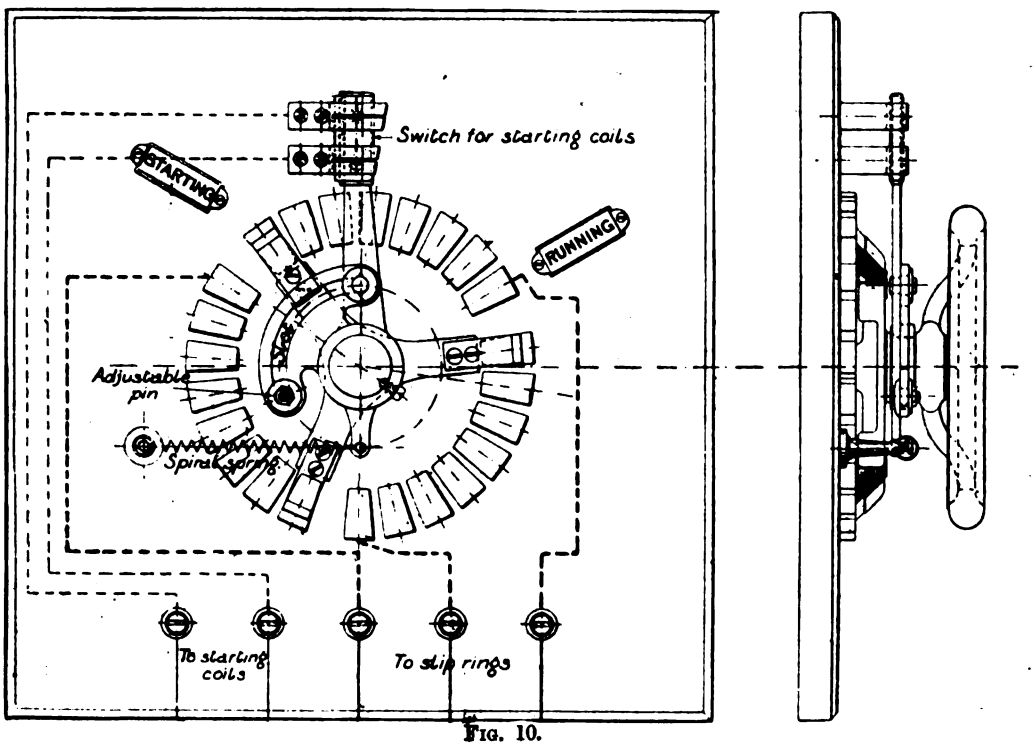


FIG. 10.

(To be continued.)

LIGHT RAILWAYS, FROM A COUNTY SURVEYOR'S POINT OF VIEW.*

BY H T. WAKELAM, A.M.I.C.E., COUNTY ENGINEER AND SURVEYOR OF MIDDLESEX.

In submitting the short paper invited by the secretary of the association, the author would state that amongst the many additional duties which have devolved upon county surveyors since the inception of county councils, on the passing of the Local Government Act, 1888, nothing has come under his notice of greater importance than the formulation of a light railway scheme under the Light Railways Act, 1896. In March, 1899, the author was asked by his Council "to consider in what way the County Council may, in the interest of the county at large, avail itself, as promoter, of the provisions of the Light Railways Act, and to prepare a scheme for that purpose accordingly." On giving the matter full consideration, the Parliamentary Committee of the Council was satisfied with the feasibility of such an idea, and of its proving a great success, both from a workable and financial point of view.

It will be remembered that the Tramways Act of 1870 confers no power by which county authorities may promote Tramway Bills in Parliament, and therefore the Light Railways Act of 1896 is the only legislative measure under which such authorities may seek power to construct lines, or, in other words, tramways. Such power being obtained under an order from the Light Railway Commissioners after a public enquiry has been held by them; the order having to be formally confirmed by the Board of Trade before it comes into operation. By the Public Health Act, 1848, all England, town and country alike, was for the first time brought under defined sanitary supervision, fairly comprehensive and complete. By the Public Health Act, 1875, advances were made in several directions, when urban and rural sanitary authorities received permanent recognition. The functions of each were gradually developed until 1888, when county councils were constituted by the Local Government Act.

There are now existing, as the result of the Local Government Acts, 1888 and 1894, three principal units of local government—viz, (*a*) county councils; (*b*) district councils; (*c*) parish councils. The term "county council," as you are all well aware, applies to the governing body of a county, and to any borough having a greater population than 50,000. Up to the passing of the Local Government Act, 1888, 15 Acts dealing with highways had been passed, commencing with the general Act, 1835. The Public Health Act, 1875, vested the powers and duties of surveyors of highways and of vestries, given under the Highways Act of 1835, in the urban authority. The Highways Act, 1878, abolished turnpike roads, and for the first time the county authority (then the justices sitting in quarter sessions) was called upon to contribute towards the cost of the upkeep of main roads. Section 11 of the Local Government Act, 1888, prescribes that all main roads shall vest in and be repaired by the county authority, unless district councils claim to retain power to carry out repairs requisite to the main roads lying within their areas, under which circumstances the county council shall pay the

* Paper read before the Incorporated Association of Municipal and County Engineers.

Digitized by Google

reasonable cost incurred. County councils, therefore, may rightly claim to be the authorities most interested in the upkeep and welfare of the main roads. The council the author has the privilege to serve, in an official capacity, was the first, and seems to be the only county authority, other than county boroughs, and the County Council of London, that up to the present has prepared an entire scheme and has sought to obtain orders from the Board of Trade to construct light railways, and to become primarily the tramways authority of the county.

The population of Middlesex has increased by leaps and bounds during recent years, and such a vast increase may be put down to: (1) the semi-metropolitan character of the county; (2) the lowness of rates; (3) the good administration of the various authorities; and (4) a gradual exodus of people caused by the acquirement of what were residential blocks in London for conversion into business premises. The great increase of population referred to has been the cause of speculative companies promoting the numerous applications for orders submitted to the Board of Trade, to empower the said companies to construct so-called light railways along the main roads. The introduction of electricity as a cheap motive power has no doubt also been a great factor in the promotion of the increased number of applications.

The County Council of Middlesex has always consistently opposed company-controlled undertakings, as being in direct opposition to the interest of the county at large. It is felt that the main roads are costly to maintain, and that the large profits that accrue from tramway undertakings should be enjoyed by the ratepayers, whose property the roads are, and that the lines of communication should not be given up to private companies. When it became known that the Board of Trade had determined to stand by their interpretation of the term "light railway," means presented themselves by which the county could be benefited; such an interpretation having already given a private company about six miles of tramways in the western portion of Middlesex at a much less cost than tramways could have been promoted. This also relieved the company of the restrictions placed upon tramways with regard to purchase by Section 43 of the Tramways Act, 1890. On the recommendation of its Parliamentary Committee the County Council of Middlesex decided by resolution to become the light railways authority, and adopted the author's scheme, which has a total length of about 103 miles, of which certain sections have already received the approval of the Light Railway Commissioners. The sections of the scheme already approved are entirely devoid of speculation, and will become a source of assured income from the date of their completion, owing to the terms of an agreement already settled with a company prepared to lease the lines. The Council have determined to construct the railways, but not to work them at present. Arrangements for leases to private companies will probably be made. It is considered advisable to do this instead of creating a special department to deal with the matter. Whatever its disadvantages, a lease, settled upon a profit-making basis, is less risky than forming a department entirely devoted to the supervision of a tramway system. Ratepayers may satisfy themselves that there is nothing speculative about an undertaking worked on such lines.

Middlesex may truly be termed semi-metropolitan in character, and it is of the utmost importance that as many travelling facilities as possible may be given to the enormous number of people who, more or less, live in the county of London, but sleep in the county of Middlesex. With this object in view the author's scheme included all the main arteries, so that direct communication may be had with, and running powers arranged over, any lines the County Council of London may construct. It was seen that grave difficulties would arise in creating a thoroughly workable and efficient system if the provision of light railways and tramways were left in the hands of private companies, and also if the local authorities promoted short lengths within the areas of their respective districts. These difficulties were also anticipated by such far-seeing men as the chairman of the Hornsey District Council and other representatives of local bodies, and projected railways within their districts were dropped in favour of the county scheme directly the extreme value of the latter was appreciated. Its inception and accomplishment are due to the foresight and energy of the very able and much-esteemed chairman of the County Council—Mr. R. M. Littler, C.B., Q.C. There is no doubt that, for advantages and convenient working, a uniform system under one authority is eminently the one to be desired. It appears to be the general opinion that county councils should take the place of private companies in light railway or tramway undertakings, and so relieve the ratepayers as much as possible of the cost they have to bear in maintaining their main roads. Light railways and tramways are, no doubt, a source of considerable profit, otherwise private companies would not so readily grant such concessions as those already offered by them in some parts of the county of Middlesex. There is no law by which companies can be compelled to cleanse and water the tracks laid down; and therefore, although the control of the track repair devolves upon the company interested, the cost of scavenging and watering devolves upon the Council, and it seems unfair to the ratepayers to allow speculators to take possession of what no doubt is, in most cases where the lines are laid, a source of considerable income to the promoters. It is seen that if companies can pay such large dividends and make such concessions as have been offered by them in various directions, the County Council of Middlesex may have very strong faith in its contemplated projects.

The effect of any county council becoming the light railway or tramway authority will be to enable that council not only to place at the disposal of the inhabitants within its area the best possible cars that can be purchased, and which can be kept free from the hideous advertisements and disfigurements which are invariably associated with company-controlled undertakings, but to provide cross-connections, which a company working solely for profit would not entertain. A county scheme can insure uniformity of rates and fares throughout the system. Cheap trams for workmen can be conveniently arranged and insisted upon. Cleanliness of the cars can be assured. A thorough system of supervision to ensure comfort in travelling can be instituted. The whole of the materials employed, the method of construction, and the positions of street standards can be prearranged with the district councils interested, without reference to the Board of Trade under arbitration clauses. Stopping places can be more conveniently arranged, after the due consideration necessary has been given to insure the requisite facilities for the ordinary road traffic—which is oftentimes altogether overlooked by private promoters. Regulations for rates of speed and punctuality can be framed and enforced, and fares for travelling on bank holidays, etc., can be definitely settled. The latter is a most important point—companies invariably charging exorbitant fares on these occasions. Double and single tracks can be laid, whichever appear most suited to the road widths, without large expenditures being cast upon the exchequer of the county by having to contribute to local widenings necessitated by companies carrying out short sections to the advantage only of the people resident in one or two districts, and not to the county as a whole. Private companies, as a rule, go for the "plums," which in a county scheme can be put in with the "paste," and still create a paying scheme and give greater advantages to the public than company-controlled undertakings are likely to give. Intercommunication, as already stated, can be provided, which with small schemes would be practically impossible; and last, but not least, equal benefits would accrue to the whole county, the profits, which undoubtedly would be reaped from such an undertaking, going towards the relief of the county rate.

There are many more minor considerations in favour of a county scheme that might have been treated, but as the secretary desired a short paper only, it has been the aim of the author to confine himself to the most important points, and to be as concise as possible in his remarks.

It is contrary to public policy to grant monopolies over main roads, and, therefore, if the latter are to be used for the purpose of light railways, the system laid down should, in the author's opinion, be as far as possible a complete one, and should be carried out by an authority representing

Digitized by Google

equally the interests of all districts within the area to be dealt with—in other words, the county council.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

291. I have a line shaft from which are driven various machines. This shaft is driven by two exactly similar motors, one at each end. An ampere-meter is in circuit with each. I note these two never read alike, but vary sometimes by 25 per cent., first one and then the other being the higher. How do you account for this?—M.

292. If a company supplying at 100 volts charge a dearer rate in the night time than in the daytime, would it be possible to charge two batteries of 55 cells each in parallel in the daytime and put them in series for part of the night time so as to make the meter rotate backwards, and so wipe out part or all of the record of the energy consumed at the dear rate in the earlier part of the night?—J. C. R.

ANSWERS.

Question No. 285.—In applying the pressure test to transformers, say with 6,000 volts between the primary winding and the secondary winding, core, and earth shield, and with 2,000 volts between the secondary winding and the core and earth shield, what reason is there for joining the primary winding to core and shield in the latter case?

Best Answer to No. 285 (*awarded* 10*s.*).—I gather from the question set by "C. W." that in the case before him there were two pressure tests made. In the first of these the secondary winding, the core, and the earth shield were all coupled together and 6,000 volts applied between them and the primary winding. In the second test the primary winding, the core, and the earth shield were coupled together and 2,000 volts applied between these and the secondary winding. The question in the mind of "C. W." seems to me to be as to why it is at all necessary to connect the primary winding on to the earth shield and core in the last test. Of course, in the previous test a voltage between the primary and secondary winding would have to be successfully borne of three times the value in the last test. At first sight it would seem, therefore, that it was quite unnecessary to couple the primary and core together, and I should not think that the conditions are likely to arise which would cause the transformer to break down on the second test. There is, however, in connection with all alternating-current apparatus a curious phenomenon known as "sparking across." This sparking across, or static discharge, occurs over distances corresponding to a voltage very much higher than anything which is applied. I have never seen a good explanation of this phenomenon, but should say that the coupling in the last test of the primary winding to the core is made with the object of ascertaining if under these conditions 2,000 volts will set up such a "sparking across" from the secondary winding to the primary and core. These static discharges do not, I believe, cause any appreciable waste of energy, but they are apt to heat up the path by which they travel, and in time to cause a complete breakdown in the insulation.—P. T.

Question No. 286.—Should high-tension mains for, say, 6,000 volts be laid in cast-iron troughs in preference to wood? And if so, why?

Best Answer to No. 286 (*awarded* 10*s.*).—This question evidently relates to a pitched-in system of mains. The voltage is extra high pressure, and the Board of Trade is very keen on using iron for this class of work. The answer depends principally upon the type of main to be used, bearing in mind that in anything like equal sections, creosoted wood is cheaper than cast iron, is almost as durable, but does not afford such protection from violence, and has not the quality of conducting leakage currents to the confines of earth. It is assumed that either lead-covered, concentric, or twin cables would be used, and that the lead covering would be metallically connected across the joints and to the outer or earth potential main at the generating station. In this case it would remain an open question to be settled by the comparative costs of, say, $\frac{3}{4}$in. creosoted timber and $\frac{1}{4}$in. cast iron in the particular district to be used. The durability and protectibility factors at that thickness are about equal, and the conductive effect not necessary. Where lead covering is not employed the conditions would not alter for concentric cables, but for a twin cable an iron trough would have to be used, in case an excavator's wedge came through and stirred up either cable. In this event the current would go to earth *viâ* the wedge and the trough, which would require to be bolted together at all joints, and connected to earth-plates at judicious intervals, to guard against rushing effects at bolted joints. Inductive effects are not considered, as with either twin or concentric cables they are imperceptible.—J. H. C. B.

PROPOSED NEW LONDON COUNTY COUNCIL TRAMWAYS.

We herewith give a list of the 28 new lines which, as mentioned in our notes, the Highways Committee of the London County Council are at present considering:

NORTH OF THE THAMES.

Archway Tavern (tramways terminus) to the county boundary in Archway-road.

Seven Sisters-road (existing lines), *viâ* Amhurst-park, to Upper Clapton-road (existing lines).

Mildmay-park (existing lines), westward, to Balls Pond-road (existing lines).

Harlesden (near the county boundary), *viâ* Scrubbs-lane, Wood-lane, Shepherd's Bush-road, Brook-green-road, and Fulham Palace-road, to Putney Bridge.

Uxbridge-road (near the railway station), *viâ* Richmond-road, Netherwood-road, and Westwick-gardens, to Shepherd's Bush-road.

Brook-green-road, at its intersection with Hammersmith-broadway, *viâ* that thoroughfare to Glenthorne-road (London United Tramways).

Victoria-embankment (Blackfriars end), *viâ* Victoria-embankment, Victoria-street, Buckingham Palace-road, Commercial-road, Bridge-road, and Chelsea-embankment, to the northern end of Battersea Bridge.

Battersea Bridge, *viâ* World's End-passage, Chelsea-embankment, New King's-road, King's-road, and Putney Bridge-approach, to and over Putney Bridge.

Hampstead-road (tramways terminus), across Euston-road and along Tottenham Court-road, to a point near Oxford-street.

Theobald's-road (tramways terminus), *viâ* Vernon-place, Bloomsbury-square, Hart-street, across Oxford-street, and along Shaftesbury-avenue, to Cambridge-circus.

Farringdon-road (present line), along that thoroughfare, to the City boundary.

Victoria-embankment, over Westminster Bridge, to Westminster Bridge-road (London County Council's tramways terminus).

Chelsea Bridge (north end), *viâ* Grosvenor-road, to a point near Lambeth Bridge.

SOUTH OF THE THAMES.

York-road, Wandsworth (South London Company's lines), *viâ* the new street in course of formation between York-road and Red Lion-street, along Red Lion-street, across High-street, along South-street, Garratt-lane, and Defoe-road, to High-street, Tooting (London County Council's lines).

St. John's-hill (South London Company's lines), *viâ* Strath-terrace, Bolingbroke-grove, and Bellevue-road, to the Surrey Tavern, at the junction of that road and Trinity-road.

Battersea Park-road (South London Company's lines) along Albert-road to the foot of Albert Bridge.

Camberwell-green (London County Council's lines), *viâ* Denmark-hill, Champion-park, Grove-vale, Lordship-lane, and London-road, to Devonshire-road, Forest Hill.

Goose-green, *viâ* East Dulwich-road and Peckham Rye, to the junction of Hall-road and Stuart-road, Peckham.

Digitized by Google

Southwark-street (South London Company's lines) at Hop Exchange Corner, *vid* Southwark-street, Stamford-street, York-road, and across Westminster Bridge-road, thence (single line) to Lambeth Palace-road (same company's lines), and returning *vid* Stangate over a proposed connection (No. 22), between London County Council's lines and the company's lines near Westminster Bridge-road.

Waterloo-road (London County Council's tramway terminus), along that road, to a point opposite York Hotel.

JUNCTION LINES.

Westminster Bridge-road (London County Council's lines), *vid* St. George's-road, to Lambeth-road (South London Company's lines).

Westminster Bridge-road (London County Council's tramways terminus) to terminus at Stangate (South London Company's lines).

Newington-causeway (London County Council's lines), *via* Dantzic-street, to Southwark Bridge-road (South London Company's lines).

Newington-causeway (London County Council's lines) to Borough-road (South London Company's lines), at junction with Southwark Bridge-road.

Newington-butts (London County Council's lines) to St. George's-road (South London Company's lines).

St. George's Church (London County Council's lines), *via* Marshalsea-road, to Southwark Bridge-road (South London Company's lines).

Great Dover-street (London County Council's lines) to Bermondsey New-road (London, Deptford, and Greenwich Company's lines).

Old Kent-road (London County Council's lines) to St. James's-road (London, Deptford, and Greenwich Company's (lines).

LEGAL INTELLIGENCE.

THE LONDON COUNTY COUNCIL v. THE NATIONAL TELEPHONE COMPANY.

In the Queen's Bench Divisional Court on Tuesday, before Mr. Justice Kennedy and Mr. Justice Darling, the case of the Attorney-General at the relation of the London County Council, and the London County Council against the National Telephone Company, came on for hearing. The London County Council claimed (1) a declaration that the company was not entitled to lay any pipes, wires, cables, or apparatus for the purposes of telephones under any of the streets in the county of London unless by license of the Postmaster-General under the Telegraph Acts, and with the consents required by those Acts; (2) an injunction to restrain the company, its officers, servants, and agents from opening or breaking up any street or public road within the meaning of the Telegraph Acts within the administrative county of London, or any part of such street or road for the purpose of extending the company's present system of underground pipes, etc., without the authority of the Postmaster-General and the consent of the London County Council; and (3) the company to pay the taxed costs. It will be recollected that the Attorney-General, at the instance of the County Council, filed an information against the National Telephone Company for opening and breaking up streets without the consent of the County Council and the Postmaster-General, and the County Council claimed the right to act as it had done. Pleadings were prepared for the purpose of trying the question.

The Attorney-General intimated that an agreement had been arrived at whereby the company acceded to the Council's claim, and therefore put an end to a long controversy.

RE THE CRYSTAL PALACE ELECTRIC SUPPLY COMPANY, LIMITED.

On Saturday last in the Chancery Division, Mr. Justice Kekewich had before him the petition of the Crystal Palace District Electric Supply Company, Limited, for the reduction of its capital.

Mr. Warrington, Q.C., said the petition first came before his Lordship on July 7, when he made an order that it should stand over for further evidence as to depreciation of assets. Mr. Chaplin had filed an affidavit on the general question whether the reduction would operate fairly towards the shareholders. The petition, as he understood it, was this: there was a fully paid-up share capital of £28,586, which it was proposed to reduce to £2,858, a loss of 18s. per share. There was a loss on working of £14,885, and there was a loss by depreciation of assets which amounted to £11,000 at least. In addition, there was a sum of £1,600, which appeared in the accounts of last year under the head of preliminary expenses and loss on working. That had been struck out in the loss account, and the accounts had been put in showing that this sum also was a loss on working.

Mr. Renshaw, Q.C., opposed the petition, on the ground that if the order were made it might prejudice the shareholders.

His Lordship, however, was satisfied that the loss had been honestly incurred, and sanctioned the reduction.

COMPANIES' MEETINGS AND REPORTS.

BRITISH THOMSON-HOUSTON.

The fifth ordinary general meeting of this Company was held on Monday at 83, Cannon-street, Mr. E. A. Lazarus presiding.

The Chairman said that they were very full of orders, and among those that they had in hand were orders from Birkenhead, Blackburn, Bristol city tramways, Croydon, Dublin city tramways, Glasgow, Huddersfield, Hull, Leeds, London United, Newcastle, Queenstown lighting, Sheffield, Tynemouth, Isle of Thanet, and several other places. At their works at Rugby satisfactory progress was being made, and he hoped that next time he had the pleasure of meeting them he would be able to tell them that they were in active work. As they were beginning to pay for part of the work, they had decided to make a call of £2. 10s. per share on Sept. 1, making £6 called up in all, and they would probably make the further call in two calls of £2 at intervals of two months, being the legal delay.

The report was adopted, and the resolution, "that dividends be now declared out of the net profits of the undertaking for the 12 months ending March 31, 1900, on the £240,000 ordinary shares, fully paid, a dividend of 10 per cent. for the year, on the £160,000 ordinary shares, of which £16,000 paid up from Aug. 15, 1899, a dividend at the rate of 10 per cent. for the year," was carried.

DIRECT UNITED STATES CABLE.

The forty-sixth ordinary general meeting of this Company was held at Winchester House on Tuesday last.

Mr. E. M. Underdown, Q.C., presided, and, in moving the adoption of the directors' report for the six months ended June 30 last, said the business done had been of a satisfactory kind. The half-year's revenue amounted to £52,204, as compared with £51,951 for the corresponding period of 1899. The working and other expenses for the same period, including income tax, amounted to £20 506, leaving a balance of £31,697 as the net profit, and making, with £6,347 brought forward, a total of £38,045. Three quarterly interim dividends of 3s. per share, amounting to £27,319, had been declared and paid during the financial year, and a final dividend of 3s. per share was now proposed, with a bonus of 2s. per share, making, with the three interim dividends, 3½ per cent. for the year, and showing a total distribution of £42,497.

Sir James Pender, Bart., M.P., seconded the adoption of the report, which was unanimously adopted.

METROPOLITAN RAILWAY.

The report of the directors of this Company states that the total receipts for the half year ended June 30 have been £444,565, and the expenses £201,087, leaving a profit of £243,477. The receipts show an increase of £18,625, and the expenses of £12,215, as compared with the corresponding half year of 1899. The directors accordingly recommend a dividend upon the ordinary stock for the half-year at the rate of £3. 15s. per cent. per annum, and to carry forward a balance of £30,767 to the next half year's accounts. The arrangements for an experimental working by electricity between Earl's Court and High-street (Kensington) Stations have been completed, and an electrical train has been working daily since May 21 last. In view of the importance to the Metropolitan and District Railway Companies of adopting electricity as a motive power, a committee consisting of three members from each of the Boards of the companies has been appointed to consider the question of applying electric traction to the working of the Inner Circle, and it has been agreed between the companies to invite eminent electrical traction firms to submit plans and specifications, with detailed estimates and tenders, for the necessary installation.

RAND CENTRAL ELECTRIC WORKS.

The report for the year ended Dec. 31 last states that, as a consequence of the war, communication with Johannesburg has for some time been exceedingly difficult, and at times altogether impossible. Owing to this circumstance the directors have not been in a position to render accounts and call the meeting at an earlier date. Business and mining work were brought to a standstill early in October of last year. It must be considered a favourable feature that the Company was at least able to pay its expenses during the last quarter of the year under review. Had the war not interfered with the Company's operations, a more favourable statement of working would no doubt have been submitted. The total revenue received amounted to £50,674 as compared with £43 208 in 1898, and the working costs to £49,834, as compared with £48,951 in 1898. The receipts for power supplied amount to £49,640, against £42,723 received in 1898. The installed power rose from 1,846 h.p to 2,219½ h.p. Under the equipment contract Messrs. Siemens and Halske guaranteed that the profits of the Company should be sufficiently large to provide dividends of 6 per cent., 8 per cent., and 10 per cent. per annum respectively for the years 1897, 1898, and 1899. The necessary amounts to provide the guaranteed dividends for 1897 and 1898 were duly paid, and the one now under consideration is due; but in regard to the profits for 1899, Messrs. Siemens and Halske claim a partial release on account of the hostilities in South Africa constituting a case of *force majeure*. The Board propose a basis of adjustment in respect of the profits of 1899, under which the sum of £21,872 will be receivable from Messrs. Siemens and Halske. Since under the

Digitized by Google

agreement with the contractors the sums received from them must be divided among the shareholders, the directors propose that a dividend of 7½ per cent. be declared for the year 1899, payable when and so soon as the necessary payment by Messrs. Siemens and Halske is made.

GLOBE TELEGRAPH AND TRUST.

The report of the directors of this Company for the year ended June 18 states that the net revenue amounts, with £1,091 brought forward, to £199,511. From this there has been distributed £132,322 in interim dividends, leaving an available balance of £67,190. The directors recommend a final dividend of 3s. per share on the preference shares, and of 4s. 6d. per share on the ordinary shares, making, with previous distributions, a total dividend for the year of 6 per cent. upon the preference and 5½ per cent. net upon the ordinary shares, leaving £933 to be carried forward. During the year the Eastern Extension, Australasia, and China Telegraph Company, Limited, and the Commercial Cable Company have both issued new share capital, which was offered to the shareholders of those companies *pro rata* to their holdings, the former at £13 per share and the latter at par. The full number of shares thus offered has, in each case, been taken up by this Company, the cost being met by the sale of other securities. The 4 per cent. debenture stock of the Western and Brazilian Telegraph Company, Limited, held by this Company has been exchanged for 4 per cent. perpetual debenture stock of the Western Telegraph Company, Limited.

LIVERPOOL OVERHEAD RAILWAY.

The accounts of this Company for the past half-year show an available balance of £14,202, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, and 3 per cent. per annum on the ordinary shares, against 2½ per cent. per annum on the ordinary shares for the corresponding period last year. The balance carried forward is £4,452, as against £4,320 last year.

ALUMINIUM.

The report for nine months ended March 31 shows a profit of £19,684. The directors recommend a dividend at the rate of 15 per cent. per annum for the nine months, leaving £11,697 to be carried forward. The directors have considered proposals made for the amalgamation of this Company with the Castner-Kellner Alkali Company, and they have entered into a provisional agreement for the sale to the Castner-Kellner Alkali Company of all the property of this Company other than the shares of the Castner-Kellner Company held by this Company.

CITY AND SOUTH LONDON RAILWAY.

Report of the directors (with abstract of accounts) for the half-year ending June 30, 1900, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on July 31, at 12 noon:

The receipts from all sources for the past half-year have amounted to £35,144. 18s. 2d., and the cost of working has been £20,860 12s. 8d., leaving a profit of £14,284. 5s. 6d. Inclusive of the balance brought forward from Dec. 31 last, the net revenue account shows an aggregate total of £18,366. 12s. 2d. After making provision for the debenture stock interest, a balance remains available for dividend of £13,215. 4s. 7d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, and four months on those of 1896 (the other two months being charged to capital as authorised), and that a dividend at the rate of 1½ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £788. 2s. 11d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165 000	1 568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,056	19,978 16 6
June 30, 1892	2,813,162	20 931 4 2
Dec. 31, 1892	3,117,602	22 002 17 5
June 30, 1893	3,146 656	22,458 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3 383 154	23 564 10 6
Dec. 31, 1894	3 275,649	23 540 12 4
June 30, 1895	3 113,199	23,711 5 8
Dec. 31, 1895	3,172.438	23,780 3 7
June 30, 1896	3,192,672	24,021 13 0
Dec. 31, 1896	3,368,480	25,456 6 9
June 30, 1897	3,437,810	26,403 3 6
Dec. 31, 1897	3,337,861	25,472 12 10
June 30, 1898	3,478,977	26,356 16 4
Dec. 31, 1898	3,462,814	26 319 14 10
June 30, 1899	3,540,098	26,749 3 0
Dec. 31, 1899	3 442 942	26,197 14 10
June 30, 1900	4,169,717	33,608 2 3
Total since the opening of the line	61,872,980	£463,412 9 7

Your directors regret the diminution in the dividend, which is largely attributable to the increase in the debenture and preference charges before the recently opened extensions have had time to develop their traffic. There has also been a considerable increase in the cost of coal, wages, and materials. Your directors have the pleasure to report that the extensions to Moorgate-street and Clapham Common were opened for traffic on Feb. 26 and June 4 respectively. The receipts have already been considerably augmented, and are steadily improving. The extension to Islington is being rapidly proceeded with, and it is hoped will be ready for opening about March next. Both tunnels are nearly completed, and the stations are progressing. The Central London Railway not having yet been opened for public traffic, the joint subway constructed for the exchange of traffic between the two companies at the Bank Station has not been brought into use. The joint subway with the Brighton Company at London Bridge is in course of construction. The important additions and alterations at the generating depôt, alluded to in previous reports, are practically completed, and the further plant required for the Islington extension is in hand. In preparation for the opening of this portion of the line 10 additional locomotives have been ordered. The Bill promoted by this Company in the present session has received the Royal assent. The consent of the proprietors was obtained to an arrangement between this Company and the Baker-street and Waterloo Railway Company, who are obtaining powers to extend their line to the Elephant and Castle Station, where it is proposed to have a subway communication between the two systems, which will, it is hoped, result in a large exchange of traffic. The interests of your Company are fully protected. At the extraordinary meeting resolutions will be submitted varying the present agreement with the City and Brixton Company with the view of facilitating the raising of the capital of that company. The station buildings at Moorgate-street being nearly completed, the offices of the Company will be removed there immediately. The upper floors of the building have been let at remunerative rentals. It is proposed to redecorate and otherwise improve the present offices at 46, King William street, with a view to letting them until they are taken over by the City and Brixton Company. It is with much regret that your directors have to report the death of their colleague, Mr. Sampson Hanbury. He had been a director of the Company from its formation, and took a very earnest and active interest in its affairs.

Dr. Revenue Account.	£	s.	d.
Maintenance of way, works, and stations	722	12	11
Locomotive and generating power	7,458	13	6
Carriage repairs	608	14	7
Traffic expenses	8,964	10	5
General charges	2,026	13	7
Passenger duty	95	16	9
Law charges	8	8	0
Rates and taxes	975	2	11
	20 860	12	8
Balance carried to net revenue account	14,284	5	6
	£34,144	18	2

Cr.	£	s.	d
Passengers (4,169,717)	32,417	15	4
Season tickets (632)	1,160	6	11
Parcels, etc.	154	12	1
Transfer fees	27	10	0
Rent of property	1,199	7	2
Sundry receipts	155	6	8
	£35,144	18	2

Dr. General Balance-Sheet.	£	s.	d.
Balance from net revenue account	13,215	4	7
Unclaimed interest	83	5	10
Interest payable or accruing and provided for	2 312	6	10
Sundry outstanding accounts	13 392	14	6
Loan account	167,900	0	0
Contractors' retention fund	51,439	13	7
Reserve fund	1,000	0	0
	£249,343	5	4

Cr.	£	s.	d.
Cash—At bankers, on deposit at interest	28,000	0	0
At bankers, current accounts	6 467	7	9
On hand	444	12	11
General stores	5,496	13	2
Sundry outstanding accounts	42,494	17	8
Investments—balance, Dec. 31, 1899, £117,000; less proportion of interest received applied in reduction of premiums, £500	116,500	0	0
Debenture stock issued against loans	30,680	0	0
Balance from capital account	19,259	13	10
	£249,343	5	4

CROMPTON AND CO.

Directors: J. Trotter, Esq. (chairman); R. E. B. Crompton, Esq. (managing director); B. Gibson, Esq.; C. F. Tufnell, Esq. F. R. Reeves, general manager.

Twelfth report of the directors (with abstract of accounts) to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on July 30, at 3 p.m.:

After providing for debenture interest, payment of interim

Digitized by Google

dividend, and other items set out in the revenue account, there remains, with the sum brought forward from last year, a balance of £24,636. 14s. 10d. The directors propose to set aside the sum of £2 500 as a provision for doubtful debts, to place £12,000 to the reserve fund, to pay a dividend at the rate of 9 per cent. per annum for the half-year, free of income tax, making, with the interim dividend paid in January last, 7½ per cent. for the year, and to carry the balance, £3,729. 18s. 11d., forward. With the above addition of £12,000 the reserve fund will now stand at £25,046. 9s. 9d. The directors propose to set aside from this account a sum of £5,000 as a special contingency fund, to provide for any possible shrinkage in the value of investments, to write off £5,000 from the goodwill account, £5,000 from the patents account, and £3,000, balance of the cost of establishing the electric cooking department, carrying the balance, £7,046. 9s. 9d., forward. The whole of the 21,902 shares offered for subscription in July last year, were taken up, and the premiums have been carried to the reserve fund. The Board have purchased an additional 10½ acres of freehold land adjoining the site of the new works. They have considerably extended the main shop at these works, which is now being equipped with the necessary machinery, and have also erected a detached pattern store. The business of the Company continues to progress in a most satisfactory manner, and the order book is very full. The Chelmsford Electric Lighting Company have hitherto been occupying a portion of the old works at Chelmsford for a generating station; a formal conveyance of the freehold, together with the plant and machinery therein, has now been made to the Company, thereby nominally increasing the investment in that undertaking, the full amount of which is set out in the accounts. The administration of that company has been thoroughly reorganised during the past year, and it is believed that the results for the current year will show very considerable improvements. This undertaking, which is owned by Crompton and Co., Limited, is earning a moderate but steadily increasing revenue, and the directors are of opinion that this improvement will continue. In accordance with the articles of association, Mr. John Trotter retires from the Board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan and Co., also offer themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS.

Dr. Capital and Liabilities.	£	s.	d.
Authorised issue, 54,000 shares at £3 each	162,000	0	0
Issued—54,000 shares, £3 per share, called up	162,000	0	0
Less calls in arrears	777	0	0
	161 223	0	0
5 per cent. first mortgage debentures	100,000	0	0
Sundry creditors	51,866	4	7
Debenture interest accrued	1,208	6	8
Doubtful debts and contingencies account	355	13	4
Unclaimed dividends	52	7	1
Reserve fund	13,046	9	9
Revenue account balance	24,636	14	10
	£352,388	16	3

Cr. Property and Assets.	£	s.	d.
Freehold land and premises	37,895	2	7
Plant, tools, furniture, and fixtures	61 560	4	8
Stock-in-trade and work in progress	95,459	16	3
Trade debtors	74,024	0	3
Chelmsford Electric Lighting Company investment in shares and loans, and balance of account for work done, etc.	38,607	9	6
Investments in other companies	1,659	10	0
Cash and bankers and in office	14 226	10	0
Patents account	10,956	3	0
Electric cooking and heating department, cost of establishing	3 000	0	0
Goodwill	15,000	0	0
	£352,388	16	3

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Trading expenses (steam and electric power, etc.)	20,245	6	1
Administration and head office expenses, rents, etc.	10,395	1	8
Repairs to buildings, plant, and machinery	676	1	1
Depreciation of plant and machinery, etc.	4 248	0	8
Net profit to revenue account	31 326	19	6
	£66,891	9	0

Cr.	£	s.	d.
Gross profit from trading account, pupils' premiums, and dividends on investments	66,891	9	0
	£66,891	9	0

Dr. REVENUE ACCOUNT.	£	s.	d.
Interest on debentures	4,791	13	4
Interest on bankers' advances	1,675	14	11
Directors', managing directors', and other fees	2,125	15	0
Income tax, £192. 4s. 2d.; interim dividend, £3 034. 2s. 6d.; balance, £24,636. 14s 10d.	27,863	1	6
	£36,456	4	9

Cr.	£	s.	d.
Balance from last year	5,129	5	3
Net profit from profit and loss account	31,326	19	6
	£36,456	4	9

EDISON AND SWAN UNITED ELECTRIC LIGHT.

Directors: J. S. Forbes, Esq. (chairman); the Earl of Lichfield; Major S. F. Page; J. W. Swan, Esq., F.R.S.; E. Villiers, Esq.; W. P. J. Fawcus, Esq.

Seventeenth annual report of the directors (with abstract of accounts) for the year ending March 31, 1900, to be presented to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel, E.C., on July 31 at 12 noon:

The profit and loss account shows a credit balance of £43,388. 1s. 5d. Providing for the interest upon the debenture stock, there remains a balance of £29,208. 11s. 11d. available for distribution. An interim dividend at the rate of 6 per cent. per annum having already been paid in respect of the half-year ending December, 1899, a further payment at the rate of 6 per cent per annum for the second half is recommended, making the dividend for the book year 6 per cent. per annum, the balance of £6,199. 18s. 5d. being carried forward. The issue of the £100,000 5 per cent. second debenture stock was duly made and fully subscribed. A quotation has been granted by the Stock Exchange. James Staats Forbes, Esq., and the Right Hon. the Earl of Lichfield retire by rotation from the Board, and offer themselves for re-election. Messrs. Welton, Jones, and Co., the auditors, offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Stock on hand July 1, 1899	160,161	0	9
Wages, purchases, etc.	272 112	1	3
Salaries, directors' remuneration, etc.	12 076	18	0
Depreciation on plant, etc.	13,936	10	10
Balance	43,388	1	5
	£501,674	12	3

Cr.	£	s.	d.
Balance brought forward	10,599	1	6
Sale of lamps, fittings, etc.	285,518	12	6
Interest, etc.	3,908	8	0
Stock on May 31, 1900	201,648	10	3
	£501,674	12	3

Dr. BALANCE SHEET.	£	s.	d.
Share capital—17,139 A shares of £5 each, fully paid	85,695	0	0
99,261 A shares, £5 each, £3 paid	297 783	0	0
	383,478	0	0
23,564 B shares, £5 each, fully paid	117,820	0	0
4 per cent. first debenture stock	344,023	0	0
5 per cent. second debenture stock	47,566	8	4
Sundry creditors and credit balances	91,009	17	6
Reserve fund (after deducting capital outlay for the year, £6,883. 0s. 6d.)	66,726	7	5
Profit and loss, as per appropriation account, £43,388. 1s. 5d.; less interim dividend, paid on Feb. 13, 1900, £11,504. 6s. 9d.; interest on debenture stock for six months, paid Dec. 31, 1899, £6,880. 9s. 2d., £18,384. 15s. 11d.	25,003	5	6
	£1,075,626	18	9

Cr.	£	s.	d.
Cost of establishing the business, goodwill, remaining patents, etc., as per last balance-sheet	325,631	8	1
Amount of B shares of this Company issued as *per contra*	117,820	0	0
	443,451	8	1
Altrincham Electric Supply, Limited, shares, £23,346; ditto, 4 per cent. debentures, £17,300.	40 646	0	0
Freehold and leasehold property	86 557	8	8
Stock (May 31) and plant	327,751	5	9
Sundry debtors and debit balances	143,959	10	11
Investment National Telephone Company, Limited	15,500	0	0
Cash at bankers and in hand	17,761	5	4
	£1,075,626	18	9

EASTERN TELEGRAPH.

The fifty-sixth half-yearly ordinary general meeting of this Company was held last week at Winchester House, E.C., the Marquis of Tweeddale presiding.

The directors recommended the declaration of a final dividend on the ordinary stock for the year ended March 31, 1900, of 1½ per cent., and a bonus of 2 per cent., making, with three previous payments on account, a total distribution of 7 per cent. for the year. Interest on mortgage debenture stock absorbed £27,590, and dividends on preference stock, £30,946.

The Chairman, in moving the adoption of the report, said the gross revenue for the half-year was £543,684, showing a general increase from all important traffic centres, especially from South Africa, but India again showed a decrease. The tariff between the Colonies of South and Western Australia and Tasmania and Europe had been reduced from 4s. 9d. to 4s. per word on May 1 last, with proportionate reductions for Government and Press telegrams. The agreement with the Australian Colonies also provided for future reductions under certain conditions to a minimum of 2s. 6d. per word. There would also be substantial reductions in the tariff between the contracting Colonies and South Africa when the new cables between Durban and Perth were opened. Negotiations were also going on with a view to a reduction in the tariff between Europe and India.

Sir J. Wolfe Barry seconded the report, which was adopted.

Digitized by Google

ANGLO-AMERICAN TELEGRAPH.

The report of this Company states that the total receipts from Jan. 1 to June 30, including the balance of £1,355 brought forward, amounted to £186 526. The traffic receipts show an increase of £982 as compared with the half-year ended June 30, 1899. The total expenses for the half-year amount to £60,784. The directors have, before declaring the net profits, set apart £12,000 to the renewal fund, leaving a balance of £113,742. One quarterly interim dividend of 15s. per cent. on the ordinary stock, and of £1. 10s. per cent. on the preferred stock, was paid on May 1, 1900, absorbing £52,500, and a second quarterly dividend of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, amounting to £52,500, will be paid on Aug. 1, 1900. A balance of £8,742 will be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Blackburn.—The Corporation invite tenders for the supply and delivery of one traction switchboard. Tenders by Aug. 6. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the works required in extension of the electricity works, Valley-road, Bradford. Tenders by Aug. 2.

Belfast.—The Electricity Committee invite tenders for the supply and erection of an auxiliary feed-water heater with pipe connections. Tenders by Aug. 15.

Stockport.—The Tramways Committee invite tenders for 20 double-deck tramcars, complete with electric equipment for overhead traction. Tenders by Aug. 31.

Darlington.—The Corporation invite tenders for the supply and delivery of arc lamp posts and brackets. Tenders by 28th inst. Details in our advertisement columns.

Bradford.—The Guardians invite tenders for the installation of electric lighting at their union workhouse. Tenders by Aug. 13. Details in our advertisement columns.

Halifax.—Tenders are invited for mechanical stokers suitable for Babcock boilers. Particulars to be obtained from Borough Electrical Engineer, Foundry-street, Halifax.

Rugby.—The Urban District Council invite tenders for taking a lease of their powers under the Rugby Electric Light Order, 1898. Tenders by Aug. 1. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of lighting cables, tramway feeders, and street lighting. Tenders by Aug. 13. Details in our advertisement columns.

Barnes.—The Urban District Council invite tenders for the supply and erection of pipework, condensers, etc., and overhead travelling crane. Tenders by Aug. 14. Details in our advertisement columns.

Extension of Time.—The time for sending in offers for the whole or part of an electric generating machine for the Port Said lighthouses and the tools for the lighthouses' workshop at Alexandria, Egypt, has been extended to Aug. 1.

Hapton.—Tenders are invited for the lighting of Hapton township with electricity from Sept. 1, 1900, to April 30, 1901. Endorsed tenders to be sent to Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, 16, Hammond-terrace, Padiham, by 31st inst. Full particulars on application.

Torquay.—The Corporation invite tenders for two water-tube boilers, with superheaters, two inductor alternators and Willans engines, pipework, surface condensers, etc., extension to high-tension switchboard, wattmeters, etc., and transformers. Tenders by Aug. 6. Full details in our advertisement columns.

Madrid.—The Spanish Government invite tenders, not later than Aug. 18, for the concession of a system of electric tramway lines in Barcelona. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Russia.—Tenders are invited by the Russian Government not later than the 28th prox. for the telephone service of Warsaw, St. Petersburg, Moscow, Odessa, and Riga. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Grays.—The Urban District Council invite tenders for the supply, delivery, and erection of the following work in connection with the electric lighting of the district: (Section A) two Lancashire boilers and pipework; (B) two 100 kw. steam dynamos, with boosters and balancer; (C) fuel economiser; (D) switchboard; (E) battery; (F) travelling crane; (G) mains and street lamp fittings. Tenders by Aug. 9.

London, W.—The Central Electric Supply Company invite tenders for the supply, delivery, and erection of (Specification 2A) dry-back marine boilers, 11ft. 6in. diameter and 14ft. long, gangways, feed and drain pipes, etc., complete, as required for each of three blocks of boilers. Each or all of the blocks can be tendered for, each block containing six boilers. Tenders are also to be submitted for mechanical stokers, with the shafting and gearing for driving them. Alternative tenders are invited for (Specification 2B) water-tube boilers as an alternative to the dry-back marine boilers, including the mountings, feed and drain pipes, etc. Copies of the specifications, with forms of tender, drawings, and general conditions, can be obtained from the General Manager, 19, Carnaby-street, Golden-square, W., on payment of £3. 3s., to be returned on receipt of a bona fide tender. Specifications and drawings can be seen at the office of Prof. Kennedy, 17, Victoria-street, S.W. Tenders, on the prescribed form, endorsed on the outside "Electric Plant—Tender to No. — Specification," must be sent to Mr. F. J. Walker, general manager, before 10 a.m. on Aug. 20.

London, E.C.—Tenders are invited by the Pacific Cable Committee on behalf of her Majesty's Government and the Governments of Canada, New South Wales, Victoria, New Zealand, and Queensland for the manufacture and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cables between Vancouver and Fanning Island, Fanning Island and Fiji, Fiji and Norfolk Island, Norfolk Island and New Zealand, Norfolk Island and Queensland. It is proposed to divide the whole undertaking under three distinct contracts, for any one or more of which contractors may tender. Each of these contracts will include a clause under which the contractor guarantees the good electrical condition and working order of the cables for 30 consecutive days after the completion of the laying. A fourth contract is also proposed for surveying and sounding the whole route before the cables are laid. Forms of contract, specification, and tender may be obtained of Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street, E.C., at whose offices charts showing the proposed route of the cable and the positions where soundings are to be taken may be inspected. The last day for the reception of tenders is Aug. 14. They must be enclosed in sealed covers, marked "Tender for Pacific Cable," must be addressed to Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street, E.C., and must be delivered by 12 noon on that day.

RESULTS OF TENDERS.

Bridgwater.—The Town Council have received the following tenders for their electrical undertaking, of which those marked with an asterisk have been accepted, subject to the approval of the Local Government Board:

Section A.—Boilers.			
Babcock and Wilcox (own)*	£2,350	1	6
Crompton and Co. (Babcock)	2 383	0	0
Stirling Boiler Company (watertube)	2,744	0	0
Tinkers Limited (Economic)	3,567	0	0
Section B.—Engines.			
General Electric Company (Reavell)	2,709	15	0
Thames Ironworks (Reavell)	2,905	0	0
General Electric Company (Willans)	2,944	15	0
Suter (Helios) (Alley)	2,969	10	0
Lancashire Dynamo Company (Alley)	3,048	0	0
Lancashire Dynamo Company (Browett)	3,088	0	0
Parsons (own)*	3 092	0	0
Lancashire Dynamo Company (Willans)	3,098	0	0
Thames Electrical Engineering Company (Allen)	3,113	0	0
Thames Electrical Engineering Company (Willans)	3,185	0	0
Lancashire Dynamo Company (Belliss)	3 308	0	0
T. Parker (Willans)	3.355	0	0
Brush Company (Willans)	3,370	10	0
Electric Construction Company (Reavell)	3,382	0	0
Clayton and Co. (own)	3,434	0	0
Crompton (Willans)	3,442	0	0
Scott and Mountain (own)	3,520	0	0
J. Fowler (Reavell)	3,537	0	0
British Schuckert Company (Browett)	3,580	0	0
Mather and Platt (Willans)	3,583	0	0
Electric Construction Company (Willans)	3 590	0	0
Mather and Platt (Browett)	3,643	0	0
W. H. Allen (own)	3,674	0	0
Electric Construction Company (Belliss)	3,682	0	0
Ashton and Frost (Willans)	3,804	0	0
Mather and Platt (Belliss)	3 833	0	0
Siemens (Willans)	3,835	0	0
Section C.—Switchboard.			
Evered and Co.	458	0	0
Williamson and Joseph	514	0	0
Hodgson-Wright*	538	0	0
Lea and Warren	542	0	0
Brook, Hirst, and Co.	561	0	0
General Electric Company	575	0	0
Andrews	575	0	0
Veritys	620	0	0
J. Fowler	639	0	0
P. C. Middeton	674	3	0
Clayton and Co.	678	5	0
Crompton	698	0	0
Vaughan	767	0	0
Mechan and Son	840	0	0
Siemens	940	0	0
Section D.—Mains.			
Western Electric Company*	8 301	19	5
St. Helens Cable Company	9,379	5	8
Dennis	9 5 7	2	2
Callender Cable Company	9,951	18	0
Andrews	10.844	19	11
Siemens	10,913	4	11½
Oliver	11,311	15	0
Henley	11,442	0	2
British Insulated Wire Company	11 564	0	0

Digitized by Google

Section F.—Accumulators.

Hart Accumulator Company*	966	0	0
Marquand	1,156	0	0
Tudor Accumulator Company	1,265	0	0
E.P.S. Company	1,359	0	0
Chloride Storage Company	1 402	0	0
D.P. Battery Company	1,446	0	0

Section G.—Cranes.

Chatteris Engine Company*	143	10	0
Carrick and Ritchie	149	0	0
Mather and Platt	155	0	0
J. Carrick	158	0	0
J. Spencer	168	0	0

Section E, dealing with meters, has been deferred for the present.

Beckenham.—The Council have been recommended to accept the following tenders: For the institute—lead-covered cables, R. Dawson, £240. 13s. 5d.; for the baths—conduit system, Tamplin and Makovski, £27. 4s.

BUSINESS NOTES.

TRACTION.

Lancaster.—The Tramways Committee have reported in favour of the overhead trolley system of tramways.

North Staffordshire Tramways Co.—A general meeting of this Company is to be held at Donington House, W.C., on Aug. 2.

Paisley.—The Town Council have decided to recommit their Tramways Bill, which was recently thrown out by a committee of the House of Commons.

London County Council Trams.—The Chelsea Vestry intends, we understand, to oppose the proposed tramway from Blackfriars to Putney. The line would pass along the Chelsea Embankment.

Kirkcaldy.—Prof. Kennedy has lately made several visits to Kirkcaldy with regard to the arrangements in connection with the tramways, the line of the route receiving his special attention. From the preliminaries already receiving attention, it is evident that no time is to be lost in inaugurating the system.

Kingston.—The Light Railway Commissioners sat on the 23rd inst. at Kingston, and, after hearing the opposition offered by the local authorities and the Surrey County Council, intimated that they could not see their way to grant the order applied for by the British Electric Traction Company to construct electric tramways in the district.

Bournemouth.—After considering the report on the electric tramways, presented by Messrs. Lacey, Clirehugh, and Sillar, the Corporation have decided to adopt the system suggested and to apply for a provisional order for this purpose. The estimated cost of the system is £166,500, and the scheme of electric lighting in connection with the tramways is estimated at £11,640.

Morecambe.—A scheme is being promoted by Mr. John Gardner, of Morecambe, for the provision of an electric tramway from Lancaster to the West End of Morecambe. At present the West End is not particularly easy of access by either train or tram from Lancaster. The electrically-propelled trams will, it is estimated, accomplish the journey to Lancaster in a quarter of an hour.

Devonport.—The Borough Council have decided to compulsorily acquire the lines of the Plymouth, Stonehouse, and Devonport Company. They propose to lease the tramways to the company for 21 years, the company to take the current for driving the trams from the Corporation. The Corporation can use the trolley posts also for electric lighting. Practically the whole of the tramways are to be relaid.

Bristol Tramways and Carriage Co.—The directors have declared an interim dividend to June 30 last at the rate of 7½ per cent. per annum, payable on Aug. 4 prox., against 7 per cent. for the corresponding period. The total receipts of the Company for the half-year have been £74 991, against £72,396, an increase of £2,595 over the corresponding period, whilst the number of passengers carried was 12,061,613, against 11,408,683, or an increase of 652 930.

Glasgow.—Sir Lewis M'Iver, in stating that the committee dealing with the Glasgow District Tramways Bill found the preamble not proved, informed those present that the committee desired to put on record that, in their view, the original scheme was a good one, and calculated to be of much service to the district, but it had been so mutilated and loaded with conditions, by conflicting interests, and the excessive demands of several local bodies, that it appeared to the committee to be wholly unworkable.

Calcutta.—We are informed that the Klein Engineering Company, of Manchester, have recently received through Messrs. Dick, Kerr, and Co., the contractors for the Calcutta electric tramways, an order for a Klein's condensing plant with patent fan draught cooling tower. The plant is designed to condense the exhaust steam from engines of about 2,000 h.p., and consists of a surface condenser with Edward's air-pumps and motor-driven circulating pumps. The cooling tower is of the latest type, specially designed for giving the highest efficiency in hot climates.

Dundee.—At a meeting of the Tramway Committee of the Town Council last week reports were submitted from General Yorke and Mr. Trotter, Board of Trade inspectors, on the electrical car service, and these were considered favourable. In his report General Yorke suggested that for the purpose of preventing accidents the life-guards and the cars should be improved, while Mr. Trotter stated that the electrical system was entirely satisfactory. An instruction was given to the tramway manager to communicate with the builders of the cars with the object of having the guards improved.

Central London Railway.—This line is to be opened for public traffic on Monday next, the trains commencing running from Shepherd's Bush at 5.15 a.m. and from the Bank at 5.20 a.m., stopping at all stations except Bond-street, the opening of which is temporarily deferred. The fares up to 7.30 a.m. will be 2d. return any distance, and from 7.30 a.m. to 12 p.m. 2d. single any distance. The tenth ordinary general meeting of the company will be held at the Holborn Restaurant on Aug. 8, at 12 noon, to receive the report of the directors and statement of accounts for the half-year ending June 30, 1900.

Bolton.—A meeting of the Tramways Committee of the Corporation was held last week, when the reports for the working of the tramways were considered. The committee ultimately approved of the "town circle" system proposed in the report of the traffic manager, Mr. H. England, subject to the approval of the General Purposes Committee, a special meeting of which is to be summoned. Mr. England's report shows in what way the tram service could be made better by means of different starting places and connections. By means of the scheme he proposes, the fares would be considerably reduced on most of the lines.

Govan.—A memorandum has been forwarded to the Burgh Commissioners asking that in the proposed system of electric traction the overhead trolley wire should be placed at a clear height of 23ft. from the ground, instead of the 21ft. 6in. new proposed. This is to enable tall loads to pass along the streets. It is, however, expected that the side pole arrangement will be adopted in Govan. This will allow one side of the street to be entirely free. At the junction of the side streets and the main thoroughfare the wires will probably be so constructed that they may be taken down, an arrangement that will also be in use at the entrance to the docks.

Durham.—At the quarterly meeting of the County Council the County Surveyor reported that the electric traction company had applied for powers to lay a light railway from a point 83 yards north-west of the junction of Crossgate and the North-road, Durham, to Meadowfield. The railway would be a single line of 4ft. 8½in. gauge. The surveyor's recommendation that the promoters should widen, at their own cost, the Stone Bridge and Langley Bridge, and that the roadway at several parts outside the city should be widened, was adopted. The railway, it was stated, could be worked by steam or electricity, and might be used for the conveyance of passengers, goods, minerals, parcels, or animals.

Bath.—At a meeting of the Urban Sanitary Authority last week the following resolution was adopted: "That, in accordance with the agreement with Sir James Sivewright and Leopold Hirsch, adopted by the Council at a meeting held on May 15 last, the Council do hereby approve of the application now being made to the Light Railway Commissioners by the Council, jointly with these parties, authorising the construction of light railways under the provisions of the Light Railways Act of 1896, upon the routes mentioned in such agreement, and conditions contained in such agreement, and that the seal of the Council be affixed to all documents necessary to carry this resolution into effect." The tramways referred to are to be electrical.

Newcastle.—At a meeting of the New Tramways General Purposes Committee held on Tuesday last to consider what fares should be charged on the new tramway system of the city, the committee divided the whole of the route into sections of two-thirds of a mile, for which a charge of ½d. was fixed. It was proposed to recommend the Council to sanction the erection of galvanised iron car-sheds on ground adjoining the site of the new car-sheds in Shields-road. The estimated cost of these proposed sheds, which will provide standage for 40 cars, is £4,000. It was also proposed to have stopping stations at all the less congested parts of the route. The cars, as on other electrical systems, will be only stopped at these fixed points for the taking up and the alighting of passengers.

Wrexham.—At a special meeting of the General Purposes Committee of the Town Council the chairman read a notice from Messrs. Evan Morris and Co., on behalf of the Drake and Gorham Electric Traction Power Company, stating that it was their intention to apply for an extension of time for 12 months from Aug. 1 next for the commencement of the electric tramways in the borough, and for an extension of a further 12 months for the completion of the work, and asking if the Council had any objection. The Council decided that the time asked for be allowed, but informed the company that they had a very strong objection to the action of the applicants, and any further application of a similar kind would be most strongly opposed, as the Council had gone to considerable expense with regard to the provision of machinery to supply them with electricity, which would be lying idle for some months in consequence.

Liverpool.—On Tuesday afternoon last in Liverpool, one of the overhead wires on the Liverpool tramways, at the junction of Dale-street and the Old Haymarket snapped, and a serious interruption of the tram service took place. A breakdown gang from the Corporation works was soon on the scene, and the wires were raised from the ground and connected temporarily. Mr. Pugh, the traffic manager, was quickly in attendance, and he speedily got rid of the congestion of traffic. Another incident of a somewhat alarming character also occurred on Tuesday in Renshaw-street. As one of the cars was proceeding down the street, the trolley became detached from the wire and came in

Digitized by Google

contact with the cross stay attached to the street pole. The tubing of the trolley arm was torn away, with the result that it could not be used and the car had to await the arrival of the succeeding tram to assist it to a less crowded thoroughfare, whence it was removed by the electrical staff of the Corporation.

LIGHTING AND GENERAL.

Maryport.—The Urban District Council have succeeded in obtaining an electric lighting order.

Dover.—The Town Council have decided to again light the Granville Gardens with electricity instead of gas.

Lancaster.—The Town Council have decided to increase the cost of current per unit in consequence of the increased cost of coal.

Bournemouth.—The Town Council have decided to provide an extra circuit in the town for four arc lamps, at an estimated cost of £150.

Llandudno.—The Local Government Board have sanctioned a loan by the Urban District Council of £12,222 for electric lighting purposes.

Bath.—The proposed decrease in the price for electrical energy has been suspended by the Corporation until the cost of coal is not so great.

Chester.—The Electric Lighting Committee have decided to fix an electric radiator in a suitable room in the town hall by way of experiment and for exhibition.

Rochdale.—The electricity works of the Rochdale Corporation are, we gather, almost ready to start work, and are expected to give supply about the beginning of September.

Penistone.—The Board of Guardians are to receive a deputation on Aug. 9 from the Urban District Council in order to discuss the question of electric lighting in the Penistone district.

Uxbridge.—The Rural District Council have given their consent to the granting of a provisional order to the Northwood Electric Light and Power Company to supply electricity in the district of Ruislip.

Tewkesbury.—The Town Council have received notice from the North British Electricity Supply Company of their intention to apply for a provisional order to supply electric light in Tewkesbury.

City of London Electric Lighting Co.—We are informed that Mr. J. B. Braithwaite, jun., of 27, Austinfriars, E.C., and Mr. H. S. Leon, J.P., of Bletchley, have been elected to seats on the Board of this Company.

Wellington.—The Urban District Council have received a letter from the English Industrial Company, Limited, notifying their intention to apply for a provisional order to supply electricity within the Council's area.

Luton.—Messrs. Garrett and Co., of Dunstable, have informed the Rural District Council of their intention to apply for a provisional order for the supply of electrical energy in Houghton Regis and Upper West street.

Compagnie Generale de Traction (of Paris).—The directors have called up the remaining 75fr. per share upon their new issue of 100,000 shares, for payment on or before the 9th prox., with Messrs. Henrotte Fils et Cie., Paris.

Wombwell.—The District Council have received a notice from the North British Electricity Supply Company of their intention to apply for a provisional order to supply electric energy for public and private use in the Council's district.

Aberaychan.—At a meeting of the Urban District Council last week it was suggested, in consequence of a dispute with the gas company, that figures respecting the relative costs of electric lighting and gas lighting should be obtained.

Kensington.—The recommendation of the Special Electric Lighting Committee of the Board of Guardians, that the workhouse, infirmary, and offices in the Marloes-road be lighted with the electric light, has been referred to committee.

Cockermouth.—The Urban District Council have received a notice from the North British Electric Company of their intention to apply for a provisional order for electric lighting in the Cockermouth district. The matter was referred to a committee.

Removal.—In consequence of the growth of their business, Messrs. Babcock and Wilcox, Limited, have removed from 147, Queen Victoria-street to more commodious offices at Oriel House, Farringdon street, E.C., where all communications should be addressed.

Aspatria.—At the monthly meeting of the Urban District Council, the Clerk reported that formal notice had been received from the North British Electric Supply Company of their intention to apply for a provisional order to supply electric light within the Council's district.

Cullen.—At the monthly meeting of the Town Council a letter was read from the North British Electricity Supply Company, stating their intention to apply for a provisional order to authorise the company to supply electrical energy for public or private purposes in the burgh.

Glasgow.—At a meeting of the Corporation on Monday it was agreed that the remit to the Joint Committee on Electric Works be extended to enable the committee to consider and make a recommendation regarding the electric lighting of streets from centre poles and span wires.

Shildon.—The Urban District Council have received a notice from the Northern Counties Electric Supply Company of their intention to apply for a provisional order to supply the electric lighting of the Shildons. The matter has been referred to the Electric Lighting Committee.

London Gazette.—A first and final dividend of 15s. 5½d per £ has been declared *re* the Chitty Dynamo and Motor Company, Limited, 4, Hythe-road, Willesden, London, payable on any day (except Saturday) between 11 and 2 at official receiver's offices, 33, Carey-street, Lincoln's-inn, W.C.

Shrewsbury.—The recommendation of the Water and Lighting Committee, that the seven lamps now in use in Dogpole be lit by incandescent electric light in substitution for gas, has been adopted by the Town Council. The estimated cost of adapting the seven lamps, including laying the cable and all fixing, is £45.

Electrical Standardising, Testing, and Training Institution. As a result of the recent scholarship examinations, the following awards have been made by the board of control of the above institution: Mr. F. E. Berry, Wellingborough School, Maxwell Scholarship, value 50 guineas, tenable for two years; and Mr. A. W. Scrooby, of Dunheved College, a prize value 20 guineas.

Stock Exchange.—The Stock Exchange Committee has ordered the undermentioned securities to be quoted in the official list: Babcock and Wilcox, Limited—440 000 ordinary shares of £1 each fully paid, Nos. 1 to 440,000; and 100,000 6 per cent. cumulative preference shares of £1 each fully paid, Nos. 1 to 100,000, in lieu of the ordinary and preference shares of old company now quoted. Westminster Electric Supply Corporation, Limited—further issue of 29,437 ordinary shares of £5 each, £2. 10s. paid, Nos. 80,001 to 109,437.

Fatal Boiler Explosion.—We gather that on Wednesday afternoon an explosion occurred on the premises of the Crystal Palace District Electric Supply Company at Springfield-road, Upper Sydenham. The great boiler burst and wrecked two large buildings. At the time of the explosion five men were working in the place, and one of these, named William James Philbrook, was instantly killed. Two other men were found to have been severely injured. The explosion was followed by a fire, which before being put out damaged some of the surrounding buildings.

Charing Cross and Strand Electricity Supply Co.—The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, have, after providing for debenture and other interest and dividend on preference shares, declared an interim dividend at the rate of 8½ per cent. per annum for the half-year ending June 30, 1900, and carry forward £10,508. The interim dividend for the corresponding period of the year 1899 was at the rate of 8 per cent. per annum, with a carry forward of £8,300. The lamps connected during the past half-year have amounted to the equivalent of 24 242 8 c.p. lamps.

"New Lamps for Old."—The Renewable Electric Lamp Company, Limited, of Brunswick-place, City-road, N., announces that the equipment of the factory and the preparations for the supply of their patent renewable lamps of any candle power, from eight to fifty candles, are now completed, and the company are in a position to supply in large quantities. All old lamps, burnt out or having become dull, will be continuously exchanged for new ones at half the original cost, providing the glass bulbs are not broken. The present prices for the lamps are as follows: lamps for 100 to 110 volts, 8 c.p. to 16 c.p., first lamp 1s., afterwards 6d. each; lamps for 150 ditto, 1s. 3d. and 7½d.; and lamps for 200 to 230 ditto, 1s. 6d. and 9d.

Parliament.—In the House of Lords on Thursday week the Taunton Corporation, Coventry Corporation, Hastings Corporation, Alexandra Park, and Southport Corporation Bills were read a second time. The Sunderland Corporation, Great Northern Railway, Midland Railway, South-Eastern Metropolitan Tramways, and Portland Urban District Gas Bills were read the third time; and in the House of Commons the Dearne Valley Railway Bill, Glyncorrwg Urban District Council Gas Bill, London Sea Water Supply Bill, and Whitechapel and Bow Railway Bill were read a third time. The Workington Railways and Docks Bill was read a second time, and the London, Walthamstow, and Epping Forest Railway Bill was withdrawn. In the House of Lords on Friday the Durham (County of) Electric Power Supply Bill and the Lancashire Electric Power Bill were read a second time. The Midland Great Western Railway of Ireland Bill was read a third time and passed. In the House of Commons the Great Grimsby Street Tramways Bill and Mersey Railway Bill were read a third time. In the House of Lords on Monday the South Wales Electrical Power Distribution Bill and the Shannon Water and Electric Power Bill were read a second time, and the following Bills a third time: South Metropolitan Gas, London and South-Western Railway, Aberdeen Corporation Tramways, and Great Western Railway. In the House of Commons the London, Walthamstow, and Epping Forest Railway (Abandonment) Bill was read a third time. The Crystal Palace Company Bill was read a second time, and the Brompton and Piccadilly-circus Railway Bill was withdrawn. On Tuesday in the House of Lords the North Metropolitan Electric Power Supply Bill was read a second time, and the London and North-Western Railway and Blackpool, St. Annes, and Lytham Tramways Bills a third time. In the House of Commons the Lords' amendments to the Burnley Corporation Bill were agreed to, and the Lords' amendments to the Great Northern Railway Bill and the Midland Railway Bill were agreed to. The Rotherham Corporation and the Motherwell and Bellshill Railway Bills were read a third time. In the House of Commons on Wednesday the Lords' amendments to the South-Eastern Metropolitan Tramways Bill and the Portland Urban District Gas Bill were agreed to, and the Liverpool Overhead Railway Bill was read a third time.

Digitized by Google

Chichester.—At a meeting of the Town Council last Friday with respect to the provisional order for electric lighting owned by the Corporation, it was decided to apply to the Local Government Board for a further extension of two years in order that the Council might further consider the matter.

Salford.—We are informed that the new Corporation electric lighting station building is now on a very fair way to completion. The building is to contain plant to the extent of 10,000 h.p., and will supply current for both lighting and traction. The plant is expected to be ready to work next January.

Cupar Fife.—At a meeting of the Town Council last week a letter was read from the Electrical Supply Company intimating their intention to apply for a provisional order to supply electrical energy within the area of the burgh. The letter was remitted to the Lighting Committee to watch the course of procedure and report to the Council.

New Company.—The Brockie Pell Arc Lamp, Limited, has been registered with a capital of £80,000 in £1 shares. Its object is to adopt an agreement with the Brockie-Pell Arc Lamp, Limited (registered in 1896), and to carry on the business of manufacturers of and dealers in electric arc lamps, electric incandescent lamps, and electrical appliances, etc.

Edinburgh.—The Faculty of Advocates have decided to introduce the electric light into the advocates' library. The work is to be started at once, so that by the end of August the new illuminant will be in working order. The lighting of this fine library is entirely artificial, and electricity should much improve the present condition of things.

Ham.—At last week's meeting of the District Council letters were read from the Twickenham and Teddington Electric Supply Company and the Richmond (Surrey) Electric Lighting Company, giving notice of their intention to apply for provisional orders for electric lighting within the district of Ham. The letters were referred to the Highways Committee.

Monmouth.—Mr. E. A. Sandford Fawcett held an enquiry at the Shire Hall, Monmouth, last week respecting an application by the Corporation for power to borrow £28,000 as a supplementary loan for the purpose of completing the combined scheme for drainage and electric light in the borough. The money is required owing to the estimates being deficient.

Newbury.—The Corporation having received a notice from Edmundson's Electricity Corporation, Limited, on behalf of the Urban Electric Supply Company, Limited, of their intention to apply for a provisional order for electric lighting in the borough, have decided that the question of the electric lighting of the borough shall be considered by the whole Council.

Birmingham.—The City Council on Tuesday unanimously decided to acquire the site of the old hospital in Summer-lane, containing about 19,409 square yards, with the buildings thereon, and the canal basins, for the purpose of a central generating and distributing station, at a cost of £23,000, and to instruct the town clerk to have the property duly conveyed to the Corporation.

Our Cables.—It was announced in the House of Commons on Monday that the Departmental Committee which is to enquire into the working of the cable systems in the Empire will consist of Lord Balfour of Burleigh (chairman), representing the Board of Trade; Mr. Hanbury, financial secretary to the Treasury; and an under-secretary from the India and Colonial Offices and Admiralty.

Explosion.—An explosion occurred last week in a manhole at the corner of Queen-street and St. Vincent-place, Glasgow, used in connection with the Corporation electric light installation. Gas had collected in the manhole through a leakage in some of the mains, and it is supposed that the explosion was caused by an electric spark. The cover of the manhole was blown off, but no one was injured.

Willesden.—The scheme for electric lighting and traction designed by Mr. Ruthven Murray, which we mentioned in our issue of the 13th inst., was on Tuesday last unanimously adopted by the District Council. A loan of £143,624 is to be applied for immediately for the lighting works, while it is proposed to promote a Bill in Parliament to authorise the construction of the tramways at an expenditure of £53,247.

County of London and Brush Co.—The directors of the County of London and Brush Provincial Electric Lighting Company, Limited, have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ended 30th ult., and an interim dividend on the ordinary shares for the same period at the rate of 4 per cent. per annum, both payable 15th prox. The transfer books and the register of members will be closed from 6th to 15th prox. inclusive.

Belfast.—At a meeting of the Electric Lighting Committee last week, the engineer submitted a report for the six months ended June 30, 1900, showing 351,641 units sold for half-year, as against 244,589 for the corresponding period of last year, equal to an increase of 44 per cent., the current sold for motor purposes being 15 per cent. of the total, or an increase of 85 per cent. over the motor current sold during the corresponding period of last year. This is probably due to the facilities which the committee gave for the hiring out of motors.

Change of Address.—We are informed by the Blackman Ventilating Company, Limited, that in consequence of the growth of their business they are now removing their central offices to their works at 443, Holloway-road, London, N., so as to concentrate management and staff for the quicker and more effective dispatch of business to the benefit of all concerned. Their engineer representatives for the London district, however, remain at and work from their City address, 63, Fore-street, E.C., but correspondence should be addressed to Holloway-road.

Croydon.—At last week's meeting of the Rural District Council the Coulsdon and Sanderstead Drainage Committee reported that the clerk had submitted a plan illustrating a proposal for the Corporation of Croydon to supply a portion of Sanderstead with electric light. The Corporation had not agreed to do it, but desired to ascertain the views of the District Council thereon. The Council said they had no objection to the Corporation carrying the electric light into the parish provided that they had power to take over the light if they wished to do so.

Poplar.—Last week the Vestry adopted a recommendation to place 15 arc light columns in the East India Dock-road, at an estimated cost of £636; that five other arc light columns be also placed in the parish, at a cost of £250; and that 25 prepayment meters be obtained on approval for three months, to be purchased if satisfactory. Mr. T. Roles, of Leicester, was also elected to the position of chief assistant in the generating department. It was also resolved to refer to the Works Committee the question of lighting the Board's offices and premises by electricity.

London County Council.—At the meeting of the London County Council on Tuesday it was agreed to lend the Battersea Vestry £14,000 for electric lighting purposes, and the Shoreditch Vestry £30,000 also for a similar purpose. In connection with the electric lighting of the Victoria-embankment the Highways Committee reported that it was necessary in connection with the electric light installation that a subway should be constructed between the generating station, which was in course of erection, and the Victoria-embankment subway. The offer of Mr. S. Kavanagh to do the work for £330 was accepted.

Bradford.—On Friday last Mr. G. W. Willcocks, one of the inspectors for the Local Government Board, held an enquiry into the application of the City Council for permission to borrow a sum of £56,000 for the purposes of the extension of the city electricity works. The amount asked for was £5,100 for extension of the buildings and the remainder for machinery, the principal items being: four water-tube boilers, with mechanical stokers, etc., brickwork, and foundations, £8,560; 2,600 h.p. engines and dynamos, £9,500; cooling towers, fans, pumps, and piping, £6,000; battery, £3,000; mains, £15,000; and meters, £4,500.

Chiswick.—The offer of the Aberystwyth and Chiswick Electricity Supply Corporation, Limited, to wire the new Council offices free of charge to the Council, the installation remaining the property of the Corporation for 10 years, after which it becomes the property of the Council, in consideration of the Council agreeing to take current from the corporation for 10 years at the uniform rate of 6½d. per unit, and undertaking not to use in the Council's offices any other form of illuminant during that period, has been accepted, subject to a proviso that in the event of the charge for electricity being made less than 6d. per unit to any other consumer in the district, the rate charged to the Council shall be similarly reduced.

Notting Hill Electric Lighting Co.—The directors have issued a circular to the shareholders intimating that the directors have decided that the method of raising the £100,000 new capital which will best serve the general interests of the Company, and at the same time afford due proportionate advantage to each class of shareholders, will be by the issue at present of £22,000 in 2,200 ordinary shares at £12 each to the existing shareholders in the following proportions: 1,100 to the holders of the 9,450 ordinary and ordinary preference shares, a proportion of about one for every nine, and 1,100 to the holders of the 550 founders' shares in the proportion of two for every one. An extraordinary meeting will be held in London on Aug. 1 to confirm the proposal.

Personal.—On the occasion of the departure of Mr. W. J. Leeming from the Blackburn Corporation electricity works for the purpose of taking up the position of assistant engineer to the electricity department of Buxton, he was presented with a travelling bag, combined silver sovereign case and matchbox, meerschaum pipe, etc., by the staff and workmen of the electricity department. Mr. Giles, the chief engineer, made the presentation, and hoped Mr. Leeming would be as successful in his new position as he had been at Blackburn.—Mr. Robert Hammond, M.I.C.E., M.I.E.E., etc., has been appointed electrical engineer to the Mansfield Corporation in connection with the establishment of the municipal electricity and refuse destructor undertakings.

Pwllheli.—The Town Council have received a letter from Messrs. Bennett and Ward-Thomas, of Manchester, offering to purchase the electric lighting provisional order obtained by the Corporation. The terms offered are to reimburse the Council the cost of order up to £400; the order to be transferred on a lease for 10, 20, 30, and 42 years; if the Council decide to take over the undertaking at the end of 10, 20, or 30 years, they must pay the company the total capital outlay, plus 2½ per cent. for 10 years on the same; the company are to charge per unit a price equivalent to gas at 1s. 9d. per 1,000ft. for public lighting, and a price equivalent to 3s. 6d. per 1,000ft. for private lighting. The lighting company would also undertake to work existing Corporation tramways at 50 per cent. of the revenue. The consideration of the matter was deferred for a week.

New Issue.—The Electric and General Investment Company, Limited, offers for subscription 19,370 5 per cent. cumulative preference shares of £5 each at par of the Dudley, Stourbridge, and District Electric Traction Company, Limited. This Company has an authorised share capital of £200,000, divided into 20,000 preference and 20,000 ordinary shares of £5 each, of which 630

Digitized by Google

preference and the whole of the ordinary shares have been issued. The Company owes the British Electric Traction Company under various construction contracts a balance of £62,750, and it is estimated that the further capital required to complete the works and discharge the remaining obligations under the various orders and contracts will be about £110,000. By the present issue of shares a capital of £96,850 will be provided, and the directors propose to raise the balance of capital when required by an issue of debentures.

Glasgow.—The accounts of the Glasgow Corporation electricity department for the year ended May 31 show that the revenue amounted to £59,762, of which £55,470 was from the sale of current per meter, and £4,201 from the watching and lighting department for lighting the streets. Compared with the previous year there is an increase of £15 620. The expenditure for the year was £38,181, leaving a balance of £21,580 to be carried to profit and loss account. In the previous year the balance was £12,607. The borrowing powers sanctioned by the Secretary for Scotland amounts to £700,000, and £628,500 has been borrowed. Of this amount £11,500 has been repaid, leaving borrowing powers to be executed to the amount of £60,000. The total amount of electricity generated last year was 3,401,731 Board of Trade units, against 2,619,019 in the previous year. The amount supplied to private consumers last year was 2,566,016 units, as against 1,885,902 units in the previous year, an increase of 680,114 units, while for public lamps the quantity supplied last year was 258,334, an increase of 30,200.

Fan Motors.—We have received from the Improved Electric Glow Lamp Company, Limited, of 103, Queen Victoria-street, London, a copy of their new catalogue of improved electric fan motors for continuous and alternating currents. Having regard to the tropical conditions of climate under which we have been labouring of late, this catalogue could scarcely have made a more opportune appearance. During such weather the efficient ventilation and distribution of air in rooms comes to be regarded rather as an urgent necessity than a luxury to be denied at slight inconvenience. Although electric fan motors have already found extensive application for the purposes of artificial ventilation, there is little doubt but that their employment might with advantage be largely extended. The present spell of hot weather should, however, do far more to stimulate this desired increase than any advice we could offer in these columns. Judging from the catalogue before us, the Improved Glow Lamp Company, Limited, seem to have devoted considerable attention to the requirements of the market. Numerous types of motor fans, each designated for a special purpose, are illustrated. To quote one paragraph: "For the convenience of our customers we stock two distinct types of desk and bracket fans, 'open-field' type and 'closed-field' swivel type. The swivel type fans embody the latest improvements, and can be adjusted to create a breeze in any direction, and are fitted with a neat handle for the convenience of removal. The open type gives the same results, but being more simple in construction can be sold at a lower price." What could be more inviting? It is almost as good as a visit to Blackpool to imagine that soothing breeze floating across as we sit at our desk in a stuffy office. Nor is such a breeze beyond the hope of those whose premises may not be connected up to a permanent source of electricity supply, since the firm in question also supply fan sets complete with batteries to run 150 hours without recharging. For the prices—in every way moderate—of an article of excellent reliability and finish, we would refer the reader to the catalogue in question.

HAMPSTEAD ELECTRICITY WORKS.

The accounts of the Vestry of St. John, Hampstead, electricity department have just been issued, from which it appears that the total expenditure on capital account up to March 25, 1900, amounted to £162,212. Abstracts of the revenue account and general balance-sheet are appended:

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£ s. d.
Coal	£7,356 14 5	
Oil, waste, water, etc.	855 13 4	
Wages at generating station	1,898 8 10	
Repairs and maintenance of buildings, £33. 7s. 10d.; engines and boilers, £633. 4s. 10d.; machinery, instruments, tools, etc., £12. 2s. 3d.	678 14 11	
General charges	3 4 11	
		10,792 16 5
Distribution.		
Repairs and maintenance of mains	402 12 9	
Transformers, meters, switches, and other apparatus on consumers' premises	76 6 0	
Apparatus at distributing stations	195 6 3	
		674 5 0
Public lamps—repairs and renewals		364 17 8
Rates and taxes		380 13 8
Management Expenses.		
Salaries of engineers, etc.	1,307 12 6	
Printing and stationery	220 5 11	
General establishment charges	393 6 7	
		1,921 5 0
Other Charges.		
Insurance	94 4 8	
Discount	8 7 10	
Testing and certification of meters	61 11 3	
Costs and stamp duty obtaining loan of £2,560	17 19 0	
Investment expenses	16 6 9	
Miscellaneous	3 4 0	
		201 13 6
		14,335 11 3
Balance carried to net revenue account		16,325 4 7
		£30,660 15 10

Cr.	£ s. d.
Sale of current per meter, at 6d. and 2½d. per B.T.U.	26,595 17 10
Ditto at 4d.	1,179 18 1
	27,775 15 1
Public lighting (sale of current, etc.)	1,773 13 4
Rental of meters	1,108 8 11
Sundry receipts	42 18 6
	£30,660 15 10

BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	131,381 0
Sundry creditors	9,209 0
Net revenue account	13,426 2
Reserve fund	6,000 0
Balance due to treasurer	24,720 18 7
	£184,737 1 3

Cr. Assets.	£ s. d.
Capital account—amount expended for works	162,212 3 5
Stores on hand March 25, 1900	5,339 1 0
Electric light consumers for current, etc., £10,678. 15s. 9d.; other debtors, £507. 1s. 1d.	11,185 16 10
Amount invested in London County Consolidated Stock	6,000 0 0
	£184,737 1 3

HASTINGS ELECTRICITY WORKS.

From the accounts of the borough of Hastings electricity works department just issued it appears that the total expenditure on capital account to Dec. 31, 1899, amounted to £78,916. We give herewith abstracts of the revenue account and general balance-sheet:

REVENUE ACCOUNT.

Dr.	Expenditure.	£ s. d.
Generation of Electricity.		
Coal* or other fuel	2,662 7 11	
Oil, waste, water, and engine-room stores	459 7 11	
Wages at generating stations	982 17 11	
Repairs and maintenance	491 18 3	
		4,596 12 0
Distribution of Electricity.		
Wages and other remuneration	21 2 11	
Repairs, maintenance, etc., of mains	31 7 7	
Repairs, maintenance, etc., of transformers, etc.	100 7 6	
Repairs, etc., at distributing stations	4 9 0	
		157 7 0
Rents, Rates, and Taxes.		
Rents payable	147 13 6	
Rates and taxes	302 16 5	
		450 9 11
Management Expenses.		
Salaries	423 2 6	
Salaries or commissions of collectors	153 8 0	
Stationery and printing	64 6 11	
General establishment charges	53 17 7	
		694 15 0
Law expenses		26 16 7
Insurances, etc.		184 11 3
Balance carried to net revenue account		5,379 9 2
		£11,490 0 11

* This amount includes £279. 5s. 9d. for town dues.

Cr. Income.	£ s. d.
Sale of current per meter	8,450 19 2
Sale under contracts	362 8 1
Public lighting, £2,650; less repairs and renewals, attendance, etc., £272. 12s.	2,377 8 0
Rental of meters and other apparatus	129 17 9
Sales and repairs	49 14 11
Rents receivable	119 13 0
	£11,490 0 11

Digitized by Google

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—Redeemable stock	6,646	14	4
Premiums on issue of stock, less expenses of issue	224	5	8
Temporary loans, £58,000; less sinking fund, £2,073. 6s. 7d.	55,926	13	5
	62,797	13	5
Redemption account—Amount at Dec. 31, 1898, £533. 2s. 4d.; appropriations from revenue, £2,321. 9s.; interest, £30. 15s. 11d.	2 885	7	3
Amount due to borough treasurer	11,876	1	5
Sundry creditors	7.713	7	7
Consumers' deposits	6	0	0
Balance at credit of net revenue account	253	2	10
	£85,531	12	6

Cr. Assets.	£	s.	d.
Capital expenditure—amount expended on various works	78,916	2	4
Loans fund—appropriations to date, £786. 16s. 6d.; interest thereon, £25. 4s. 2d.	812	0	8
Stores on hand: coal, £304. 12s.; oil, waste, etc., £112. 17s. 7d.; general, £152. 0s. 5d.	569	10	0
Sundry debtors for current supplied, £4,807. 8s. 8d.; other debtors, £272. 14s. 8d.	5,080	3	4
Insurance premiums unexpired	153	16	2
	£85,531	12	6

PROVISIONAL PATENTS, 1900.

JULY 16.

12772. Improvements in and relating to arms and trolleys for overhead electrically-driven tramcars. James Townsley Pearson, St. James's Hall, Burnley.

JULY 17.

12827. Improvement in electrical switches. Ernest Edward Bartlett and John Edward Robinson, 10, St. George's-crescent, Liverpool.

12838. A "safety" carbon holder and carbon economiser for use in electric arc lamps. James William Ferrier, 7, Eythorne road, Ackerman-road, N. Brixton, London.

12842. Electric bell. Hans Edgar Friese, St. Mary's mansions, Paddington, London.

12846. Improvements in portable electrical safety lamps. Johann Glasmachers and Carl Müller, 221, Allecstrasse, Barmen, Germany. (Complete specification.)

12855. Improvements relating to the manufacture of bulbs for electric incandescent lamps. Charles Junge, 75, Chancery-lane, London. (The Oberlausitzer Glashüttenwerke Otto Hirsch, Germany.)

12874. Improvements in and relating to telephonic apparatus. Gregor Blanck, 323, High Holborn, London.

12876. An improved trolley for overhead electric traction. Edward Greenberry Johnson, Franklin Denise Palmer, and Carl Coenen, 53, Chancery-lane, London. (Complete specification.)

12893. Underground wires for transmitting electric energy. Tito Rosati, 52, Chancery-lane, London. (Complete specification.)

JULY 18.

12922. Improvements in electrical tramways and trains. Sir William Henry Preece, K.C.B., and Philip Cardew, 13, Queen Anne's-gate, Westminster, London.

12944. An improved electrical switch. Herbert Fitzroy Clayton, Thomas Bell, and Samuel Simpson Berry, 62, Market-street, Manchester.

12956. Improvements in voltameters for the electrolysis of the water system Garuti. Pompeo Garuti and Riccardo Pompili, 77, Colmore-row, Birmingham. (Complete specification.)

12971. Improvements in electric switches. David Robertson Bruce, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12972. Automatic booster in connection with a multiple-wire system. John Somerville Highfield, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

12973. An indicator for high electrical tensions. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

12977. Improved electric battery. Paul Emile Francken, 322, High Holborn, London.

12992. Improvements in or connected with electric traction. William James Davy, 40, Chancery-lane, London.

JULY 19.

13010. Improvements in high-voltage fuses. Walter Jamieson and the Scottish Wireless Electric Syndicate, Limited, 53, Bothwell-street, Glasgow.

13014. Improvements in and connected with fuses or cut-outs for high-voltage circuits. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

13015. Improvements in and connected with insulated bases for switches. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

13020. Apparatus for generating dynamical electricity by means of the direct influence of steam. Edmund van Haanen, 4, Corporation-street, Manchester.

13021. Improvements in electric ignition devices for internal-explosion engines. Edward Gardner, Thomas Harry Gardner, and Lawrence Gardner, 55, Market-street, Manchester.

13024. Improved means for starting and stopping electro-motors. August Edward Segnitz, 128, Colmore-row, Birmingham.

13031. An improvement in or connected with laminated electric switches. Albert Reame and Charles Wokes, 8 Quality-court, Chancery-lane, London.

13035. Improvements in or connected with apparatus for electrically igniting miners' safety lamps. Albert Edward Best, 33, Chancery-lane, London.

13036. Improvements in dynamo-electric machines and electric motors. Henry Francis Joel, 74, Windsor-road, Forest Gate, London.

13044. An improvement in electric railways in which transformers are carried on the train. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.

13048. Improvements in and relating to means for controlling the speed of electromotors. William Brewster Elliott and John William Eskholme, 1, Queen Victoria-street, London. (Complete specification.)

13049. Improvements in maximum demand electricity indicators. Ernest Schattner, 55, Chancery-lane, London.

JULY 20.

13081. Improvements in means for grinding and truing up dynamo commutators and the like. Percival John Purdy, 55, Market-street, Manchester.

13085. Improvements in the method of and means for sounding alarms on electric tram and motor cars. Alexandre Parietti and Aimé Regis Durante, 57, Barton-arcade, Manchester.

13095. Storage battery electrode. Roderick MacRae and Hector Campbell MacRae, 17, Basinghall-street, London (Complete specification.)

13102. Improvements in and relating to electrical conductors. William Alfred Phillips and Charles Eyre Kent, 323, High Holborn, London.

13103. A new or improved method and means for fire-proofing insulated wires and cables. William Alfred Phillips and Charles Eyre Kent, 323, High Holborn, London.

13104. Improvements in means for covering wires and cables. William Alfred Phillips and Charles Eyre Kent, 323, High Holborn, London.

13105. Improvements relating to the covering of electrical conductors. William Alfred Phillips and Charles Eyre Kent, 323, High Holborn, London.

13106. Improvements in safety devices for electric interlocking or block signalling apparatus. Frederick Thomas Hollins, Liverpool-street Station, London.

13125. Improvements in automatic cut-outs or combined cut-out and shunt switches for overhead trolley wires for electric traction, overhead electric cables, or the like. Robert Hacking, 111, Hatton-garden, London.

13134. Improvements in and relating to electric arc lamp. Allyn Ballard Walton, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 21, 1899, being date of application in United States.) (Complete specification.)

13143. Improvements in telephonic signalling apparatus, applicable also to other purposes. The Thomson-Davis Telephone System, Limited, and Arthur Thomas Milnor Thomson, 22, Southampton-buildings, Chancery-lane, London.

JULY 21.

13134. The Eiland electric "railway" fog-signal. Alfred Brook, 10, Stratford-grove, Putney, London.

13195. Improvements in electrolytic apparatus for the production of caustic soda. George Henry Smith, 40, Chancery-lane, London.

13198. Improvements in electric traction. Baptistin Cruvellier, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on August 11.

1899.

14703. Carbon electrodes for arc lamps. Bremer,

Digitized by Google

12566. Arrangement and connections of the windings of dynamo machines. Abel. (Karmin.)

14572. System of electro dynamic propulsion. Rosenfeld, Zelenay, and Dulait.

14806. Counter or meter for electric lamps, motors, and other electric apparatus. Magini.

14878. Covering electrical and other wires and apparatus therefor. Colley.

15017. Electric accumulators or secondary batteries. Weymersch.

15207. Production of battery plates or other articles by electrolytic or chemical deposition of spongy metal. Neumann.

15418. Insulated electrical conductors or cables. Edmunds.

15904. Transformer boxes. Lawson, Dallas, and Goslin.

16091. Electrical apparatus suitable for lighting, cauterising, and other purposes. Richardson and Ramsbottom.

17877. Composition of or from which may be manufactured tubes for various purposes, tyres, and other articles requiring more or less flexibility, or for use as a non-conductor of electricity. Bestwick.

19446. Apparatus for periodically producing electric current by means of irregular motive power. Gehre.

20084. Method of and means for transmitting and receiving electric waves for the production of signals and for imparting motion to machines or apparatus. Cervera-Baviera.

20436. Electric arc lamps. Curwen.

22517. Electrical influence machines. Pidgeon.

22960. Electric insulating devices. Lake. (McCarthy.)

1900.

516. Points and switches of electric tramways and railways. Vesely.

4784. Magnet winding for continuous current machines and converters for effecting simultaneously a sparkless commutation and a pressure regulation. Déri.

7781. Apparatus for wireless telegraphy. Robinson. (Secret document under Sec. 44 of the Patents, etc., Act, 1883.)

7782. Transmitting and receiving switch for wireless telegraphy. Robinson. (Secret documents under Sec. 44 of the Patents, etc., Act, 1883.)

8344. Double pin plug and socket for electrical connections. Minn and Sun Electrical Company, Limited.

8704. Apparatus for facilitating the photometry of arc lamps and like sources of light. Carter.

8829. Safety lock with electrical door-opening device. Skopec and Herd.

8930. Phonograph record cylinders of celluloid, and the method of making the same. Petit.

8945. Electric motors particularly applicable for propelling boats. Boult. (Hatch.)

9413. Electric motor suspension on electrically-propelled vehicles, such as tramcars and the like. Gibbs.

9769. Manufacture of electric railways, rail bonds, and other electric couplings or terminals. McTighe.

10444. Electric incandescent lamps of the refractory conductor type. Patrouilleau.

11006. Secondary electric batteries. Lake. (Reuterdahl.)

11022. Electrical apparatus for adjusting tramrail points. Macaulay.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	July 21	863	826	+ 36	5,176	4,669
Birmingham Tramways Co.	,, 21	4,711	4,390	+ 321	124,229	117,033
Blackburn Corp'rat'n	,, 20	540	490	+ 50	11,025	12,595
Blackpool Corporatn.	,, 19	1 321	939	+ 382	10,352	7,997
Blackpool-Fleetwood	,, 21	1,491	1,371	+ 120	3,241	3,334
Bradford City Trams	,, 22	535	441	+ 94	7,950	6,324
Bristol Tramways Co.	,, 20	3,605	3,677	- 72	—	—
City & South London	,, 22	1,411	864	+ 547	4,294	2,762
Cork E. T. and L. Co.	,, 19	489	501	- 12	11,088	9,894
Dover Tramways ...	,, 21	283	249	+ 34	5,292	4,959
Dublin U.T., elec. cars	,, 20	3,937	1,336	+2,601	—	—
Dublin S.D. Electric	,, 20	1,301	1,195	+ 106	—	—
Halifax Corporation	,, 21	867	600	+ 267	11,293	8,666
Hull Corporat'n E.S.	,, 14	1,357	—	—	18,016a	—
Liverpool Corporat'n	,, 14b	8,624	7,718	+ 906	205,803	180,814
Liverpool Overhead	,, 22	1,751	1,610	+ 141	5,193c	4,742
Sheffield Corporation	,, 22	2,450	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. b Partly electrical. c Since July 1.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Monday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 —	¾-¾
British Insulated Wire, Ord., 1-40,000	5 —	11-12
—— 6 per cent. Cum. Pref., 1-37,500	5 ..	5½ 6¼ xd
—— 5 per cent. Mortgage Debentures	100 —	96½-100½
British Electric Works, Ordinary, 50,001-95,000	1 —	¾-¾
—— 6 per cent. Cum. Pref., 1-50,000	1 —	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108 —	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 —	4¾-5¼
Brush Electrical Engineering, Ordinary	2 —	1¾-1¾
—— Non. Cum., 6 per cent. Pref.	2 —	2-2¼
—— 4½ per cent. Debenture Stock	100 ..	109-114
—— 4½ per cent. 2nd Debenture Stock	100 —	101-103
Callender's Cable, Debentures	100 —	110-114
—— Ordinary	5 —	13-14
—— 5 per cent. Pref.	5 —	5¼-5¾
Crompton and Co.	3 —	3¾ 4¼
—— 5 per cent. Debentures	— —	99-102
Edison and Swan United, Ordinary	3 —	2-2¼
—— 5 per cent. Debentures	5 —	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100 —	91-93
Electric Construction	2 —	2-2¼
—— 7 per cent. Cumulative Pref.	2 —	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100 —	102-105 xd
W. T. Henley's Telegraph Works, Ordinary	5 —	13-14
—— 4½ per cent. Preference	5 —	5¼-5¾
—— 4½ per cent. Debentures	100 —	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 —	21-22
—— 4 per cent. Debentures	100 —	101-104
Telegraph Construction and Maintenance	12 —	85-90
—— 5 per cent. Bonds	100 —	101-104
Telegraph Manufacturing, Ordinary	5 —	10-11
—— 5 per cent. Cum. Pref.	5 ..	5¼-5¾
Willans and Robinson, Ordinary, 1-30,000	5 ..	10¾-11¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5 —	6¾-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	105-107
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	¾-¾
Bournemouth and Poole, Ordinary	10 ..	11¼-12¼
—— 4½ per cent. Cum. Pref.	10 ..	10-11
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	8¼-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	5-6¼
Charing Cross and Strand	5 ..	9¼-10¼
—— 4½ per cent. Cum. Pref.	5 —	5¼-5¾
Chelsea Electricity Supply	5 —	6¼-7¼
—— 4½ per cent. Debentures	100 —	107-110
City of London, Ordinary	10 ..	8-9
—— 6 per cent. Cumulative Pref.	10 ..	12-13
—— 5 per cent. Debenture Stock	100 ..	122-127
County of London and Brush Provincial, Ordinary	10 —	8¼-9¼
—— 6 per cent. Cum. Pref.	10 —	11¼-12¼
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	— —	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4¼-5 xd
—— 4½ per cent. First Mort. Deb.	100 ..	99-102 xd
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 —	10-10½
London Electric, Ordinary	3 ..	1-1¼
—— 6 per cent. Pref.	5 ..	4-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	98-100
Metropolitan, Ordinary	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 —	111-114
—— 3½ per cent. Mortgage Debenture, Red	100 ..	96-98
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1¼-1¾
—— £5 Shares	5 ..	7¼-7¾
—— £4½ Shares, New	4½ ..	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	5¼-6¼
River Plate Electric Light and Traction, Deb.	100 ..	75-85
Royal Electrical Company of Montreal	$100 ..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100 ..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2-2½
—— 4 per cent. Debenture Stock	100 ..	85-95
South London, Ordinary	3 ..	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14-15
—— 7 per cent. Pref.	5 ..	8¼-9¼
Westminster, Ordinary	5 —	12¼-13¼
Electric Railways.—		
Central London, Ordinary	10 ..	9-9½
—— Pref. Half-Shares	5 ..	4¼-5
—— ,, ,, deferred	5 ..	4¼-5
City and South London, Consolidated Ordinary	100 ..	57-60
—— Ordinary	10 —	6-7
—— 4 per cent. Debenture Stock	100 —	120-125
—— 5 per cent. Pref. Stock '91	100 —	140-145
—— ,, ,, '96	100 —	132-137
Liverpool Overhead, 5 per cent. Pref.	— —	12½-13½
Waterloo and City, Ordinary	100 —	94 97
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 —	17½-18½
Brisbane Tramway	100 —	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10 —	10½-10¾
British Electric Traction, Ordinary, 1-30,000	10 ..	14-15
—— 30,001-75,000	10 —	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10 —	12-13
—— 5 per cent. Perpetual Debenture Stock	100 —	123-126
—— ,, ,, 1900	100 —	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 —	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 —	4-4¼
—— 5 per cent. Deb. Stock, Red.	100 —	102-105
Isle of Man Electric Power, 1-95,000	1 ..	1/16-⅛
—— 6 per cent. Preference, 100,001-170,000	1 —	1/16-⅛
Kidderminster and District Lighting and Traction, Pref.	10 —	10-10½
New General Traction, Ordinary	5 —	2¾-3¼
—— 6 per cent. Cum. Pref.	5 —	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10 —	16-18
—— 5 per cent. Cum. Pref.	10 ..	10¾-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10 —	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10 —	10-11
Telephones.—		
National Telephone, Ordinary	5 ..	4¾-5¼
—— 6 per cent. Cum. First Pref.	10 —	13-15
—— 6 per cent. Cum. Second Pref.	10 —	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 —	5-5½
—— 3½ per cent. Deb. Stock, Red.	100 —	97-100
Oriental Telephone and Electric Company	1 —	¾-1¼

Digitized by Google

NOTES.

West Indian Cables.—We are glad to notice that the Jamaica-Colon cable of the West India and Panama Telegraph Company has been repaired, and messages for the Isthmus of Panama and all places in the United States of Colombia can now again be sent "*vid* Bermuda."

New Atlantic Cable.—The Commercial Cable Company's new cable from the Azores to New York, *vid* Nova Scotia, has been successfully laid, and was opened for business on Aug. 1. This line, which forms the company's fourth Atlantic cable, will connect at the Azores with the system of the Europe and Azores Telegraph Company.

Motorcar Accident.—We regret to note that the local manager for the National Telephone Company in the Cumberland and Westmoreland district, Mr. H. H. Eley, met with his death last week. The cause of death was an accident while trying a new motorcar. The deceased gentleman was well known and greatly liked in the district to which he was attached.

Institution of Electrical Engineers. — It is announced that permission has been kindly granted for the Institution of Electrical Engineers at their Paris meeting this month to hold a reception in the British Royal Pavilion in the Paris Exhibition from 5 to 7 p.m. on Wednesday, Aug. 22, and that arrangements for the reception are being made accordingly.

Books Received.—We have received from the Street Railway Publishing Company, of New York, a copy of a book by Mr. G. T. Hanchett, S.B., entitled "Modern Electric Railway Motors."—We have also received a copy of a small work entitled "The Application of Electric Motors to Machine Driving," by Mr. Andrew Stewart, A.I.E.E., published by Messrs. S. Rentell and Co., Limited, 2, Exeter-street, W.C.

Wedding. — A pretty wedding was solemnised last week at St. Saviour's Parish Church, St. Helier, Jersey, between Mr. Ellis John Hidden, district manager, National Telephone Company, Liverpool, and Miss Isabel May Laurens. Both Mr. and Mrs. E. J. Hidden have, we believe, been the recipients of a number of handsome presents, several of which have been forwarded by the staff of the National Telephone Company.

New Book.—For some time past, we are informed, Mr. W. Perren Maycock, M.I.E.E., has been engaged on a new work entitled "Electric Wiring Tables." This is now in the press, and is shortly to be published by Messrs. Whittaker and Co., of Paternoster-square, E.C. The book will be of small size for the waistcoat pocket, and the 30 or so tables therein, which are for the most part quite original, should be found of considerable use to electricians.

Electric Water-Cart.—A trial was made recently in Sydney of a new electric watering-cart, which has been constructed for the purpose of watering the tramway routes. The result of the trial was eminently satisfactory, and the car is expected to be of great practical use. The cart carries some 2,000 gallons of water, and can travel at a good rate of speed. By the use of this cart a surface of 10ft. from each side of the vehicle can be sprinkled with water.

Telephones.—We are informed that the Government offices in Germany have been testing the value of certain improvements in telephones, and the Bank of Darmstadt has now been entrusted with the floating of the novelties. It is claimed that the spoken message can be recorded in such fashion as to be reproducible as often as required; and that one wire under the new system can be used simultaneously by several persons. The sound is also strengthened, so as to make long-distance work easier, and a message can be transmitted simultaneously to various points.

Cape-to-Cairo Telegraphs. — The Berlin correspondent of the *Daily Mail* informs us that the trans-African telegraph line, which is being constructed by Mr. Rhodes, was to reach Kassanga, which is in German territory, by the end of July. The information which we receive as to the progress of this line is not very much, but such as it is, it always points to the fact that great efforts are being made to complete this important line within a comparatively short space of time.

Channel Steamers and Wireless Telegraphy.—We have stated before in our columns that a system of wireless telegraphy was to be installed on the South-Eastern and Chatham and Dover Railway Companies' boats between Dover and Calais. This scheme, however, seems doomed to failure, owing to the obstruction of the Post Office authorities. The installation was not intended to have in any way taken the place of the Post Office telegraphs in the conveying of messages, but would have been used by the railway companies entirely on their own business.

The Pacific Cable.—According to the Ottawa correspondent of the *Times*, there is another outburst of indignant protest in the Canadian Press over the inexplicable delay in connection with the Pacific cable tenders. Canadians cannot understand why the manufacturing firms should have been given a month's notice when a week would have sufficed, unless it was so arranged in order that the tenders should be received at a date (Aug. 14) when London is deserted, and the members of Parliament interested in the question are away on their holidays, thus securing further delay in the interests of the Eastern Extension Company.

Our Volunteers.—At the meeting of Messrs. Crompton and Co., which was held last Monday, one of the shareholders asked for information as to the members of the firm who were away in South Africa. The chairman himself could not give much new information on this point, but stated that the corps had been showing itself of great use. Another of the shareholders, however, gave the required information, and stated that, from a conversation with a member of Mr. R. E. B. Crompton's family on the previous day, he learnt that Mr. Crompton was still in Pretoria in connection with the organisation of the construction train.

To Brighton by Motor.—From the *Daily Mail* we gather that a new electric automobile — a voiturette to carry two persons—built by the National Motor Carriage Syndicate, has made a successful run from London to Brighton on one charge of electricity. The total distance covered was 53 miles, the run being made at an average speed of 10 miles an hour, and varying from 15 miles per hour on the level or slight inclines to six miles per hour going up the hills. The automobile is of English construction, the carriage being the work of Mulliner, of Northampton, while the electrical and mechanical part is by Messrs. Joel and Potter, of London.

A Novel Mission.—According to the *Daily Mail*, Mr. Charles T. Yerkes, the American street railway magnate, has arrived in England from New York. The reason of the visit of Mr. Yerkes is to negotiate with the County Council for the building of electric tramways in London. It is stated that it was at first Mr. Yerkes's intention to bid for the control of London's street tramways; but as London is rather an expensive place for little experiments of this kind, he now proposes to confine himself to the mere task

Digitized by Google

of building the lines if he can obtain the contract. Mr. Yerkes is stated to own the controlling interest in most of the principal street railways in the United States.

Royal Telephones.—The telephone evidently finds favour in Royal eyes, as we learn that a telephone has been established between Windsor Castle and Cumberland Lodge, which is situated some distance away in the Windsor Park. In former times it was usual to send a mounted courier with messages from the Queen to Prince and Princess Christian, but under the new order of things this messenger has been found to be needless. The telephone had previous to this been installed between Windsor and Buckingham Palace, Marlborough House, and the principal Government buildings.

Electricity in Lahore.—We are glad to note that yet another important town in India has seen the advantage to be derived from using electricity as an illuminant. We have from time to time during the past few years noted the fact of one or other Indian town installing electricity, and in most of them it has proved quite a success. The latest convert to this system of lighting is Lahore. In this town the municipal authority have decided to instal electric light, but as a makeshift, until the electrical scheme is finished, they are about to proceed with the lighting of the main road with acetylene. The electrical scheme is, we understand, expected to be realised in about two years' time.

Russian Electric Tramways.—The tramway lines in Moscow, we learn, are about to be extended, and will reach a total of 84 miles. It has been decided at the same time to change the present system of horse traction for the electric trolley system over the greater part of the system, while the remainder will be operated on the surface-contact system and by accumulators. The cars will travel at a speed of 12½ miles an hour. The time limit allowed for the conversion of the lines from horse to electric traction is four years. At Riga, also, the Municipal Council have decided to construct a system of electric tramways, and have obtained powers to borrow £160,000 for this purpose.

Indian Electric Tramways.—We notice in our contemporary *Indian Engineering* the announcement that proposals having been made for making an electric tramway between Hyderabad and Secunderabad, a scheme has been formulated which combines a service of electric lighting and all the other advantages derivable from electrical power supply installation. The scheme is, however, at present only under consideration, and its fate is very uncertain. However, the mere fact of the necessity for electric traction having been recognised in this important part of our Indian Empire should be very encouraging to the makers and designers of apparatus for this kind of work.

The Shah in Paris.—The visit of the Shah of Persia to Paris has, one would judge from the accounts of his doings in that city, furnished him with ample food for thought during the next few months. Thus his Majesty has been surprised and pleased with the horseless vehicle as used in France. He is, we gather, intending to purchase one or more to take back to Persia with him, and for this purpose has had several makes brought up for inspection, but it is supposed that he will inspect the exhibition at Vincennes before taking the final plunge. His method of inspection and trial is rather dangerous, it would seem, as it consists of rushing up and down the Bois de Boulogne at breakneck speed.

A New Transatlantic Cable.—It is stated that on Wednesday last the first German-American cable was opened for the transmission of direct messages between Germany and the United States. The line stretches from Borkum to Fayal, one of the Azores, and thence to New York, and is 4,366 knots in length. The cable was laid by a British company, but was taken over by the German Atlantic Telegraph Company on payment of a sum of nearly two millions sterling. The German Government will, we understand, subsidise the new undertaking by an annual payment of £140,000 for 40 years on condition that another cable is laid should the Government consider this advisable. The price per word to New York will be just over 1s.

Electricity in Germany.—From statistics recently published in Germany, we gather that the electrical industry in that country is progressing at a very fast rate. Thus in the German Empire, it is stated, more towns are supplied with electricity than with gas, and electrical railways are becoming more in demand. There is, however, great difficulty in Prussia in getting the authorities to allow a charter to be granted to a private company for running long electric lines. The reason for this is said to be that the authorities look to the railways as one of their chief sources of revenue, and in consequence wish to have practically entire control of them. It has, however, been stated that experiments are being tried in high-speed electric traction, and we hope that some good results will follow.

The Central London Railway.—The opening of this line to the public last Monday seems to have been rather successful as a start. There was but one slight mishap, owing, we believe, to a brake getting out of order; but, taken as a whole, the railway performed its first day's public service in a very creditable manner. The effect of the opening of the line on the other underground railways has yet to be seen, but as far as one can judge from personal observation the new railway has drawn away a considerable number of passengers from the older ones. A great many, no doubt, may return to the latter in time, probably only travelling on the new line as a novelty. There can be no doubt, however, but that this new facility for reaching the City will to some extent affect the receipts of the other companies.

Electricity on German Warships.—Electricity is finding extensive employment both for lighting and power purposes upon some of the newer ships of the German navy. In proof of this it will suffice to instance the "Fürst Bismark," which possesses, perhaps, the largest electrical installation of any war vessel in the world. The vessel in question, it may be mentioned, is an armoured cruiser displacing some 10,608 tons. Her electrical equipment comprises five compound-wound steam dynamos, each having an output of 590 amperes at a terminal potential of 110 volts. The electromotors on board number 43, while five 40,000-c.p. searchlights are installed, besides about 1,000 incandescent lamps. In addition to the interior lighting of the ship, and for the telegraph, signalling, and searchlight apparatus, etc., electrical energy serves for working the numerous ventilators, ammunition hoists, gun turrets, steering gear, and boat hoists.

Spanish Overhead Lines.—It is gratifying to learn that the negotiations which for some time past have been taking place between the American Thomson-Houston Company and the municipal authorities at Valencia have terminated successfully. The agreement provides that the company shall equip the trams electrically, and pay a yearly rental of about £4,600 while the receipts are below £32,000, after which the lessors receive 5 per cent. more, and on reaching £40,000, 10 per cent. The whole electric plant is to be the property of the lessors, who are also to possess the right to devote to public lighting any surplus electricity generated. Electric machinery and plant is to be supplied by the American General Electric Company, but the cars will be constructed in Spain, where a few

Digitized by Google

factories recently established turn out fairly good and cheap work, though in elegance, solidity, and comfort the cars are not equal to those manufactured in the American and English shops.

Electrical Potatoes.—The question was asked in the House of Commons recently by Mr. Austin if the Vice-President of the Department of Agriculture could state what were the reasons of the enquiry promised regarding certain experiments made by Mr. O'Sullivan, of Athea, county Limerick, in the improvement of the potato crop by the introduction of electricity through lightning conductors distributed through the crops by means of wires, by which it was stated that an increase of 80 per cent. was shown. In reply, Mr. Plunkett said a departmental inspector had visited Athea to make enquiry on this subject, and reported that the experiments conducted last year by Mr. O'Sullivan to test the influence of electricity on the growth of potatoes were too limited in extent to warrant conclusive deductions. Similar experiments on a large scale were, it was stated, in progress this year under Mr. O'Sullivan's direction, and would be watched with interest by the Department.

H_2O.—The remarks of a correspondent in a contemporary upon the "all-penetrativity" of water have suggested the following lines:

The like hath Wilfred Lawson's mouth enjoyed;
It also hath a pleasant use with soap;
And in the boiler-house is well employed.
But, Allah! how the mains it hath annoyed!

It makes its path no matter where nor how,
It takes the insulation for its prey;
It shorts the main (by devil's aid, I vow)
That hath been laid with pains and care enow.

And when, by use of iron and plumbed joints,
The hand of man hath baffled it to-day—
Through the still air a passage it appoints,
It changes body twice, and then anoints.

It pays no heed to earthly rules or laws;
At gravity its nose and thumb are met.
It is its own effect without a cause.
(And very keen it is in finding flaws.)

* * * * *

'Twould seem as though the play was tit-for-tat:
Since in the sky the force the element rules,
And splits the liquid clouds. To balance that
The water strives, remembering Ararat.—J. H. C. B.

Liverpool Tramways.—The progress of the electric tramways in Liverpool is very interesting, as the conversion from horse to electric traction is in that town carried on at a rate which is unprecedented. Thus the first part of the system, which is worked by means of the overhead trolley, was opened in November, 1898. This experimental line having proved a great success, the City Council decided to equip all their lines electrically, and last year some 30 miles of track was reconstructed. About 80 miles have now been finished, and the engineers hope to finish the system within the year. During the past few months the rate of construction has been about two miles per week, a rate which, it is stated, has never before been reached. The accommodation for passengers with the electric cars will be ample, and the fares appear to be also very low, a penny fare covering from 2 to 2½ miles. The fares are to be even further cheapened, however. It is hoped that in another year a uniform 1d. fare will be established, when passengers will be able to travel nearly 8½ miles for 1d.

Electric Cars in New York.—We gather from our contemporary, the *Electrical Review* of New York, that an attempt is once more to be made to introduce storage battery cars on the streets of New York. Our contemporary remarks concerning the trial made with such cars 12 years ago in New York, that failure was at that time practically a certainty, and that it was surprising how near success the experiment came. In view, however, of the high state of perfection to which accumulators, motors, and controlling gear have been brought at the present date, it is stated that on reasonably level roads the accumulator car should prove a great success. With respect to this revival in New York, we think it would be a rather good thing if in London a similar revival were to take place, and, not discouraged by the non-success of the London Electric Cab Company, another company with a fair amount of capital were to take upon themselves to place really good and serviceable accumulator cars on London's streets. The causes which led to the downfall of the first company were in a very large measure preventable, and, with capable engineers and a good Board of directors, such a company could not fail to succeed.

The Earth's Magnetism.—In the course of a contribution to the *Elektrotechnishe Zeitschrift* upon the subject of the generation of thermo-electric currents, Herr von H. Egg-Sieberg makes some interesting deductions concerning the earth's magnetism. From the experiments which he describes, the author concludes that the magnetic influence exerted by the earth at any point must be strongest when the maximum fall of temperature occurs at that point. This assumption would explain the daily fluctuations of the earth's magnetic influence, and at the same time the circumstance that these daily fluctuations are greatest in the summer and smallest in winter. Assuming the aurora to be caused by the discharge of atmospheric electricity into the earth's surface, it is probable, continues the author, that the local direction of the earth's current is thereby so modified that the lines of force vary in the manner observed upon the appearance of the phenomena in question. Finally, it is conceivable to the author that the earth's current may undergo an appreciable change through momentarily great changes of the earth's surface caused by earthquakes and volcanic eruptions, disturbances of the magnetic needle such as have been observed on such occasions being thereby entailed.

The China Troubles.—As happened when Ladysmith, Kimberley, and Mafeking were besieged, certain papers are exclaiming, "Why was not wireless telegraphy installed at Pekin?" It would, of course, be a great relief to the various countries if communication by this means could be employed, but up to the present wireless telegraphy seems to require a lot more developing before it could be of use between Pekin and the nearest station to which the allies could approach it. In addition to this, it might be pointed out that it would take a considerable amount of time and money to instal wireless telegraphy in every town or village which might suddenly be surrounded by a hostile force. It is surprising that no one seems to have made the same remark about Coomassie, in which there was also a British garrison. It might, perhaps, be well, however, if, while there is any prospect of other important towns in China being attacked, an installation of this telegraphy were placed in them. Another important thing in connection with the Chinese rising is the need for a good cable service between that country and Europe and the United States. The present service would be anything but adequate if called upon to bear the strain of a large number of war cables, and would probably break down at most important times.

New South Wales Electrical Association.—A general meeting of this association was held recently, when an interesting paper on "The Electrical Industry in America and Great Britain" was read by Mr. J. R.

Digitized by Google

Bainton, M.I.E.E. The lecturer's remarks were confined to the appearance of the industry between October, 1899, and January, 1900. A noticeable and important feature which he noticed was the greatly increasing use of polyphase transmission schemes, with rotary converters for long-distance lines. He referred to a novel departure in traction in London—viz., the method of operating the City and South London Railway on a three-wire system, with 1,000 volts on the outer wires. The conduit systems of New York and Washington were, in his opinion, types of the very highest class of electrical street railways in the world. Apart from its application to tramway work, polyphase transmission was largely on the increase. Incidentally, the lecturer compared Sydney with San Francisco, which, with a population of 300,000, possessed 250 miles of tramway, as against 50 in the former town. He also dealt with various other matters which the electrical industry affected. In conclusion, Mr. Bainton said he was very much disappointed with the appearance of the electrical industry in England as compared with America.

The Metropolitan Railway.—We are glad to see that a success has been made of the electrical train running between Earl's Court and Kensington High-street. The success must be even greater than the chairman stated at the meeting, as the train is run at a time when the passengers are likely to be few. The chairman's statement as to the employment of electrical traction on the whole of the Inner Circle line is very gratifying. Thus he stated that a committee consisting of three members from each of the Boards of the Metropolitan and District Companies has been appointed to consider the question of applying electric traction to the working of the Inner Circle, and it has been agreed between the companies to invite eminent electrical traction firms to submit plans and specifications with detailed estimates and tenders for the necessary installation. In addition to the good results obtained from the experimental train in London, the experiments in the direction of electric traction made by the companies at Wembley Park were also stated to have been eminently satisfactory. The two companies recognise that those best informed as to the systems applicable for certain conditions are those who are engaged in building such lines, and they are doing a wise thing in asking some of the most eminent electrical firms to submit their views as to the best method or system to adopt for the working of the Circle.

House Cooling.—A great deal of ingenuity has been applied to the perfecting of methods of heating dwelling-houses in the United States. For relief from the extremes of hot weather, however, very little has been done, and there is practically no feasible method of cooling small houses. Of course, large places of entertainment are provided with apparatus for this purpose, but private houses do not offer such an easy problem from an economical standpoint. The matter has been given somewhat more attention abroad, and an interesting paper was presented at a recent meeting of the Heating and Ventilating Congress in Munich by Dr. Bruckner, who explained that the most feasible means of cooling were through ammonia or carbonic acid, which took up heat as they expanded. Dr. Bruckner described, however, one house in Germany which had a regular system of cooling operated by a 3-h.p. electric motor. The house was in Frankfort, and the system has been working for five years, salt water being cooled and carried through pipes in the ceilings of the dwelling-rooms, the ceilings being perforated with narrow slits, through which the air as it was cooled fell into the room. Being an electric motor, it was easily handled, and, in fact, the only attention given to it was by the woman cook. It is estimated that the entire outfit cost about £1,000, and the power for running it was estimated at about £15 a year. The smaller charges incidental to the machinery were not included.

Sydney Tramways.—We mentioned in a recent issue some facts as to the progress of electric tramways and railways in Australia. We again notice that in Sydney electric tramways seem to be becoming more and more appreciated. Thus in the New South Wales Railway Budget we see it mentioned that representations have been made to the Railway Commissioners urging the early conversion of the Balmain line to electrical traction, and also the extension of the line from the present terminus to the foot of Darling-street. The Commissioners, in reply, stated that they hoped to make this alteration by the end of the present year. The construction of the electric tramway from the shore of Neutral Bay to Military-road is now about completed, and was to have been opened on June 25. Trials made previous to the above-mentioned date were very satisfactory, the overhead system working extremely well. The Railway Commissioners are also stated to have recently imported a tramway motor equipment fitted with electric brakes, and experiments with this are said to have given satisfactory results. The electric tramway car-shed at Newtown is approaching completion. It is of considerable dimensions, having been designed to hold as many as 120 cars of the bogie combination type. In connection with the conversion of the steam trams to electrical working, it is also understood that similar sheds will be necessary at Randwick and elsewhere.

The Incandescent Electric Lamp.—We notice in the *Electrical Review* of New York an article on Edison incandescent lamps. The *raison d'être* of the article is that 20 years ago Mr. Edison first gave a public exhibition of his lamp, and started the first factory for its manufacture. It is pointed out as an interesting fact that while the lamp at the present time contains the same elements as when first manufactured, yet each of the elements have been so changed and developed that the present lamp is entirely different to that of 1880. The lamps were at first naturally more expensive than now, and one is not surprised to find that the cost was five times as great. In spite of this, however, the profit per lamp is now much greater than at first. Amongst the points of difference noted by the article in comparing the old and new lamp is the shape, which depended on the skill of the operator, but is now moulded. The bamboo filament of the old lamp has given place to a much neater and more useful one with a carbon coating. The amount of platinum used has been greatly reduced, and the base of the lamp considerably improved. The vacuum in the lamp, although only taking one minute to produce, is much more perfect than that of the early days, when the time taken was some hours. While dealing with these lamps, it is interesting to note that the Edison lamp factory of the General Electric Company in America turns out 55,000 lamps per day, or nearly 16,000,000 per annum.

Electrical Fires.—An attempt has recently been made by a fire insurance company in France to recover damages from an electric lighting company with respect to a fire in a consumer's premises said to be due to electricity. The company pleaded that the work was badly done, and hence that the electric lighting company was liable. The case was tried before the Court at Narbonne, and the verdict given in favour of the electric lighting company. We have seldom heard of a more ingenious attempt of an insurance company to avoid meeting its obligations. These companies have to insure their clients against damage, and before doing so must consider the risks undertaken. It is when examining these risks that they have the right to

Digitized by Google

insist on modifications, either in building construction or in the detailed equipment of the same, and the company always fix the amount of the premium in accordance with the probability of a fire occurring. Unless afterwards they can prove that the owner or the electric lighting company, for instance, has wilfully caused the fire, the insurance company has to bear the whole cost of the damage done. If this were not so, it would obviously be better for the private individual to take the risk himself, and recover from gas and electric light companies in the event of a fire occurring. In fact, we do not remember seeing anywhere a claim made with less reason, as the electric lighting companies have, as a rule, no right to inspect and condemn electric light work on the consumer's premises.

Institution of Junior Engineers.—On Friday last a number of the members of this Institution availed themselves of the opportunity afforded by Mr. Basil Mott for visiting the generating station of the Central London Railway, at Shepherd's Bush, under the guidance of Mr. Beaumont Pontifex. The electric locomotive shed was first seen, and two specially-designed steam locomotives capable of working in the tunnels were also shown. In the boiler-house were seen 16 Babcock and Wilcox boilers in eight pairs fitted with Vicar's mechanical stokers. Hunt's coal conveyor was seen in operation, taking the coal from the storage bunkers, which are of 1,000 tons capacity. Four sets of Green's economisers are fitted, and four Barnard-Wheeler cooling towers. Although the line was not open to the public, trains were running and had been for some days previously under ordinary working conditions, to accustom the employés to their duties. In the engine-house are six Reynolds-Corliss compound condensing engines supplied by the Edward P. Allis Company, each engine being of 1,300 i.h.p., and running at 94 revolutions per minute. The engines are coupled direct to three-phase generators of 850 kw. capacity, 5,000 volts pressure, and 25 cycles. At the conclusion of the visit, the party travelled over the line from Shepherd's Bush to the Bank and back.—The Institution of Junior Engineers proposes this year to hold its summer meeting at Newcastle-upon-Tyne from Aug. 13 to Aug. 18, the president being the Hon. Charles A. Parsons, F.R.S.

Sparking at Alternating-Current Switches.—An article by Herr von Ludwig Kallir, abstracted in the *Elektrotechnische Zeitschrift*, tells us something about the sparking phenomena which occur between the two metallic terminals of a switch upon pulling it out of an alternating-current circuit. The sparking which occurs upon breaking a circuit fed with alternating currents is notably of shorter duration than that which takes place when breaking a continuous-current circuit. According to Arons, the formation of an alternating-current arc between two metallic electrodes is impossible, even if the electrodes be slowly drawn asunder and previously heated. In order to learn more about the sparking phenomena in question, the author photographed the sparks on a plate moving at a known velocity. The contacts of the switch employed were of platinum or copper and mercury respectively, the cup containing the mercury being lowered at a known speed. The experiments showed that under ordinary conditions the spark is maintained only for a half period, but under conditions particularly favourable to sparking (high E.M.F., large current, slow breaking of the circuit) the spark continued for more than a half period, in many cases for nine to eleven periods. The longer maintained spark appears on the negative as a uni-directed current wave; it is not an alternating spark, but an intermittent direct-current spark. The spark, however, behaved otherwise in a vacuum, where it occurred at half periods in both directions. This may be attributed, the author thinks, either to the absence of oxygen or to the decreased pressure.

Tramway Troubles at Dudley.—A most extraordinary state of affairs has just occurred at Dudley. In connection with the reconstruction of the local tramways, the Dudley Corporation have an agreement with the British Electric Traction Company to take over at valuation in about four years' time the whole of the lines within the borough. One clause in the agreement provides that the lines shall be constructed and equipped to the satisfaction of the borough surveyor, and this caused all the trouble. On Saturday last work was proceeding on the Sedgley line of tramways when the surveyor discovered that, instead of laying the cables in earthenware conduits and setting them in pitch, the tramway company's workmen were drawing the cables through pipes. The surveyor protested, but the company's foreman still continued the work, and relations then became strained between the various officials, and a gang of Corporation workmen were set to fill up the trench which the tramway men had excavated, and as fast as the tramway men pushed forward their cutting the Corporation employés filled it up. Naturally, high words passed between the two sets of workmen, and threats were indulged in. This continued throughout the evening and into the night, but actual blows were prevented by the police. It is stated that at the earliest possible opportunity an injunction is to be applied for by the Corporation, but surely other methods than the one adopted could have been employed to get over the difficulty. The whole action seems to have been quite childish, and one would have thought beneath the dignity of the officials of a corporation and of a large tramway company.

Wireless Telegraphy.—We notice that further experiments in wireless telegraphy are about to be made between Ilfracombe and the Mumbles, across the Bristol Channel, a distance of about 25 miles. For this purpose a pole 115ft. high has been erected at Ilfracombe, and a similar pole has been fixed at the Mumbles. The system designed by Sir W. H. Preece, before that of Marconi, and improved recently, is to be tried. In commenting on this fact, the *Western Morning News* considers it remarkable that the Admiralty have made no wireless telegraphy installations on the coast for communicating with the battleships at sea during the manœuvres, all that has been done being to signal to passing ships by semaphore and flagstaffs. These are visible only a few miles at sea, and in foggy weather are of little use. In such weather guns are used, and loud sirens giving long and short blasts representing the dots and dashes of the Morse alphabet. Four ships of the "A" Fleet—viz., the "Majestic," the "Diadem," the "Blake," and the "Edgar"—are fitted with the wireless telegraphy apparatus designed by Captain H. B. Jackson, R.N., which is similar in some respects to that of Marconi. The navy this year has abandoned Marconi's system, which was successfully worked by the inventor last year between two battleships 65 miles apart, and has fallen back upon the earlier system invented by Captain Jackson. So far this system has not been worked a greater distance than 25 miles, and then somewhat imperfectly, the dots and dashes having a tendency to run into one another. That the Admiralty is fully alive to the importance of the subject is obvious from the fact that a series of experiments has recently been carried on more or less successfully on board 32 vessels of the navy, at a cost of £6,400, the difference between this sum and £9,500 recently voted in the navy estimates for wireless telegraphy being charged by the company holding the royalty.

Digitized by Google

ELECTRIC LIGHTING AT ROTHESAY.

The Royal burgh of Rothesay is the most important of the many beautiful coast resorts for which the estuary of the Clyde is justly famous. It occupies a position which for natural beauty, and the various attributes that go to make up a desirable holiday haunt, it would be hard to beat.

Rothesay is to Glasgow and the West of Scotland what Brighton is to London—indeed, one often hears it described as "the Brighton of Scotland," or, again, as "the Madeira of Scotland." Though Rothesay is compared to Brighton and Madeira, this does not in the least imply that Scotchmen consider either of these places to be a patch on their favourite holiday resort, as a born Scot would not consider Brighton to be "in the same street" as Rothesay, while Maderia would only come in as a bad second. Situated on a beautiful bay in the island of Bute, and surrounded by the lochs and mountains of Argyleshire, the town presents on a fine summer day an appearance which pleases the eye of the tourist, even though he has seen all the most beautiful seaside resorts both at home and in other lands.

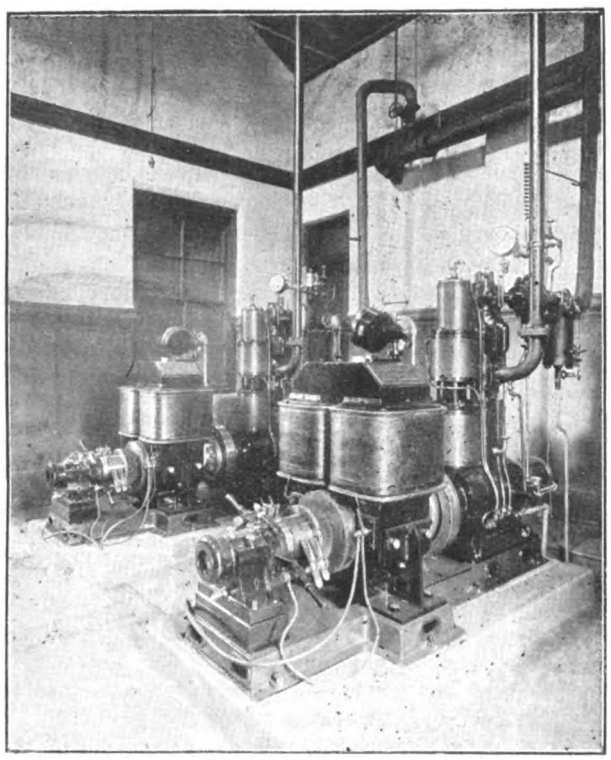


FIG. 1.—Interior of Engine and Dynamo Room, Rothesay.

However, enough has been said with regard to the natural beauties of the town, and now we come to the latest acquisition which has been obtained to supplement these natural attractions—namely, the installation of the electric light. In the year 1897 it was decided to obtain a report and preliminary estimate with a view to applying for a provisional order, should the Town Council consider the proposed outlays as likely to result in the benefiting of the community. At the time of the inception of the scheme Rothesay was fortunate in having for its provost the Marquis of Bute, who, having an extensive private installation at his beautiful residence, Mountstuart, near Rothesay, was in a position to appreciate the great advantages which would accrue to the burgh from the introduction of electric light. A committee of the Council was formed to deal with the question of electric lighting, having for chairman ex-Provost Milloy, who from the time that the matter first came up to the completion of the work has spared no trouble to insure the success of the scheme. The Council employed as their consulting engineer Mr. T. Crichton Fulton, of Glasgow, and a provisional order having been applied for and granted in November, 1898, Mr. Fulton was instructed to prepare a report on the most suitable scheme for the town. Several schemes were submitted, and the one that was chosen was for a continuous-current supply for public and private lighting on the three-wire system, with 500 volts between the outers.

We may here digress to point out that Rothesay is not in the happy position of having an "all-the-year-round" season like most of the English watering places, about four months being the extent of the season proper. The only establishments which are at all extensively patronised in the winter are the two hydropathics, the larger of which has a private electric light installation. For this reason, principally, it was not thought advisable at the commencement of the undertaking to put down plant for private consumers, as owing to the short hours of lighting during the "season" the demand would have been very small. In spite

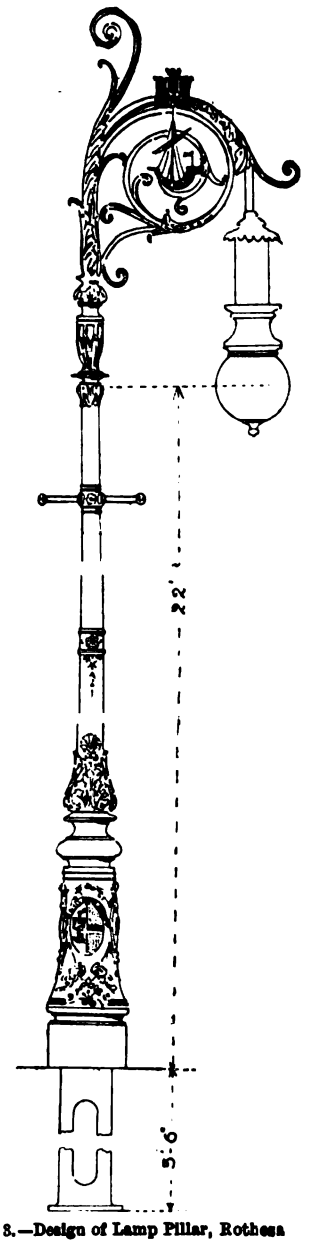


FIG. 3.—Design of Lamp Pillar, Rothesa

of this fact, however, there should be no difficulty in running plant for private lighting at a profit after a reasonable time has been allowed to elapse for the new illuminant to "catch on" with the public.

The Council having decided to proceed with the public lighting of the burgh, the work was put out to public tender. The tender accepted by the Council was that of Messrs. Lowdon Bros. and Co., of Temple Electric Works, Dundee, whose offer for the work was about £2,500, exclusive of trenching and foundation work. The total cost of the work, including all extras and trenching, came to about £3,000. The plant as at present running is arranged so as to fit in with the extended scheme, with the minimum amount of expense and alteration when the extensions have to be made. The site of the generating station is at the new Corporation gasworks, which are situated barely half a mile from the central part of the town.

The station is a substantial brick-built house about 80ft

Digitized by Google

square, situated only about 10ft. or thereabouts from the boilers. The main steam-pipe is 7in. in diameter, of welded steel, with flanges screwed and riveted, and jointed with corrugated brass jointing rings. The branch steam and exhaust pipes are of wrought iron, with screwed connections. All the piping under pressure is lagged with "magnesian sectional" covering. The steam-pipe system is drained into a Sturtevant steam-trap, and is supported by means of slings from the roof and from wall brackets.

The boilers are two in number, and have been working now for about four years, being put down when the new gasworks were erected. They are not of very suitable type for an electric supply station, as they are single-flued, burning slack with Meldrum's system of forced draught, but for present demands they answer the purpose fairly well. They supply, at a reduced pressure, the gasmaking apparatus and pumps, while the electric lighting engines are supplied with steam at the full pressure of 150lb. per square inch. The boilers are fed by means of two Worthington feed pumps, which were substituted for the injectors formerly in use. These pumps are of the vertical Admiralty pattern, and each is capable of delivering 1,500 gallons of water per hour. It is intended to put down additional boiler power when the station is extended.

There are two 20-b.h.p. compound high-speed non-condensing engines, made by Messrs. Alley and McLellan, of Glasgow. They have each two cranks, four cylinders, two high-pressure 4½in. in diameter, and two low-pressure 7in. in diameter, working tandem, one pair on each of the cranks. The normal speed is 575 revolutions per minute. The governor is mounted directly on the end of the shaft, and actuates a special throttle regulating valve. The engines are guaranted to work with a steam consumption of not more than 24lb., 25lb., and 26lb. of dry steam at 145lb. pressure at full, three-quarters, and half loads respectively. The engines are coupled direct to two Parker dynamos, each capable of giving 47 amperes at 280 volts, and of being run up to 360 volts for battery charging. These are intended to act as balancers when private supply is commenced, but in the meantime they are coupled in series and supply the arc lighting circuits with current at 500 volts. Fig. 1 shows the interior of the engine and dynamo room.

The switchboard is of Messrs. Lowdon Bros. and Co.'s standard type, with fuses having a clear break of 4in., to deal with 500 volts. A Kelvin standard pattern voltmeter reading up to 600 volts and a Kelvin ammeter are mounted on the board.

The mains from the station to the centre of the town are two three-core $^7/_{18}$ S.W.G. cables, each with the three cores connected up in parallel to form a $^{21}/_{18}$ cable. When private consumers are to be supplied, the arc lamps will be fed from the distributing mains, and what are at present supplying the current for them will be used as two three-core pilot wires for two feeding points on the system. This arrangement has done away with the necessity of laying down special arc lamp mains from the station to the town, which would have been subsequently of no use. About a mile of three-core $^7/_{18}$ cable has been laid, and about 5½ miles of $^7/_{17}$ single-core cable for the arc circuits. The cables are all of the British Insulated Wire Company's make, lead-covered, armoured with steel tape, and served over all with impregnated jute yarn. They are laid directly in the ground (for the most part under the footpaths) with rough deal boards laid over them as a precaution against damage from street excavation work. Lead-covered cable without armouring, but drawn into 3in. cast-iron piping, is used on the pier. At the height of the season it is no uncommon thing for 10 or even 12 pleasure steamers to be at the pier at one time. Of course this has the effect of so crowding the pier, as to render it impossible to break up the surface for cable repairs without causing great inconvenience to the public. Hence the use of cables drawn into iron piping for this portion of the work. A diagram of the mains showing the positions of the arc lamps is given in Fig. 2.

There are 34 arc lamps in all, three of which are special Board of Trade signal lanterns for harbour purposes. The lamps are of Messrs. Crompton and Co.'s well-known "P" type, with special weather-proof hoods. They are mounted on cast-iron pillars with curved bracket arms, which present an exceedingly tasteful appearance (see Fig. 3).

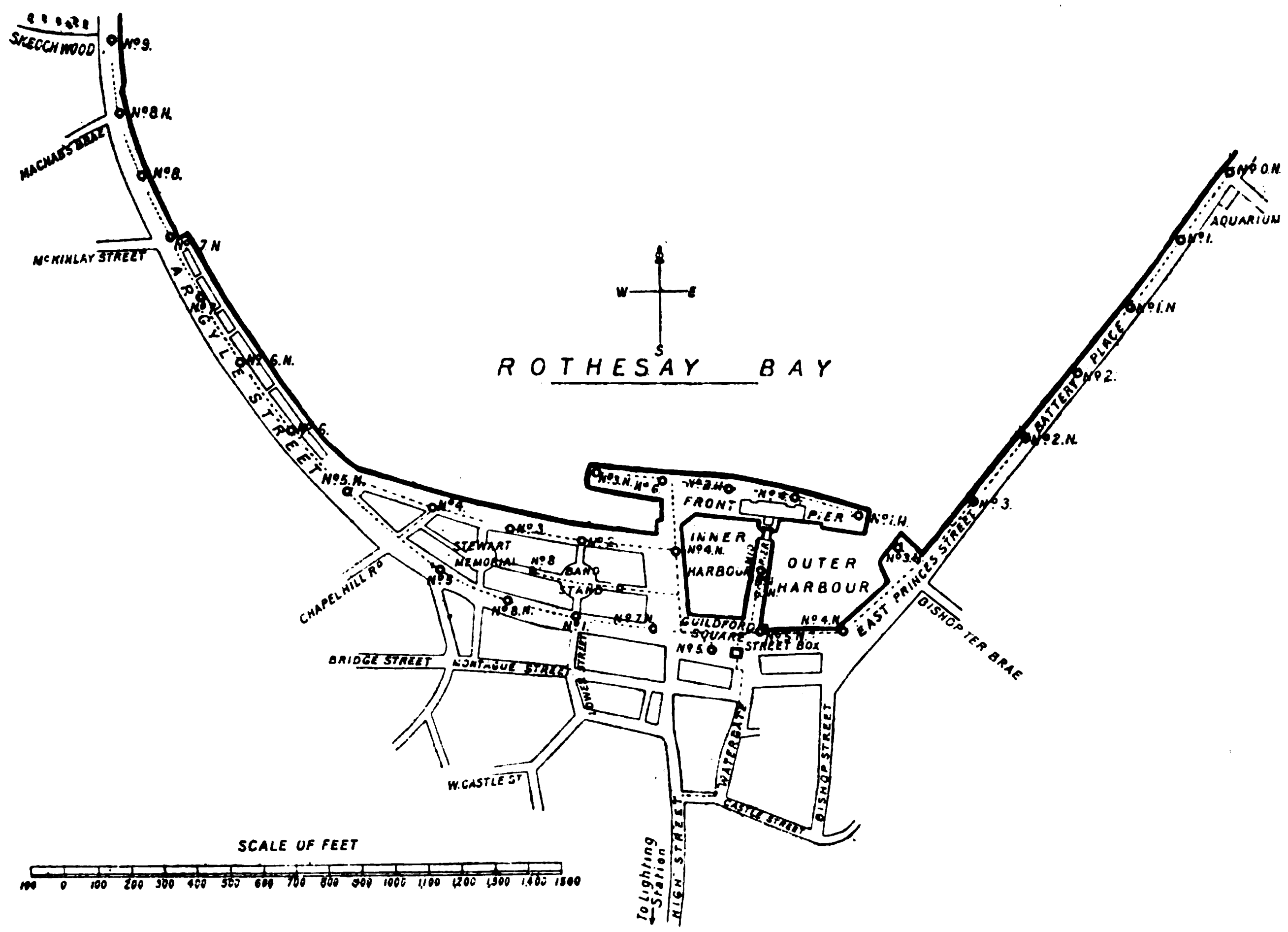


FIG 2.—Diagram of Mains, Rothesay.

Digitized by Google

The Rothesay coat-of-arms is embodied in the ornamental scrollwork of the bracket, and also embossed on the base of the pillar. They were designed and made by Messrs. Walter Macfarlane and Co., Saracen Foundry, Glasgow, who also made the special signal lanterns for the harbour. The arc lamps are arranged in four circuits, two of nine lamps each and two of eight lamps each. They are also arranged in alternate circuits, so that one half of the lamps can be switched off at midnight if desired. The switches for this purpose are arranged in the base of the first pillar of each of the four groups, which are all situated near the centre of the town and within a small area. Thus the attendant has no great distance to cover when switching off. Each lamp has an automatic cut-out, substitutional resistance, and special cutting-out switch for switching off the lamp, and at the same time substituting the resistance, leaving the lamp perfectly "dead" for examination and retrimming, should such be necessary.

The installation was successfully started up in September of last year, and has been running satisfactorily ever since, the new light being much appreciated alike by the natives of the town and the "stranger within its gates." Now that Rothesay has led the way in introducing the electric light, it is expected that most of the other coast towns on the Clyde will follow its example, as there is no mistake that the popularity of Rothesay will be greatly increased owing to the much enhanced appearance which the electric lighting has given to the town, especially the esplanade and pier, which are, of course, the parts most frequented by visitors. Messrs. Lowdon Bros. and Co. are to be complimented on the shortness of the time which elapsed between the commencement of the work and the switching on of the installation. The cable laying was commenced about the middle of May, 1899, and the lighting was started up on Sept. 12 following. In view of the amount of work which had to be got through and the delays, inseparable from the fact of all material having to be shipped, this was a remarkably good performance. On behalf of the Council, Mr. J. C. Sinclair, the burgh chamberlain, did everything in his power to expedite the work, and has, since the inception of the scheme, had its success thoroughly at heart. Messrs. Lowdon Bros. and Co. have been running the plant on contract throughout the season, and so far no serious hitch has occurred. The whole work was under the supervision of Mr. George Balfour, of the firm of Messrs. Lowdon Bros. and Co., while Mr. James Allan represented the firm on the spot from start to finish of the work.

It may be mentioned, in conclusion, that the photograph of the engine-room which we reproduce herewith was taken by Messrs. Adamson and Sons, of Rothesay, together with a unique photograph showing the bay under the electric light. The latter was obtained only after repeated attempts on a very dark night. The effect obtained is very interesting, but, unfortunately, will not bear reproduction.

THE OPENING OF EDMUNDSON'S ELECTRIC SUPPLY COMPANY'S WORKS AT GUERNSEY.

On Wednesday, July 25, the official opening of the works of this company took place, being performed by Sir Thomas Godfrey Carey, Bailiff of Guernsey, in the presence of a goodly assemblage. The ceremony took place at 12.30 p.m., when those present were invited to inspect the works.

In a lengthy speech Mr. J. C. Wigham, of Messrs. Edmundson's, explained that the company was started in Guernsey in the spring of 1897 by Messrs. Edmundson's Electricity Corporation, Limited, of Westminster, who had applied to the States of Guernsey for a concession for the establishment of an electricity supply in Guernsey. The supply was now complete, Messrs. Edmundsons having found the whole of the capital required. The concession was granted by the States in the spring of 1898, and obtained the Royal assent later on in the same year. Mr. James Duquemin, sen., M.I.C.E., architect, was subsequently asked to prepare plans for the necessary buildings, while Mr. W. H. Druce, A.M.I.C.E., engineer and manager for Messrs. Edmundsons in the island, was entrusted with the designs for the electrical equipment of the station. The building operations were commenced early in 1899 and completed about a twelvemonth after, the contract for the building work being let to Mr. J. H. Mansell, of St. Sampson's, Guernsey.

Sir Thomas Godfrey Carey said that the company had been one of high standing from the commencement. It had proved great efficiency, and deserved the full confidence of the community. He expressed the hope that every success would crown its labours, and returned thanks to Mr. Wigham for the able way in which he had explained the working of the station. The concern would be crowned with success, both for the shareholders and for the benefit of the island of Guernsey. Sir T. G. Carey then declared the works open.

Mr. Wigham prayed Sir Thomas to set the machinery in motion, the switch being turned on by Miss Carey (daughter of Sir Thomas). Mr. Edmundson subsequently presented the switch button to Sir Thomas, and three cheers for the success of the company were given by those assembled, who were then invited by Mr. Wigham to luncheon at the Yacht Hotel, where host Pells had provided a menu worthy of the occasion, and at 1.30 p.m. about 60 sat down to partake of it. After full justice had been done to the fare provided, and the usual loyal toasts had been duly honoured,

Magistrate Brouard was called upon to propose "Success to the Electric Light in Guernsey.' He said he remembered the good old time when they had to depend on oil lamps for their light. Great progress was made when gas was introduced, but now, in its turn, electric light in the island was an accomplished fact. He was sure that everyone would join in the toast which he had the honour to propose.

Mr. Edmundson, in responding, said he was glad to see so many present. He thought that the electric light in Guernsey would be a success. The work of installation had been done in a thorough and up-to-date manner.

Mr. Wigham, in proposing "Continued Success to the Island of Guernsey," said the directors of Edmundson's Electricity Corporation, Limited, advocated installations in small towns. In Guernsey they already had penny-in-the-slot meters, and he hoped that artisans would procure them. Personally, he hoped to see the electric light the poor man's light in Guernsey. The company thought it would be able to pay a small dividend at the end of the first complete year of working. Up to now three hotels had availed themselves of the new light. As to public lighting for town and harbour, they intended to have a friendly contest with their friends the gas company. They also wished to see motors installed for working cranes, printing machinery, lifts in hotels, and the stone-breaking machines at St. Sampson's, etc. Many houses and business places in the island would also some day go in for electric lighting. All the gas companies had given notice that the price of gas would be increased owing to the rise in price of coal, but it was not his company's intention to raise the price of their light. On the contrary, they would only be too pleased, as customers increased, to make a reduction.

Mr. Henry Giffard, responding to the toast, said that Mr. Druce had had the coolness to provide coolness to his guests in the shape of electric fans, and he thanked him for them. He was a born Guernsey man, but had spent the greater part of his life away from his native home, and it was the spot to which he had always wished to return. He attributed the success attained by Guernsey to its always being willing to accept light, and to-day they had accepted a new light. He remembered the time when their only light came from tallow candles, and no Bryant and May's matches to light them with. But progress had made a big step, and he could only wish continued success to the island of Guernsey.

Sir T. G. Carey proposed "Our Visitors," and gave them all a hearty welcome. It gave him great pleasure to see present so many gentlemen from England and Jersey, and he hoped that the island would profit by the light thrown into it by visitors.

This toast was responded to by Mr. W. H. Dickson, manager of the Jersey Railway Company, and Alderman Chave, of Weymouth, the latter gentleman remarking that

Digitized by Google

the Weymouth Town Council had been talking about the electric light for four years, and he hoped that they would soon have it.

"The Contractors" was proposed by Mr. GERVASE PEEK, of Guernsey, and responded to by Mr. T. CALLENDER, of Callender's Cable Company.

The toast, "The Chairman," proposed by Mr. T. W. PRESSLAND, was heartily received, and Sir THOMAS, in reply, said he was pleased to be present. He appreciated the electric company, and what he had seen of their work was a proof that the company was a sound and reliable one. The intercourse between the States and the company had always been cordial. There was one gentleman whom he thought had been forgotten in the toast list, that was Mr. D. uce, who had been the channel of communication between the States and the company, and he offered his personal thanks for the way in which that gentleman had managed the affairs of the company.

Mr. DRUCE, in a few chosen words, thanked the Bailiff for his kind remarks, and the company for the way in which they had drunk his health.

The proceedings terminated at 4 p.m.

The following is a short description of the works: As mentioned above, the work of erecting the generating station buildings, which are situated at Les Amballes, was commenced early in 1899 and completed in about 12 months. No less than 4,000 tons of earth and rock had to be removed from the site before the foundations could be put in, owing to the slope of the ground, which, therefore, necessitated putting the floors at different levels. On approaching the works, the first thing noticed is the chimney stack, which is 100ft. high and 5ft. diameter inside, the top being finished off with a neat cap of Guernsey granite. The buildings are built of local granite throughout, with the exception of the temporary end to the boiler and engine houses. The buildings comprise a boiler-house, 36ft. by 51ft., with a bunker capable of holding about 100 tons of coal next the street; an engine-house, 24ft. by 51ft.; an accumulator-room, 17ft. by 51ft.; a private office, large public office, workshop and lavatories, etc. The premises are well lighted, and sufficiently commodious for the purposes for which they are designed. An important point is that they are arranged so as to facilitate extensions when required, without disturbance to the existing structure or plant.

There are at present installed two Babcock and Wilcox 100-h.p. water-tube boilers, each capable of evaporating 3,500lb. of water per hour at a pressure of 160lb. per square inch, and room has been left for a new boiler, double the size of the existing ones, which is to be delivered in October, and which is to be fitted with mechanical stokers. In the boiler-house are also two feed pumps, one driven by steam, and the other by an electric motor; one of these is intended to act as a reserve, and the piping and valves are so arranged that in case of the failure of one pump the other can be used to supply either boiler. At the back of the boilers is the main flue leading to the chimney, and outside the boiler-house is a Green's economiser. Like the feed pipes, the steam-pipes to the engines are also in duplicate, rendering very remote any chance of a complete failure of steam to the engines. The engine-room contains two Belliss engines of 80 i.h.p. each, coupled direct to two-pole 74-kw. dynamos, running at a speed of 500 revolutions per minute, by Messrs. Thomas Parkers, Limited. These generators supply 160 amperes each at 460 volts terminal pressure. Room is left for two more engines, each capable of supplying 5,000 8-c.p. lamps, one of which is to be erected this autumn. Facing the engines is the switchboard. This has a base of Sicilian marble framed with a carved mahogany moulding. All the measuring instruments, etc., are of the Kelvin type. The battery of accumulators consists of 230 23-plate D.P. cells in glass boxes, and has a normal output of 336 kilowatt-hours and a maximum discharge rate of 80 amperes, being therefore capable of supplying 1,200 lamps for nine hours when fully charged.

The main feeder and distributor cables, of which there are at present about seven miles laid, were supplied by Messrs. Callender's Cable and Construction Company, Limited. They are of sufficient capacity to supply 10,000 lamps, so that the streets will not require to be opened again until the system has grown very considerably.

The feeders are of the triple-concentric lead-covered, armoured type, laid direct in the soil. Distributors of the three-core type are used, and these are laid in the same manner. A low-pressure three-wire system of distribution has been adopted, with a pressure of 210 volts at the consumer's lamps. The price charged per unit for lighting is 7d. and 4d., while 4d. and 1½d. is charged per unit for power, on the maximum demand system. Supply was commenced in February, 1900, and the undertaking gives every promise of complete success, well over the equivalent of 5,000 8-c.p. lamps having already been connected up to the mains. Included in this load is a fair number of motors. No street-lighting has at present been done. St. Peter Port is the principal centre supplied, the population of which amounts to 18,000. The local gasworks are owned by a company, the price charged per 1,000 cubic feet of gas being 4s. In conclusion, it may be added that Mr. W. H. Druce, A.M.I.C.E., is acting as Messrs. Edmundson's resident engineer and manager in Guernsey.

THE LEGAL RELATIONSHIP OF THE SUPPLY COMPANY TO THE CONSUMER.

[FROM A LEGAL CORRESPONDENT.]

In view of the provisions of the Electric Lighting Acts which render compulsory the supply of electricity to the private consumer, it is sometimes important for the company to have an exact idea of their legal rights and responsibilities. Foremost among a long list of penalties to which the company may become liable are the penalties for default in supplying energy, which are imposed by Clause 30 of the schedule to the Electric Lighting (Clauses) Act, 1899. It is not to be supposed, however, that a company is unable to protect itself, or that it is bound to supply electricity to all comers. Although it is provided by Section 19 of the Electric Lighting Act, 1882, that every company or person within the area shall be entitled to a supply, and by Section 20 that no undue preference shall be shown to any local authority, company, or person, yet this does not mean that the company need lay wires at their own expense for the accommodation of everyone. The whole matter is now regulated by certain sections in the schedule to the Electric Lighting (Clauses) Act of 1899. After the provisions of Section 21, which provide for the compulsory laying of street mains, it is provided in Section 27 that the undertakers shall furnish a supply to everyone whose premises are situate within 50 yards of such mains, and that they must furnish and lay any electric lines that may be necessary for the purpose, provided that the cost of (1) wires laid on the property of the owner, (2) of so much of any line as it may be necessary to lay for a greater distance than 60ft. from the main, shall, if the undertakers so require, be defrayed by the owner or occupier. The undertakers may also require security for the payment of rent by the occupier.

As electricity is still a comparatively new commodity, we are unable to refer to any cases which might be likely to render the statutes passed in relation thereto more easy of comprehension. The close analogy which exists between electricity, on the one hand, and gas and water, on the other, may, however, prove to be of assistance in our researches.

"Consumer" is defined by Section 1 of the schedule to the Electric Lighting (Clauses) Act, 1899, to mean "any body or person supplied or entitled to be supplied with energy by the undertakers." The "undertakers" are defined by Section 2 of the same Act to be "the authority, company, or other person named for that purpose in the special order." In connection with this article we may take it that the supply company are "owners" or "undertakers." In dealing with the Electric Lighting (Clauses) Act of 1899, it is important to observe that it has no application to the administrative county of London (see Section 2). Nevertheless, the form of provisional order hitherto in common use is to all intents and purposes identical with the schedule to the Act of 1899,

Digitized by Google

which must now be incorporated with and form part of every provisional order made by the Board of Trade after Oct. 1, 1899.

The Electric Lighting Act, 1882, incorporates by Section 12 the provisions of the Gasworks Clauses Act, 1847, as to breaking up streets for the purpose of laying pipes, and also with respect to waste or misuse of the electricity or injury to the pipes. It also incorporates Sections 38 to 42 and Sections 45 and 46 of the Gasworks Clauses Act, 1871, as to the recovery of electricity and meter rents. In order to ascertain the rights of a supply company to recover their reasonable charges from private owners it is therefore necessary for us to refer to the incorporated sections of the Gasworks Act, and the cases which have from time to time arisen thereunder.

The incorporated sections of the Gasworks Clauses Acts, 1847 and 1871, are to be construed for the purposes of the Electric Lighting Act, 1882, as if "gas" meant "electricity," and as if "pipe" meant "electric line," and "works" meant works as defined by the Electric Lighting Act, 1882, and as if "the limits of the special Act" meant the area within which the undertakers are authorised to supply electricity under any license, order, or special Act (see Electric Lighting Act, 1882, Section 12, Sub-Section 3). "Works" are defined in Section 32 of the Act of 1882 to be, and to include, electric lines, also any buildings, machinery, engines, works, matters, or things of whatever description required to supply electricity and to carry into effect the object of the undertakers under the Act. Bearing the above section in mind, we shall be entitled to treat the cases which have arisen with reference to gas as authoritative in relation to the supply of electricity. For the sake of clearness it will be convenient to substitute the word "electricity" for "gas," and the words "electric line" for "pipe," in setting out the incorporated sections.

By Section 39 of the Gasworks (Clauses) Act, 1871, it is provided that in case any consumer of *electricity* supplied by the undertakers leaves the premises where such *electricity* has been supplied to him without paying the rent or meter rent due from him, the undertakers shall not be entitled to require from the next tenant of such premises the payment of the arrears left unpaid by the former tenant, unless such incoming tenant has undertaken with the former tenant to pay or exonerate him from the payment of such arrears. In connection with this section it is important to remember that by Section 27 of the schedule to the Electric Lighting (Clauses) Act the undertakers are entitled to demand security for the payment of rent, therefore, if suitable precautions are taken, no liability need be incurred.

By Section 40 of the Act of 1871, if any person supplied with electricity, or with any electric meters, or fittings by the undertakers neglects to pay to the undertakers the rent due for such electricity, or the rent or money due to the undertakers for the hire or fixing of such meter, or any expenses lawfully incurred by the undertakers in cutting off the electricity from the premises of such person, the undertakers may recover the sum so due in like manner as a penalty under the Act. The use of the word penalty does not make the proceedings criminal (see R. *v.* Master or Martin, L.R., 4 Q.B., 285; 38 L.J., 73; 19 L.T., 733; 17 W.R., 442; 10 B. and S. 42), and the money due is in reality only in the nature of a civil debt, recoverable by complaint and order under Sections 6 and 35 of the Summary Jurisdiction Act, 1879. Thus, in the case of R. *v.* the Justices of Torquay (1895: 1 Q.B., 1; 64 L.J., 70; 71 L.T., 574; 43 W.R., 59), it was decided that where the justices, upon an information in writing, made an order that the defendant should pay a cab fare and costs due under Section 66 of the Town's Police Clauses Act, 1847, and that in case of non-payment he should be imprisoned in default of a sufficient distress, it was held that the order was bad, and that the fare was recoverable only in the manner in which "civil debts" are recoverable in a court of summary jurisdiction under Section 35 of that Act. There is no necessity, however, to have recourse to these decisions in the case of a recovery of electricity rents, for it is provided by Section 12, Sub-Section 3, of the Electric Lighting Act, 1882, that all offences, forfeitures, penalties, and damages under the incorporated provisions of the said Acts—*e.g.*, the Gasworks Clauses Acts—or any of them, may be prosecuted, and may be recovered in manner by the said Acts respectively enacted in relation thereto, provided that sums recoverable under the provisions of Section 40 of the Gasworks Clauses Act, 1871, shall not be recovered as penalties, but may be recovered as civil debts. The recovery of civil debts in a court of summary jurisdiction is provided by Sub-Sections 6 and 35 of the Summary Jurisdiction Act, 1879 (42 and 43 Vict., cap. 49).

It must not be supposed that the above sections limit the electric supply company to taking proceedings in a court of summary jurisdiction. It is provided by Section 41 that whenever any person neglects to pay any rent or sum due and payable, the undertakers may recover the same, with full costs of suit, in any court of competent jurisdiction; and the remedy of the undertakers under this enactment are, in addition to their other remedies, for the recovery of such rent or sum.

The register of a gasmeter is *primâ facie* evidence of the quantity consumed, and two justices may settle the difference (see Gaslight and Coke Company *v.* Cresswell, 1897, 61 J P., 699.) An important difference is made with regard to an electric lighting meter, the register of which affords conclusive evidence. Thus Clause 54 of the Electric Lighting (Clauses) Act of 1899, after declaring that in the cases of dispute the electric inspector must decide whether the meter is or is not in proper order, provides that the register of the meter shall be conclusive evidence of the value of the supply. It is also interesting to notice that the accuracy of a meter, which was sworn to be perfectly correct by a Government inspector, was successfully disputed at Wandsworth Police Court July, 1887 (see Wandsworth and Putney Gas Company *v.* Rye, 31, Sol. J., 633).

In the next place, it is important to consider the time within which proceedings for the recovery of an electric lighting rate should be instituted. This seems to be regulated by Section 11 of the Summary Jurisdiction Act, 1848, which provides that in all cases where no time is specially limited, such complaint shall be made or information laid within six calendar months from the time when the matter of it arose. That section has been applied to the hearing of a summons before justices for arrears of water rate under Section 85 of the Waterworks Clauses Act [see East London Waterworks Company *v.* Charles (1894), 2 Q B., 730; 53 L J., 209; 42 W.R., 702; 58 J.P., 764], and in the absence of express authority it is submitted that an undertaker would be unable to recover any rates beyond those which accrued due within six months of the date of the demand.

By Section 23 of the Electric Lighting Act, 1882, it is provided that any person who maliciously or fraudulently abstracts, causes to be wasted or diverted, consumes or uses any electricity, shall be guilty of simple larceny, and punishable accordingly. The introduction of this clause rendered it unnecessary for the Court to say whether electricity was a "substance" capable" of being stolen, a question which arose with regard to gas, but which was answered in the affirmative by the case of R. *v.* White (21 L. T., 159). A consumer of gas is liable to the penalty prescribed by Section 18 of the Gasworks Clauses Act, 1847, for altering a pipe communicating with a pipe belonging to the company so as to increase the supply without the company's consent, although fraud is not intended or effected [Wood *v.* West Ham Gas Company (49 J.P., 662; 62 L.T., 817)]. Having regard to the express words of Section 23, which apparently make "fraud" and "malice" an essential ingredient of the offence, the foregoing case would not appear to apply in the case of electricity.

Sections 18 to 20 of the Gasworks Act of 1847 impose penalties upon persons for (*a*) fraudulently using *electricity* of the undertakers, (*b*) wilfully removing or damaging *electric* wires, and (*c*) renders all persons breaking *electric wires*, pillars, or lamps liable to pay for the damage done to an extent not exceeding £5. Section 38 of the Act of 1871 imposes penalties for injuries to meters. Special provisions with regard to these instruments now form an integral part of every provisional order [see Clauses 49 to 59 of the schedule to the Electric Lighting (Clauses) Act, 1899].

Digitized by Google

STANDARDS OF E.M.F.

BY JOHN HENDERSON, D SC., F.R S E., A.I.E.E.

(Concluded from page 124.)

Time or Diffusion Lag.—No matter how accurately we may know the temperature of a cell and have determined its temperature coefficient, it does not always follow that we are justified in applying it in order to calculate the E M.F. of the cell under all circumstances, as it is found that the change in the E M.F. does not immediately follow on the change of temperature, but, in general, lags behind it. This is known as "time lag," and is due to the slowness of the process of diffusion in the cell when the density of a particular layer of solution has been altered by the temperature change. Many experiments have been made to determine the amount of the time lag in cells and the limiting rate of fluctuation of temperature that may be permitted whilst using the ordinary coefficient. The most important results in connection with this point are those of Ayrton and Cooper, who have shown that in a cell of the Board of Trade pattern, if kept at a constant temperature for 30 minutes before use, the E.M.F. will not differ more than 1 part in 10,000 from its calculated value. In a still more recent investigation it has been shown that in cells made up in accordance with Dr. Kahle's specification, the time lag amounted to the following values with various rates of temperature change:

·0004 volt,	temperature	changing	1deg. C.	in	7	minutes,
·00025 „	„	„	„	„	15	„
·00005 „	„	„	„	„	30	„

whilst in the case of the Board of Trade cell the time lag amounted to more than four times the above values. The time lag must depend largely on the construction of the cell and on its treatment, as, if shaken, the rate of diffusion would be much greater than if kept perfectly still Callendar states that the E.M.F. of a cell kept perfectly still may go on changing for weeks before it reaches a steady value, consequent upon a sudden change of temperature. The Callendar crystal cell has an advantage over the other forms in this respect, since having no liquid for diffusion currents to be set up in, the lag is very small.

The Clark Cell Supplying a Current.—Although it is not usual to take any appreciable current from a standard cell in ordinary testing, yet in view of possible accidental short-circuits it is advisable to investigate how far the generation of such currents will affect the E.M.F. of the cell. On this subject a number of interesting experiments have been made. According to Skinner, the amount of polarisation in a Clark cell is directly proportional to the current density, but if the resistance of the external circuit is not less than 100,000 ohms, polarisation need not be taken into account. In the Carhart-Clark cell, when the resistance of the external circuit was 300,000 ohms, no polarisation was detected, and when it was 1,000 ohms the polarisation only amounted to 1 part in 10,000 in five minutes. In connection with the production of larger currents, such as those produced by an accidental short-circuit, Fisher gives some interesting and remarkable data. In one experiment, after allowing a Clark cell to supply a current on a potentiometer wire due to a want of balance of ·01 volt for one minute, the E.M.F. fell 6 parts in 14,000, and the cell required 10 minutes' rest to recover, whilst after an actual short-circuit for 30 seconds through 2in. of No. 18 copper wire, the E M.F. fell 1 part in 1,400, and required 30 minutes' rest to recover. The rate of recovery could in every case be accelerated by slightly charging the cells from a higher E.M.F.; thus a cell which had been short-circuited for 20 hours through a few inches of thick copper wire, and whose E.M.F. had fallen to 0·17 volt, recovered after 24 hours' rest, but the same cell recovered in 2½ hours when charged from an E.M.F. of 1 4 volts. Also a cell short-circuited for five seconds whose E M.F. had fallen 8 parts in 14,000 recovered in 10 seconds when charged from an E.M.F. $\frac{1}{10}$ volt in excess of its normal value. Fisher also found that the internal resistance of Clark cells rose greatly after standing for a long time unused, but that a temporary short-circuit would reduce this in some cases from several thousand to a few hundred ohms, so that an occasional short-circuit far from being injurious to the cells was, if anything, rather beneficial.

To sum up the information we have on the Clark cell, it will be seen that it by no means comes up to the level of an ideal standard of E M.F., the chief defects being inconstancy of E.M.F. over long intervals of time and the want of certainty as to whether under given conditions we are justified in applying corrections, such as those for temperature change, which must in many cases have been obtained under totally different conditions of which we have no knowledge; and even if we did know the conditions, Jaeger's experiments on the change of constitution of the zinc sulphate indicate that the entire life history of each cell must be known before we can put much reliance on it. With regard to the most suitable form of Clark cell for commercial purposes, the Rayleigh H-cell is much too fragile to stand the knocking about such a cell must receive. The Board of Trade cell, whilst being more compact and portable, does not fulfil the other conditions necessary. The Carhart-Clark cell is open to the same objections. The Callendar crystal cell appears to be the most satisfactory form yet devised, the time lag being small and its construction admitting of its being completely immersed in a water-bath, although in other respects it is open to the same objections as the others.

Before leaving the subject of the Clark cell it will be well to look briefly at the methods of preparing the materials required in its construction and the probable impurities they contain. The mercury as supplied by chemists can, in general, be relied upon for purity if it has been redistilled, as can also the zinc rods. The greatest difficulty will doubtless be experienced in obtaining pure neutral mercurous sulphate; this as supplied usually contains mercuric sulphate, which under the action of water splits up into an acid and a basic salt; the latter is insoluble in water and can readily be detected by its yellow colour; it does not affect the E M.F. The acid salt, however, must be got rid of, and, as it is soluble in water, it is generally recommended to wash the mercurous sulphate well with distilled water, and grind it up into a paste with some pure mercury. In one specimen of mercurous sulphate which had a strong acid reaction, this process was adopted by the author with very poor results, whilst in another case mercurous sulphate, which at first gave no acid reaction, six months later turned yellow, thus indicating that decomposition had occurred. A cell employing some other salt more stable and more easily obtained pure would be much more likely to give satisfactory results.

Cadmium Cells.—Many experiments have been made with various combinations of metals and salts, with a view to obtain a primary cell free from the defects found to exist in the present Clark cell, and one of the most important results of these experiments has been the production of the cadmium cell. This cell appears to have been first devised by Weston, in America, in 1891 as the result of endeavours to obtain a cell with a small or negligible temperature coefficient. Weston, recognising that the most important factor determining the variation of the E.M.F. of the Clark cell with temperature was the alteration in density of the $ZnSO_4$ solution, chose as the electrolyte in his cell a salt which was equally soluble in hot and cold water—viz, cadmium sulphate. The electrodes of the cell are mercury and an amalgam of cadmium and mercury. The mercury is covered with a layer of paste consisting of neutral mercurous sulphate, mercury, and cadmium sulphate, the remainder of the cell being filled with a saturated solution of neutral cadmium sulphate. The form of cell adopted by Weston is shown in the accompanying figure (Fig. 5). According to Weston, the E.M.F. is 1·019 volts, and the temperature coefficient ·01 per cent. per 1deg. C. In 1893 Dearlove published the results of some experiments on cadmium cells of the Rayleigh H-form. No mention is made by him of any test for acidity of the paste or $CdSO_4$ solution, or whether any special difficulty was experienced in obtaining neutral salts. The only precaution specially mentioned was that the Hg_2SO_4 should be present in excess, otherwise the E.M.F. obtained was too high. After construction, the E.M.F. of his cells fell by 4 parts in 10,000 in 16 days. Experiments were also made using various proportions of mercury

Digitized by Google

and cadmium in the amalgam, a pure cadmium electrode giving an E.M.F. of 1·0800 volts, whilst a proportion of 1 Cd to 100 Hg gave an E.M.F. of one volt. The other values obtained have been plotted on the accompanying curve (Fig. 6), and show a rapid rise in E.M.F. with the proportion of cadmium till a proportion of 7 Cd to 100 Hg is reached, after which the curve becomes much flatter; for all proportions below 14 in 100 the E.M.F. was found to be very unsteady. Experiments on the temperature coefficient also appear to have been made on a cell having

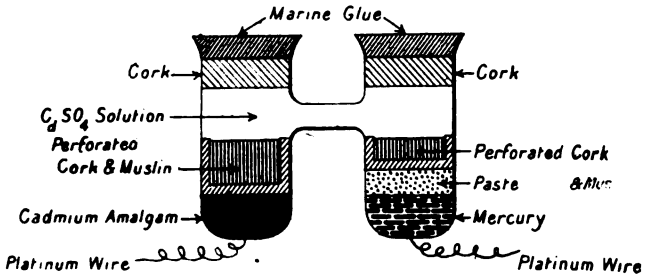


FIG. 5.

an amalgam of 1 Cd to 5 Hg, and a value of ·016 per cent. per 1deg. C. between 15deg. to 43deg. C. was obtained; the alteration of E.M.F. appeared to be entirely due to the action of heat on the amalgam, the E.M.F. falling as the temperature rose. Dearlove also states that a considerable time lag was observed in the change of the E.M.F. with temperature, but gives no data. In 1894 Jaeger and Wachsmuth published the results of a research on the cadmium cell, in which they give 1·025 volts (true) as the E.M.F. of the cell, and the following expression for the temperature variation:

$$E_t = E_0 - 1{\cdot}25 \times 10^{-5}\, t^\circ - {\cdot}065 \times 10^{-5}\, t^{\circ 2}.$$

They mention that considerable quantities of impurities in the salts only alter the E.M.F. by a few parts in 10,000. The same authors in a later paper give the results of a comparison of seven cadmium cells in series with five Clark cells in series, the cadmium cells being of the H-type.

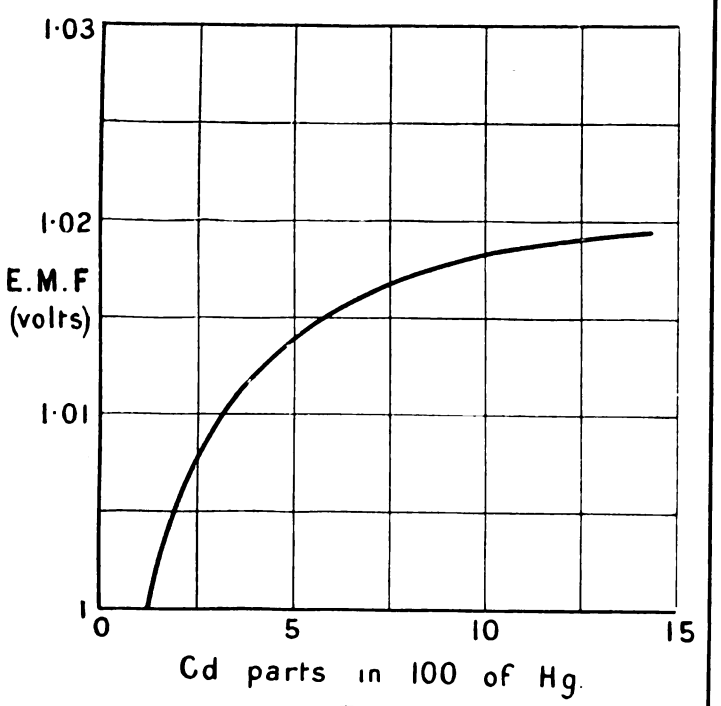


FIG. 6.

Assuming the E.M.F. of the Clark cell to be 1·435 volts at 15deg. C., they found the E.M.F. of the cadmium cell to be 1·019 volts at 20deg. C. The proportion of mercury to cadmium in these cells was 6 to 1, the Hg_2SO_4 was free from acid and basic salt, and the $CdSO_4$ gave no acid reaction. The temperature variation was expressed in the following relation:

$$E_t = E_{20} - 3{\cdot}8 \times 10^{-5}\,(t^\circ - 20) - {\cdot}065 \times 10^{-5}\,(t^\circ - 20^\circ)^2.$$

As far as ordinary impurities are concerned, they appear to produce a very small effect on the E.M.F. of the cell, one of the most likely to occur being zinc in the cadmium. This Jaeger showed raised the E.M.F. by only ·00019 volt when present to the extent of 1 per cent.; also an increase of 1 per cent. in the amount of cadmium in the amalgam raised the E.M.F. by ·001 volt. The cadmium sulphate solution was saturated by shaking up powdered $CdSO_4$ and distilled water, and allowing to stand for a long time. Any acidity could be neutralised by digesting with cadmium hydrate, made by precipitation from $CdSO_4$ with caustic soda. In a paper dated 1897, Jaeger gives a detailed description of the form of cadmium standard cell adopted by the Reichsanstalt; the Rayleigh H-form of cell is employed, and the amalgam has the composition 6 Hg to 1 Cd; the temperature coefficient is given as ·004 per cent. per 1deg. C. at 20deg. C., and it is stated that the E.M.F. is independent of the proportion of mercury in the amalgam between 6 and 13 parts to 1 of Cd. Another important contribution to our knowledge of the cell was made in 1897 by Cohen, who showed that there is a break in the solubility curve of $CdSO_4$ at 13deg. C., above which temperature it is constant; this, he suggests, will account for the irregularities in the behaviour of cadmium cells that had been observed at low temperatures. A similar observation has been made by Callendar and Barnes, two different rates of temperature variation having been obtained at temperatures between 0deg.-10deg. C., according to the treatment of the cell; this they suppose due to the existence of two hydrates of $CdSO_4$, similar to the two zinc sulphates which may occur in the Clark cell. In the most recent of their communications on the cadmium cell, Jaegar and Kahle admit irregularities in the behaviour of the cell at low temperatures, and recommend that the cell should only be used at temperatures between 20deg.-70deg. C. Also taking the most recent value for the Clark cell to be 1·4328 volts at 15deg. C., they give 1·0186 volts as the E.M.F. of the cadmium cell at 20deg. C.

From a careful study of the results of the experiments made by different physicists it will be seen that there are several points in connection with the cadmium cell that still remain to be cleared up, and several statements that are apparently at variance with one another that call for further investigation. As regards the question of acidity of the $CdSO_4$ and Hg_2SO_4, Jaeger and Wachsmuth specify neutral salts, although afterwards they state that acidity produces no effect. The next point of importance is the effect on the E.M.F. of varying the composition of the amalgam. Jaeger states that an addition of 1 per cent. Cd to the amalgam increases the E.M.F. by ·001 volt, whilst Dearlove's results show that up to 7 Cd in 100 Hg this variation of E.M.F. obtains, but from 7 to 14 Cd in 100 Hg the number is considerably less, being about ·0004 volt per 1 per cent. Cd added. Nor is Jaeger's later statement, that the E.M.F. is independent of the proportion of Cd and Hg within the limits of 7·7 and 16 parts of Cd to 100 of Hg, consistent with Dearlove's results, which show a variation of E.M.F. within these limits. The influence of impurities on the E.M.F. of the cell has been shown by all experimenters to be very small, comparatively large quantities of zinc, iron, and magnesium added to the $CdSO_4$ solution producing variations of only a few parts in 10,000 in the E.M.F. When we come to the temperature coefficient of the cells, however, we are met with a considerable divergence of opinion as to its actual value, although all experiments agree in showing it to be very small. The uncertainty in making the measurement may perhaps be largely due to the fact that the total change in E.M.F. of the cell through a range of 20deg.-30deg. C. falls within the limits of possible inaccuracy in calculating the E.M.F. of the Clark cell, which seems always to have been employed as the standard. Weston gives ·01 per cent. per 1deg. F. over a range of 200deg. F. as the maximum observed change in the E.M.F. This corresponds to a variation of ·018 per cent. per 1deg. C. A number of results by Dearlove are interesting as showing how the temperature coefficient depends on the composition of the amalgam. For cells having amalgam 1 Cd to 5 Hg the following numbers were obtained:

Range.	Coefficient.
0deg.-15deg.	·022 per cent.
15deg.-27deg.	·05 ,,
27deg.-43deg.	·035 ,,

Digitized by Google

The most interesting values, however, were those obtained from a set of five cells in which the amalgam had the composition 1 Cd to 7 Hg, and which are given in the following table:

Cell.	E.M.F.	Coefficient 15·5°-33·5°.	Coefficient 15·5°-64°.	Coefficient 33·5°-64°.
1	1·0197	·007 %	·008 %	·008 %
2	1·0196	·006 %	·010 %	·013 %
3	1·0194	·003 %	·010 %	·015 %
4	1·0189	·003 %	·010 %	·014 %
5	1·0193	·004 %	·007 %	·008 %

Taken all over it would appear that the temperature coefficient diminishes as the proportion of mercury in the amalgam increases, and the last column would indicate an increase in the temperature coefficient with rise of temperature. The change from abnormally low values at low temperatures to abnormally high values at high temperatures in some cases, points to some change in the constitution of the salt. Jaeger's two formulæ correspond to coefficients of ·001 per cent. and ·0038 per cent. Another possible explanation of the wide differences observed in the temperature coefficients of the cells is to be found in the different values of the time lag in different cells.

The Cadmium Crystal Cell.—This represents the latest form of cadmium cell, and was introduced independently by Prof. Callendar and by the author, the object being to get a cell without free liquid, and which would be portable. The following Fig. 7 shows the cell as constructed by the

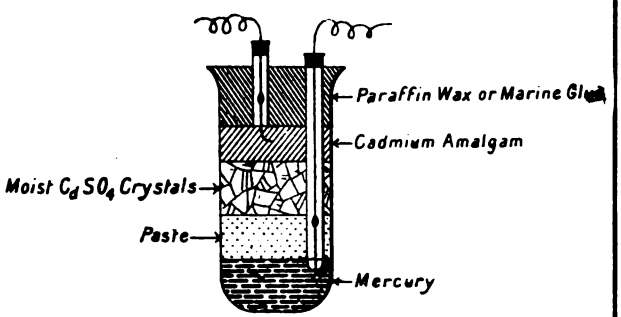


Fig. 7.

author; Fig. 8 shows an enlarged view of one of the contact wires. Several sets of these cells were made up in order to test certain disputed points in connection with cadmium cells. A set of four cells were made up with Hg_2SO_4 and $CdSO_4$ sold as pure, but which, when tested, were found to be very strongly acid. The Hg_2SO_4 was first made up into a paste with mercury, water, and a few crystals of $CdSO_4$ until it was quite stiff, when it was placed on the

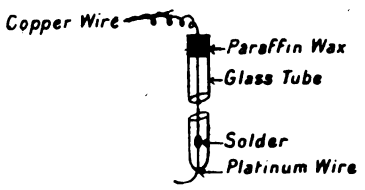


Fig. 8.

top of the pure mercury in the test tube. A thick layer of $CdSO_4$ crystals ground small in a mortar was placed above the paste, and then moistened with a few drops of distilled water. The amalgam was melted in an evaporating basin, and consisted in all cases of 1 Cd to 6 Hg by weight (M.P. 60deg. C.); this was poured on the top of the $CdSO_4$, and the connecting wire placed in it before it solidified. Paraffin-wax or marine glue was poured above the amalgam to seal up the cell. A set of two cells similar to the above, but to which strong H_2SO_4 had been added to acidify the paste and $CdSO_4$ crystals, were made up to test whether added acid would have any different effect to the ordinary acidity of the salt. A set of four cells were made up with perfectly pure and neutral $CdSO_4$ and Hg_2SO_4 (obtained from Messrs. Kahlbaume, of Berlin), and a cell acidified with H_2SO_4 was also made up with pure chemicals. The E.M.F.'s of the cells were compared on a specially-constructed potentiometer, the standard of reference for temperature variation experiments being a cadmium cell kept always at one temperature. The E.M.F. of this cell was measured absolutely by balancing it against the difference of potential between the terminals of a standard resistance carrying a current which was measured on a current balance. The results of over 200 observations at various temperatures are given below:

I.—Cells Containing Impure Salts.

Cell.	10deg.-15deg.	15deg.-20deg.	20deg.-30deg.
1	1·0185	1·0186	1·0182
2	1·0184	1·0187	1·0182
3	1·0187	1·0187	1·0181
4	1·0187	1·0187	1·0178
Mean values	1·0186	1·0187	1·0180
Maximum variation from mean—	·0002	·0001	·0002

II.—Cells Containing Pure Salts.

Cell.	10deg.-15deg.	15deg.-20deg.
1	1·0188	1·0187
2	1·0189	1·0188
3	1·0188	1·0186
4	1·0189	1·0188
Mean values	1·0188	1·0187
Maximum variation from mean—	·0001	·0001

Both the impure cells containing added acid had E.M.F.'s much greater than the above, and did not agree so well with one another. The values are given below:

Cells Containing Added Acid.

Cell.	10deg.-15deg.	15deg.-20deg.	20deg.-30deg.
1	1·0192	1·0191	1·0183
2	1·0196	1·0199	1·0191

The pure-salt cell which was acidified also gave a similar value. From the above results a remarkable agreement will be seen to exist between the E.M.F.'s of cells made of ordinary "commercially pure" materials and those of "chemically pure" salts, there being a difference of only 2 parts in 10,000 between the limits of 10deg. to 15deg., and exact agreement from 15deg. to 20deg. C. The temperature coefficients have also been calculated from the above values, and are given in the following tables:

I.—Cells Made from Impure Salts.

Cell.	Temperature coefficient.
1	·003 per cent. per 1deg. C.
2	·002 ,, ,,
3	·006 ,, ,,
4	·009 ,, ,,

II.—Cells Made from Pure Salts.

Cell.	Temperature coefficient.
1	·002 per cent. per 1deg. C.
2	·002 ,, ,,
3	·004 ,, ,,
4	·002 ,, ,,

The effect of added acid on the temperature coefficient is very evident, the values for the specially acidified cells being ·007 and ·006 per cent. respectively, as compared with average values of ·005 and ·003 per cent. respectively for the cells made up with impure and pure salts but not containing added acid.

Time Lag.—In order to examine the nature of the time lag which was found to exist in all cells, one of the cells in each set was kept at a constant temperature for several days and its E.M.F. measured; it was then immersed in a water-bath at a temperature about 15deg. C. higher, and kept there until its E.M.F. became constant. In all cases the E.M.F. showed a sudden drop on first heating, the amount increasing with the acidity of the cell and being about ·2 per cent. for the perfectly pure cells; the E.M.F. then rose slowly for about two hours, when it attained a steady value.

Recovery from Polarisation.—Very satisfactory results were obtained from all the cells with respect to the recovery of the E.M.F. after polarisation. One cell was connected up to a coil of 1,000 ohms resistance for five minutes, and two minutes after the circuit was broken its E.M.F. had returned to its original value. Several of the cells were short-circuited for five minutes, and after five minutes' rest the E.M.F.'s were found to have returned to within ·4 per cent. of their original value. Whilst if the cells received a small charge from an E.M.F. ·01 volt in excess of their proper value, they recovered almost immediately. The conclusions drawn from these experiments are that, so far as regards the fulfilment of the necessary conditions for an ideal standard of E.M.F., the cadmium

Digitized by Google

cell, and more especially the cadmium crystal cell, is distinctly superior to any modification of the Clark cell. With ordinary care, and no previous experience of standard cell manufacture, anyone can make up a cadmium crystal cell, and rely safely on its E.M.F. being well within ·1 per cent. of 1·0186 volts at all ordinary temperatures, whether the materials from which it is made up have been specially purified or not; the temperature coefficient of even acid-salt cells being so small that for most measurements it is not necessary to take any account of it.

LONG-DISTANCE TRANSMISSION IN TELEPHONIA.

The following is the abstract by the *Electrical World* of New York of a paper read at the fourth annual meeting of the Pacific Coast Transmission Association by Prof. C. L. Cory. The paper, which is to do with the regulation of transmission systems, takes up the problems connected with the transmission of power over a distance of 150 miles. The treatment had particular application to the system now under construction by the Standard Electric Company of California. The data of that plant was given as follows:

Length of transmission (approximately)	150 miles
Voltage	60,000 volts
Diameter of conductors (aluminium-stranded)	·75in.
Area of conductors	471,034 cir. mils
Maximum resistance per mile at 70deg. F.	·205 ohm
Frequency—periods per second	60
Distance between centres of conductors	42in.

The following are some of the constants of the line computed from the above data:

Inductance of the 150-mile transmission, or 300 miles of wire	·48 henry
Inductive reactance per mile of wire, or half-mile transmission, using 60 p.p.s.	·634 ohm
If 30 p.p.s. were used	·317 ,,
Impedance per mile of wire, or half-mile transmission, using 60 p.p.s.	·664 ,,
If 30 p.p.s. were used	·3775 ,,
Impedance factor of line (impedance divided by resistance), using 60 p.p.s.	3·25
If 30 p.p.s. were used	1·84
Resistance of 300 miles of line (two wires of 150-mile transmission)	61·5 ohms
Inductive reactance of 300 miles of line, using 60 p.p.s. (two wires of 150-mile transmission)	190·2 ,,
Inductive reactance of 300 miles of line, if 30 p.p.s. were used	95·1 ,,
Impedance of 300 miles of line, using 60 p.p.s.	200·0 ,,
If 30 p.p.s. were used	113·2 ,,
Capacity of the 150-mile transmission or 300 miles of wire (considered as two parallel cylinders)	1·43 microfarads
Capacity per mile of transmission line	·0095 ,,
Capacity reactance between two wires, per mile of transmission, using 60 p.p.s.	279,000 ohms
Capacity reactance between two wires, per mile of transmission, using 30 p.p.s.	558,000 ,,
Capacity reactance between two wires of 150-mile transmission, using 60 p.p.s.	1,860 ,,
Capacity reactance between two wires of 150-mile transmission, using 30 p.p.s.	3,720 ,,
Capacity or charging current between two wires of 150-mile transmission, using 60 p.p.s. and 60,000 volts	32·25 amperes
Capacity or charging current between two wires of 150-mile transmission, using 30 p.p.s. and 60,000 volts	16·125 ,,
Apparent energy to charge line, using 60 p.p.s. and 60,000 volts	3,348 kw.
Real energy to charge line, using 60 cycles and 60,000 volts	32 ,,
Apparent energy to charge line, using 30 p.p.s. and 60,000 volts	1,674 ,,
Real energy to charge line, using 30 p.p.s. and 60,000 volts	16 ,,
10,000 kw., using 60,000 volts at unity power factor requires 96·3 amperes per wire.	
The kilowatt loss in 150-mile transmission	855·5 ,,
Per cent. power loss in transmission	8·55 per cent.
Volts loss, per pair of wires, in 150-mile transmission, using 60 p.p.s.	19,260 volts
Per cent. volts loss, per pair of wires, in 150 mile transmission, using 60 p.p.s.	32·1 per cent.
Volts loss, per pair of wires, in 150-mile transmission, using 30 p.p.s.	10,901 volts
Per cent. volts loss, per pair of wires, in 150-mile transmission, using 30 p.p.s.	18·2 per cent.

The effect of capacity on a 150-mile line was shown by considering a single-phase transmission of 3,000 kw. at the receiving end, the pressure, 50,000 volts, to be maintained constant at the sub-station. The approximation was used of considering the line as shunted at the generator and at the sub-station by two condensers of one-sixth the line capacity each, and in the middle by a condenser of two-thirds the line capacity. With the line open at the sub-station the generator voltage is but 47,676, the line capacity causing the rise at the sub-station to 50,000 volts. With 3,000 kw. at unity power factor at the receiving end, the current required is 60 amperes at 50,000 volts. The 32·25 amperes charging current, when combined at right angles with the 60 amperes power current, requires 69·2 amperes at the generator, the resulting generator pressure being 58,800 volts. With 3,000 kw. at a power factor of 80 per cent. at the receiving end, the current required is 75 amperes at 50,000 volts, or 60 amperes power current and 45 amperes inductive current. The 32·25 capacity or charging current, when combined with the 60 amperes power current and 45 amperes inductive current, requires but 62·1 amperes at the generator, the resulting generator pressure being 60,000 volts.

In the discussion which followed, the value of induction motors in reducing the leading current on long lines was clearly shown. Artificial regulating impedance coils may be used to accomplish the same result. On the 83-mile 33,000-volt transmission line of the Southern California Power Company from San Bernardino to Los Angeles, the heavy charging current has been largely neutralised by distributing induction motors for pumping purposes at points along the line. Measurements were reported as having been made of the charging current on the 62-mile 20,000-volt line of the Yuba Power Company, which agreed very closely with the computed charging current as shown in the paper.

VOLTAIC CELLS.

In an article in the *Electrical World* of New York, Mr. A. G. Dell states that in working with voltaic cells he had rarely found two cells which would act exactly alike, one to all appearances polarising sooner than the other, though the solution used in each cell were exactly the same. With two cells, zinc-carbon, with bichromate of potash as a depolariser, he found that one would work for some time before there was any sign of polarisation, while the other would show apparent polarisation after but a few minutes. The zinc and solution in both were exactly alike. The carbon that polarised sooner was new, while the other had been used for about a year. Then Mr. Dell says, if the bichromate is the only agent that acts on a depolariser the two should act alike, excepting that one might furnish a larger current than the other on account of a difference in the connection. The connections in the two mentioned above were made at first equally good, and the current at start was equally good, but seeming polarisation set in sooner in one than the other. Local action in the carbons could not have caused a resistance, as the carbons were in the solution when not in operation, and the zincs are raised out of the solution. When the zincs were lowered, if local action in the carbons were the cause, the fall-off should have taken place at once, and not started with a current equal to that of the better cell and then fallen off in a few minutes. The author then states that he had often found a cell which, after working well for a time, would suddenly get in a condition such that the time for apparent polarisation to commence would be shortened, and he had also found just the reverse. These remarks applied to the cells used separately, and not connected up in series or parallel. Mr. Dell then wishes to know if it can be that the self-induced impulses that dart around the circuit (the cells being used with coils, and the current being rapidly interrupted) produce some changes at the connections of some carbons and none or little at others? If this were the case, it was possible an increase in resistance at the carbon connections was the cause, the increased resistance disappearing when the cells were left idle for a short time,

Digitized by Google

ALTERNATING-CURRENT INDUCTION MOTORS.*

BY A. C. EBORALL, ASSOCIATE.

(*Concluded from page 132.*)

Performance.—The Heyland motors standardised for circuits of 40, 50, and 60 cycles are designed in three ways, as follows: (*a*) To start without load. Under these circumstances the starting current does not exceed four-fifths of the full-load running current. (*b*) To start with two-thirds of the full-load torque. Under these circumstances the starting current does not exceed 1½ times the full-load running current. (*c*) To start with full-load torque. Under these circumstances the starting current does not exceed twice the full-load running current.

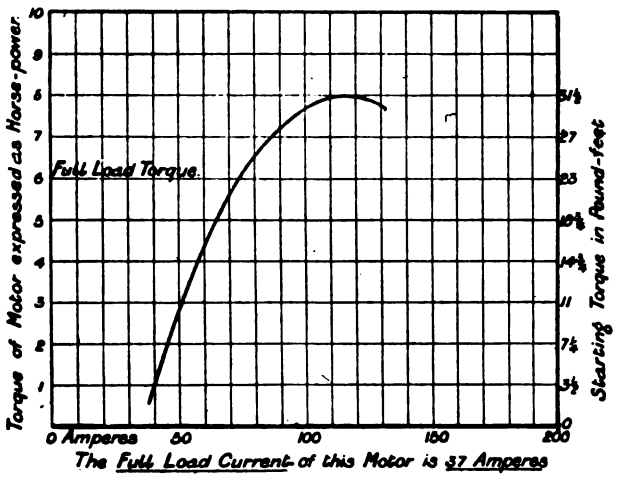


FIG. 11.

Design (*a*) has been evolved in order to conform to the ideas of many station engineers in this country. Design (*c*) represents the normal winding, while design (*b*) is frequently asked for. The starting torque with the standard stampings is determined purely by the number of turns of the starting coils and the permissible current; this torque can be arranged to have a value equal to two or three times the full-load running torque if enough current is given to the starting coils, the limiting value occurring at the saturation point of the iron.

Figs. 11 and 12 illustrate the starting performance of two motors designed to fulfil conditions (*b*) and (*c*) respectively, while Fig. 13 illustrates the running performance of the motor whose starting curve is given by Fig. 11. All these curves represent the results of actual brake tests, and many motors built have given better results than indicated here.

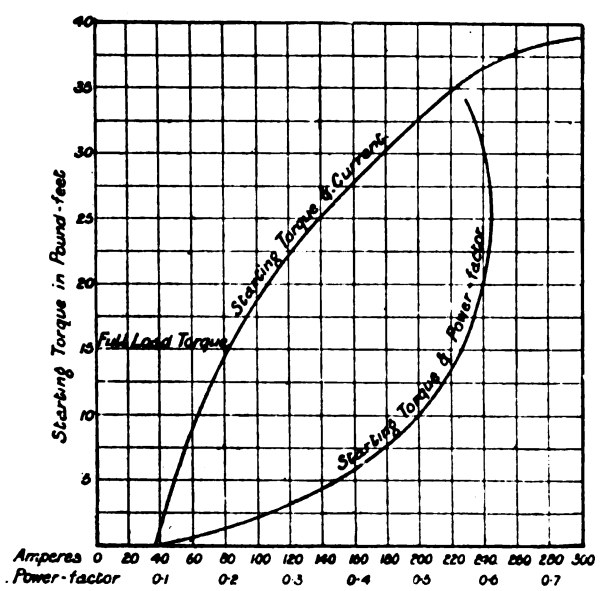


FIG. 12.

Particular attention is given in all the designs to the overload capacity of the motor, and all motors are guaranteed to stand a 25 per cent. overload for one hour. The small overload capacity (varying from 0 to 10 per cent.) found with the alternating-current motors hitherto used has been one of their worst features, as for most work it is impossible to fix the amount of power required so exactly as this, with the result that the motors installed are invariably too large and costly for the work they have to do. This reacts on consumer and supply company alike: the former has to pay for a larger motor than he wants, which will be working on the average at low efficiency, while the latter most of the time is supplying an underloaded motor

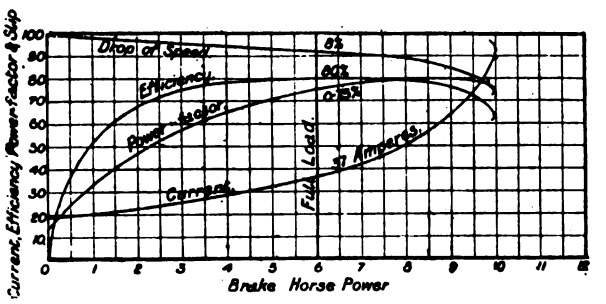


FIG. 13.

having a low power factor. The author would here like to make an exception in favour of the Wenström motor, whose overload capacity (as found with examples tested by him) is everything that can be desired.

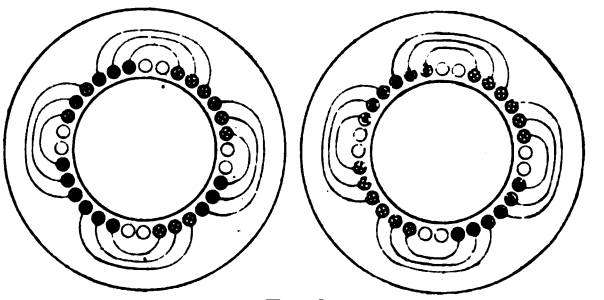


FIG. 14.

The results obtained with the Heyland motors for circuits of 80 and 100 cycles are not quite so good as those given above with regard to starting torque. That is to say, these high

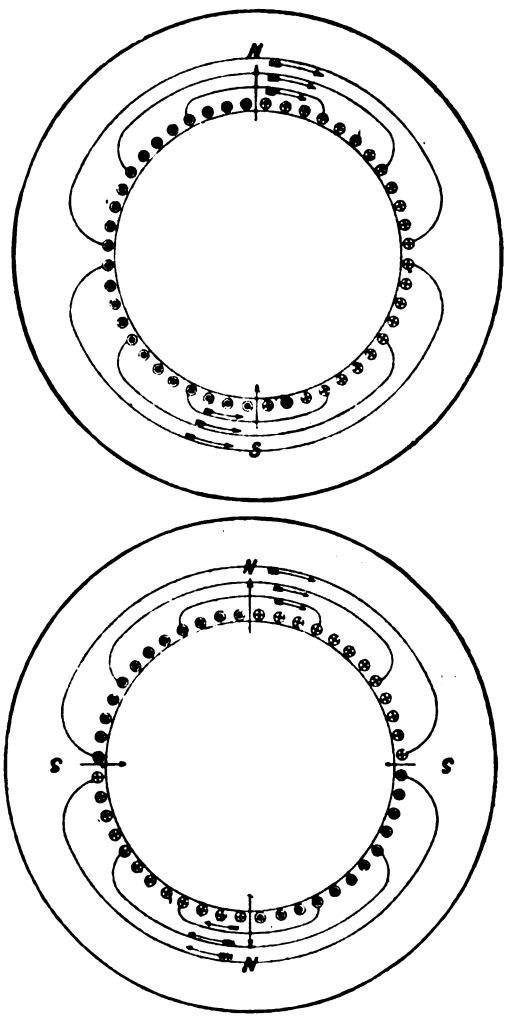


FIG. 15.

frequency motors as built up to the present take a relatively greater current for a given value of starting torque, the values being—(*a*) when starting without load, current is equal to the

* Paper read before the Institution of Electrical Engineers.

Digitized by Google

full-load current; (*b*) starting with half the full-load torque, the current is 1½ times the full-load current; (*c*) starting with full-load torque, the current consumption is 2½ to 3 times the full-load current. The increased values of current consumption are of course due to the larger number of poles necessary to bring the speed to a reasonable figure; particularly in small motors the number of poles has a very great effect on the amount of magnetic leakage with a given design. As, however, the Heyland motors are not yet fully standardised for 80 and 100 cycles, the designers hope to effect considerable improvements within the next few months in the direction of reducing the current for a given value of starting torque.

Before leaving the subject of these motors, the author would like to draw attention to an exceedingly neat method Mr. Heyland has devised for regulating the speed of induction motors, single and polyphase. As is well known, there are two principal ways of altering the speed of such motors, the supply frequency being constant. The method of "tandem parallel control" for two motors while excellent theoretically, is hardly likely to come into commercial use at present on account of the great complication involved, and because of the bad conditions under which the motors have to work. The first is by rheostatic control, a non-inductive regulating resistance being in circuit with the rotor windings, while the stator windings are connected

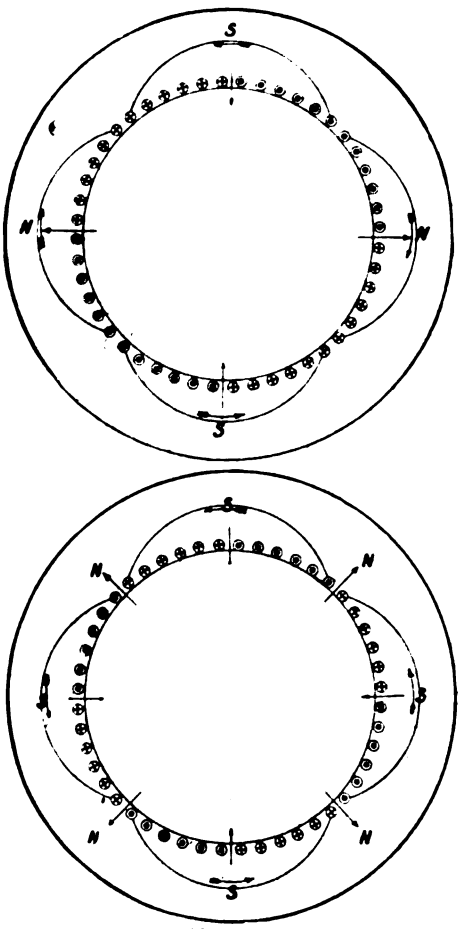


FIG. 16.

directly to the mains; the second is by altering the number of stator poles by means of a suitable controller, together with those of the rotor, unless the latter is of the "squirrel-cage" type. Here the motor is wound for the maximum number of poles, and when it becomes necessary to pass from a greater to a less pole number, in order to get increased speed, the windings on some of the poles are reversed, thus producing fewer poles, which are in consequence much broader. For instance, in order to double the speed, half the poles have their windings reversed, the stator having now half the number of poles, each of double the former breadth. While rheostatic control is simple and easy to use, it has the great objection of being very uneconomical. The waste of energy brought by its use is entirely analogous to that found with shunt-wound direct-current motors, with constant field excitation and a regulating resistance in the armature. The case of the induction motor is really more unfavourable, because it has been found by experience that the motor has to be rated very liberally in order to get the necessary power.

On the other hand, the method of altering the number of motor poles has two serious disadvantages. Firstly, the reduction of the number of poles causes an unfavourable distribution of the magnetic flux, a large increase of magnetic leakage, and a loss of winding space. This is of course owing to the fact that after the reversal of the appropriate coils the currents flowing down one side of these coils are neutralised by the currents in the adjacent side of the unreversed coils, as will be readily seen from Fig. 14 illustrating the single-phase case. Secondly, unless the motor has a squirrel-cage rotor, the rotor circuits become very complicated; the polarity of the rotor windings has to be changed each time in accordance with the stator polarity, which means that a large number of slip-rings have to be used, in order that this may be done. Mr. Heyland's method consists of certain winding arrangements which, when it is desired to change the number of poles, render any reversal of the rotor winding superfluous, and to a large extent obviate the drawbacks stated above in the reversal of the stator coils.

The method of winding the stator as applied to single-phase motors is illustrated in Figs. 15, 16, 17, and 18, the last figure showing how the stator coils are wound in practice. In all cases the winding is carried out for the smaller number of poles, and divided into sections, one or more of these sections being reversed to obtain a greater number of poles. Thus, for instance, in Fig. 15 the stator being wound initially for two

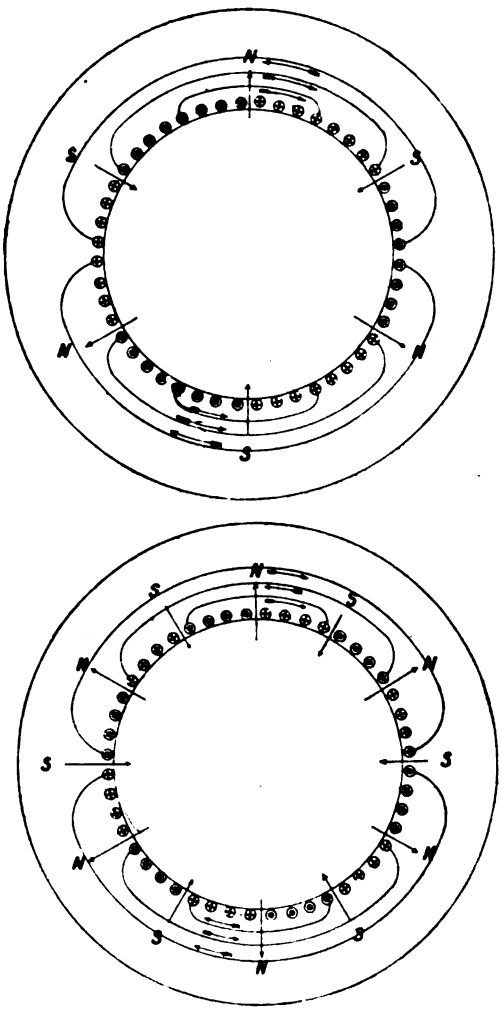


FIG. 17

poles, by reversing one of the sections of the winding a four pole stator results, as indicated, and it will be seen at a glance that there is no neutralising action between adjacent conductors, and that the distribution of magnetic flux in the air-gap will be perfectly good. Fig. 16 shows the arrangement for a four-pole to eight-pole stator, and Fig. 17 that for a six-pole to 12-pole, to which the same remarks apply. The manner of carrying out the stator winding for the last case actually employed is illustrated in Fig. 18. For polyphase motors exactly the same winding arrangements are used, applied, of course, to each phase. For these motors, if more than one change of speed is desired, the controllers get somewhat expensive, and it is, therefore, better on the whole in such cases to combine the method with rheostatic (rotor) control, the rheostat being used for the intermediate speeds only. For small motors having squirrel-cage rotors, no modification of the rotor winding is needed; but where wound rotors are employed, the general method of rotor winding is illustrated in Fig. 19, which illustrates the single-phase case for simplicity. The general principle is to so arrange the windings of each phase that they are formed of a number of sections in parallel. With a certain number of poles the E.M.F. of one section will neutralise that of another section in parallel to it, and a current will flow through the sections only when they are externally short-circuited. On the other

Digitized by Google

hand, with double the number of poles the external short-circuit is superfluous. Thus, consider Fig. 19, representing (diagrammatically) the winding for one phase of the rotor for a two-pole four-pole stator. Each phase has two sections, permanently short-circuited one on the other. At starting, the stator switch is put over to the four-pole position, and the slip-rings gradually closed through the starting resistance. So long

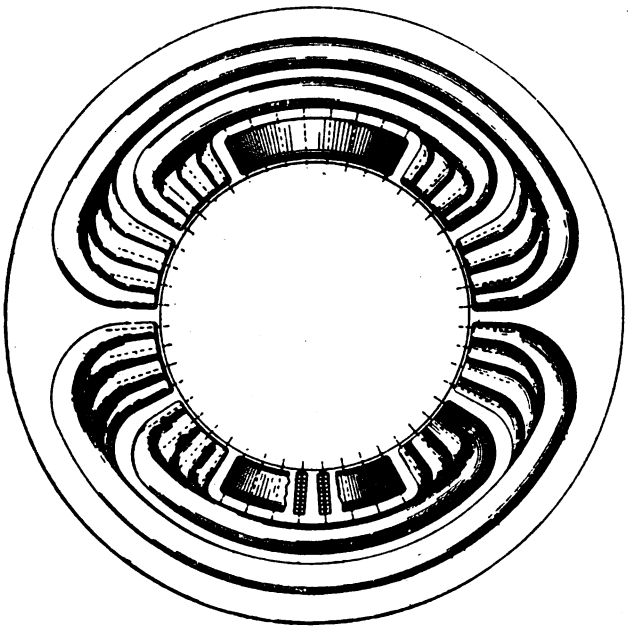


FIG. 18.

as the slip rings are open no currents flow in the rotor windings, as the induced E.M.F. has the same value in each section, and the two E.M.F.'s neutralise one another on account of the four stator poles, but the rotor currents circulate as soon as the rings are connected through the resistance. This latter is gradually cut out in the usual way as the motor comes up to speed. In changing over now to the two-pole position (if the higher speed is required) the slip-rings are not wanted, as the two sections are now in series, with the E.M.F. in the same direction, and so the rotor currents can circulate independently of the external short-circuit.

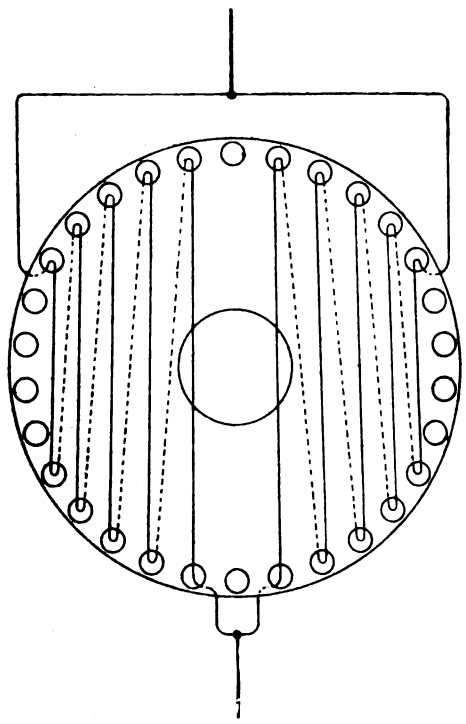


FIG. 19.

The same general arrangement is used for motors to run at more than two speeds. Here the rotor windings (per phase) can have more than two sections, these sections being wound partly to overlap one another, while still being in parallel, so that the various E.M.F.'s partly neutralise one another and partly add themselves together. With this arrangement the same rotor winding can be effectively used with a stator having several different arrangements of the poles—that is, for a motor running at several distinct speeds. For induction motors having rotors with star-connected three-phase windings, which is the practical case, only three slip-rings are required, the (second) common junction being at the three slip-rings, as usual. In the workshops of the author's firm, where many of the tools are driven by three-phase motors, the Heyland method of speed regulation is employed with great convenience. Several of the larger tools (such as planing machines and the like) are driven by independent three-phase motors wound for two speeds, the alteration of speed being effected by throwing over the reversing switch. It has been found by tests on these motors that the power factor is diminished very little by the increase in the number of poles, attaining a high value at both speeds, while the efficiency is also high at each, there being but slight loss of energy involved by the change over. At the same time, the increase of first cost with the two-speed motors is very small.

CONCLUDING REMARKS.

Although the author has dwelt at some length upon the subject of single-phase motors, it has been more on account of the technical interest attached to it than because of any belief in the present or future possibilities of single-phase systems. Regarding the Continent and the States it is not too much to say that single-phase supply is practically played out, and that engineers responsible for putting down new stations for either power or lighting consider single-phase supply systems out of date and their employment bad practice. Moreover, indications are not wanting that the present tendency in this country is to follow in the same direction. It is certain that for all those cases where continuous-current systems are out of the question every requirement can be far more successfully met by three-phase systems than by any other. It is true that certain engineers in this country hold the opinion that pressure regulation troubles are bound to occur with three-phase working (an opinion not shared by the author), but, even supposing this to be the case, the complete solution is to hand—convert to continuous current by means of rotaries, or better, by means of motor-generators. The standardisation of the above two systems, together with that of two voltages for each system—220 and 440 volts—and one frequency—50 cycles—for the supply networks, is greatly to be desired, particularly from the point of view of the motor manufacturer and the motor user. With the hope that this ideal may be eventually realised, this paper can be concluded.

LIGHT RAILWAYS.

The Light Railway Commissioners have decided to recommend the order for the construction of a light railway from Bridgwater to Cannington, Bolam Bridge, Fiddington, Stowey, and Stogursey.

An enquiry was held last week into the application for an order to construct a light railway from Norwich to Dereham. The Commissioners said they were left in the dark as to the raising of the necessary capital and the prospect of the line proving sufficiently remunerative, and therefore they could not recommend the granting of the order applied for.

An enquiry into the South Hams Light Railway scheme was held last Wednesday.

The Light Railway Commissioners have submitted to the Board of Trade an order made for the construction of a light railway in the parishes of Oakington, Westwick, and Cottenham.

The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways in the urban district of Aldershot.

At Thursday's meeting of the Middlesex County Council the following recommendations of the Parliamentary Committee were adopted: "That an agreement embodying the terms contained in an undertaking of Messrs. Booth and Smee, subject to the insertion of words to enable the County Council to promote such schemes as they may think necessary, be sealed with the common seal of the County Council, in a form approved of by the county solicitor; and that the Staines company be required to promote, at the cost of the company, a joint order in the name of the County Council and the company for authorising the following light railways: (1) a light railway commencing at the termination of the proposed Staines and Egham light railway line, and terminating at Hampton; (2) a light railway commencing at Staines through East Belfont to Hounslow; (3) a light railway from Hounslow through Cranford and Longford to Colnbrook; (4) a light railway from Hounslow through Heston to Southall; (5) a light railway from Twickenham through Hanworth to Kempton Park; (6) a light railway from Hounslow to Hanworth. That the county solicitor to have charge of the carriage of the order, and that the necessary notice be given in order to enable the County Council to pass, at its meeting in October, special resolutions approving of the intention to make the application."

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	145	The New York Metropolitan Street Railway	163
Electric Lighting at Rothesay	150	The Holly Gravity-Return System	164
The Opening of Edmundson's Electric Supply Company's Works at Guernsey	152	Questions and Answers	166
The Legal Relationship of the Supply Company to the Consumer	153	London County Council Tramways	167
Standards of E.M.F.	155	Companies' Meetings and Reports	172
Long-Distance Transmission in Telephonia	158	Contracts for Electrical Supplies	174
Voltaic Cells	158	Traction Notes	175
Alternating-Current Induction Motors	159	Lighting Notes	176
Light Railways	161	Legal Intelligence	179
Our Cousins from Across—	162	Provisional Patents	179
Speed Regulation	163	Specifications Accepted	180
		Traffic Returns	180
		Companies' Stock and Share List	180

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

OUR COUSINS FROM ACROSS—

Before this time next week many of our American cousins will be amongst us, and collectively and individually a hearty reception will await them. It is their due. They have led the race of progress throughout the century so far as applied electricity is concerned. Let us see. There is no necessity to enter into detail as regards dates and particulars—the broad facts must suffice. Notwithstanding the fear of Mr. Fahie's historic accuracy, there is no doubt the world of telegraphy owes much to Morse. He gave a much-needed fillip to the application—in a way, in fact, made it practical. Then Henry, so long forgotten, is now acknowledged to have been a pioneer discoverer in things magnetic. Come we to the telephone. Thick-headed, conservative, blundering, muddle-through-it-somehow John Bull did all he could by means of the men in authority and subjugated by red-tape to stop the introduction of one of the grandest and greatest of the discoveries in electricity. Talk about driving a joke into a Scotchman's head by the aid of a sledge-hammer; telephony has been driven into England's industries by the skill, energy, and pluck of our American brethren, who believed in it, and the converts their push obtained here. There is not a single paragraph in the history of telephony that redounds to the credit of England. True, the man who made it practical—the late Prof. Hughes—was long a resident amongst us and beloved by all, but even his great services, gratuitous to the world as they were, would not have aided much in the development of the industry had it not been for the business men who took the work in hand. Be it far from us to say there was no foresight among the permanent officials here. To our own knowledge there was plenty, because in the earliest of early days we discussed the whole subject with the then scientific chief. The stumbling block was elsewhere. "Move on," says the policeman, and we move on. Who, we ask, introduced electrical energy for lighting purposes? In England we played with it. Our manufacturers manufactured in driblets. Neither manufacturers nor moneyed interests tackled the question as a whole. Edison blundered along, consumed with the idea that electric lighting was not for the unit, but for the multitude. He studied the installation as a whole, not as a fortuitous concatenation of parts brought from various sources and having no earthly connection the one with the other. We did not agree with the bombast of his coadjutors, but Edison gave us the thing as a whole, each part designed to fulfil its function; and from his first installation the industry really started, has grown and developed, till, like the sparrow, it has made a home throughout the civilised world. Shall we proceed, and discuss power, distribution, and traction? Who will be found ready to take up the battle gage for England in this development as against America? What we have done is not pioneering work; it is simply the weight of circumstances and national characteristics that compel the pioneers to build and equip their factories here. From a national point of view this is a distinct gain, but it detracts nothing from the fact that someone else had to show us the

Digitized by Google

way, to produce the "go," and generally to direct our eyes and our feet in the way they should go. Many of the men who have assisted in our learning, who, in fact, have been teachers, are passing through our homeland to visit Paris. After all, they are scions of our own race, they are brothers in blood—younger as a nation; and, as is usual with the young, pushing, energetic, ambitious? They look upon England as the centre of their race, and shall we fail them in their just reward—a due appreciation of the works they have done. The very thought of backwardness is a libel upon the temperament of John Bull. His heart is still in the right place, and he will show that it is so by giving a most cordial and hearty welcome to the members of the institute from across the sea.

SPEED REGULATION.

We notice in a recent issue of the *Electrical World* a description of a patent, granted to Mr. Alexander D. Lunt, which relates to a means for equalising the speed of shafts, machines, or other rotating bodies, and is particularly applicable for preventing the hunting of synchronous motors, rotary converters, or other synchronously-operated electric machines. Briefly, the means consists of a flywheel mounted loosely on a shaft, on one side of the rim of which are electromagnets; opposite the electromagnets is a copper disc keyed to the shaft. In normal operation the friction of the flywheel on its bearing will generally be sufficient to maintain it in rotation in fixed relation to the copper disc. When, however, the speed tends to fluctuate, the flywheel, owing to its large inertia, will continue its regular rate of rotation, thereby causing a relative movement between the flywheel and its shaft, and a consequent shifting of lines of force along the disc. This latter action will result in generating electric currents in the disc, which produce a powerful braking action, and thus restrain the shaft and the parts to which it is connected from fluctuating in speed either above or below a regular rate of rotation—that is to say, the disc constitutes a closed electric circuit, which dissipates the electrical energy produced by the relative motion between itself and the flywheel carrying the electromagnets, thereby acting as a damping device, the effect of which is the more powerful the greater the tendency to deviation from normal speed. The flywheel is grooved on the rim face opposite the copper disc; windings filling these grooves are connecting with two collecting rings mounted on the hub of the flywheel, through which direct current from an exterior source is supplied to the windings. The edge of the disc furthest away from the flywheel is made of magnetic material, which serves to complete a magnetic circuit for the lines from the pole-pieces on the flywheel.

THE NEW YORK METROPOLITAN STREET RAILWAY.

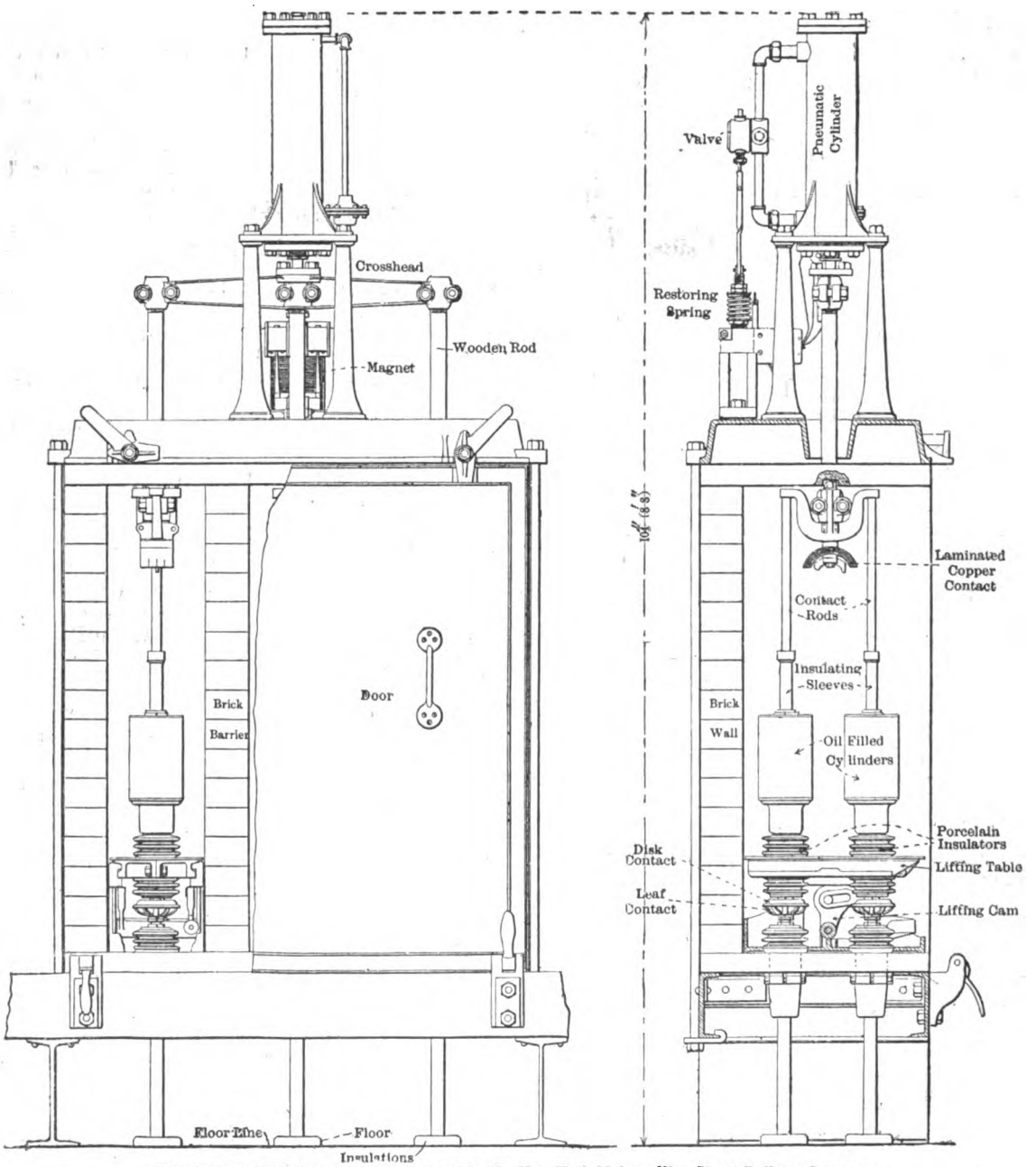
In our issue for May 11 of this year we briefly mentioned that a special feature of the high-tension circuits on the New York Metropolitan Street Railway was the employment of an improved type of oil-break switch, which in this installation takes the place of switches, circuit breakers, and fuses in low-tension work. From the *Electrical World* of New York we gather that the main power station will contain over 100 of these oil circuit breakers, all of the same size, and only differing in their capacity for carrying current. The same type of circuit breaker will also be used in the sub-stations to a very large extent. Each switch will stand on its own foundation, with its three phases in three separate cells divided by brickwork walls, and all will be operated by pneumatic power. In this new oil circuit breaker, compressed air forces a piston up or down in a vertical cylinder above the top of a brick structure enclosing the live parts. The valve controlling this cylinder is operated by the one magnet with which the device is fitted, the circuit of this magnet running from the operating switchboard. When this magnet is excited and draws its armature down, it pulls the valve into such a position as to admit air above the piston and exhaust it below, thus forcing the piston down and closing the main current contacts. If current is cut off from the magnet by any means, the valve is instantly restored by a spring into such a position as to admit air below the piston and open the contacts. The magnet is wound with two coils, one of fine and one of coarse wire, connected in series with each other. The movement of the armature moves an automatic switch, which short-circuits the high-resistance part of the winding when the armature is up, thus allowing a powerful current to pass from the constant-potential source of supply to draw the armature down with plenty of reserve force. As soon as the armature is drawn down, the increased resistance thrown in by the automatic switch reduces the flow of current through the magnet winding to an amount only sufficient to hold the armature in the down position, thus economising the current, which must be left on as long as the oil circuit breaker is closed. The magnets are supplied with current at 110 volts from exciters at the main station. The compressed air for the pneumatic cylinders is supplied by motor-driven air-pumps with automatic controllers. In the old type of oil breaker the controllers would make no move if current failed them, but in this new type of breaker the controlling switch simply opens or closes the circuit of the one magnet operating the valve, and the oil breakers will all open if the supply of current for the magnets fails. In the case of a sub-station, the failure of the motor-generators therein would, with the new type of circuit breaker, shut down the station, unless it were prevented by an assistant. The main position of the oil circuit breaker raises or lowers a metal cross-head carrying three wooden rods, which extend down into three cells, each containing the switching apparatus for one leg of the circuit. The cells being separated by brick partitions, a burn-out in one cell cannot spread to the others. As the opening of two legs breaks a three-phase circuit, an arc in one cell will not render the breaker useless. The circuit-breaking parts of the breaker consist of two brass cylinders for each phase, into the tops of which two copper rods extend from above, these two rods connecting the two cylinders together when lowered by the cross-head to which they are attached. The two brass cylinders in each cell are respectively mounted on copper castings, to one of which is connected the incoming lead and to the other the outgoing lead of the same phase. Each cylinder is nearly filled with transil oil, and is covered by a metal cap, which carries a long insulating sleeve in stuffing box, and oil-wiper round the rod. When the three pairs of rods on one cross-head are lowered, their ends make contact with the copper castings under the oil and the circuit is closed. When the rods are lifted the circuit is broken under the oil at two points in each leg, or six points in each complete three-phase switch. The range of movement of the cross-head is a foot, giving in each leg an opening of nearly 2ft., and thus in series with each phase an opening of nearly 4ft.

The enclosure of the cans containing the oil gives a certain amount of compression to suppress arcing if the drowning of the arc by the oil is alone not sufficient. Although the long insulating stuffing box does not fit tightly around the rod, any arc which might form on breaking the circuit causes such a sudden expansion of the oil that the air above it in the can does not find time to escape, thus preventing the arc from blowing the oil away from its path. The brass cans are lined inside with fibre to prevent the arc from jumping from the rod to the metal of the can if it is drawn up through the oil to its surface. As to the more detailed construction of the apparatus, on the lower end of each copper rod is screwed a removable blunt-pointed brass tip. When the rod is lowered, it passes through two tubes or sleeves, each split into four segments, which surround the rod tightly and are forced against it by springs. Of

Digitized by Google

the two split sleeves, the lower one is made of copper and the upper one of brass. When the rod is drawn up the final opening is between the brass sleeve and the brass tip, thus making use of the non-arcing metal principle. When the brass tip leaves the brass the segments of the latter close in and rub against the tapering end of the rod, transferring the final break and any pitting that may occur to the tapered end of the rod, where it will not scratch and injure the surface of the copper sleeve the next time the rod goes down.

The piston and cross-head of the circuit breaker are prevented from falling and thus closing the circuit, if the air fails, by a hook or latch, which catches the cross-head in its raised position. When air is turned on above the piston it is led by a branch pipe to a small auxiliary cylinder, this auxiliary cylinder releasing the latch and allowing the cross-head to fall, thus promptly closing the circuit. Each lead into and out from the oil-cylinders comes up through the floor and terminates in an inverted crown of copper leaves, termed in our illustration a leaf contact. Normally there rests upon each of these leaf contacts a disc contact fixed to the copper casting which forms the bottom of one of the oil-filled cylinders or cans. The two copper castings in each cell are fastened to corrugated porcelain insulators mounted on a small table which can be raised or lowered. When raised, the disc contact is lifted away from the leaf contact, giving an air opening in the circuit each side of the breaker in each phase. This allows for repairs or adjustment of the live parts of the breaker.



Elevation of an Oil Circuit-Breaker as used by the New York Metropolitan Street Railway Company.

These oil circuit breakers are made in two capacities, the larger rated at 800 amperes and used for the generators and for groups of feeders, the smaller with a capacity of 300 amperes for the feeders and for all of the high-tension work in the sub-stations. The breakers are of the same size, the difference between them being that the one with the larger capacity has an auxiliary or primary contact in air made by means of a brush of copper leaves bridging from the top of one of the brass cans to the top of the other of the same phase, and thus shunting the contacts under the oil. Normally this primary contact in air carries the greater part of the current, but when the breaker is opened the primary contact is broken first, throwing the whole load on the rods and their surrounding sleeves under the oil. A good idea of the construction of these circuit breakers can be gathered from the illustrations given.

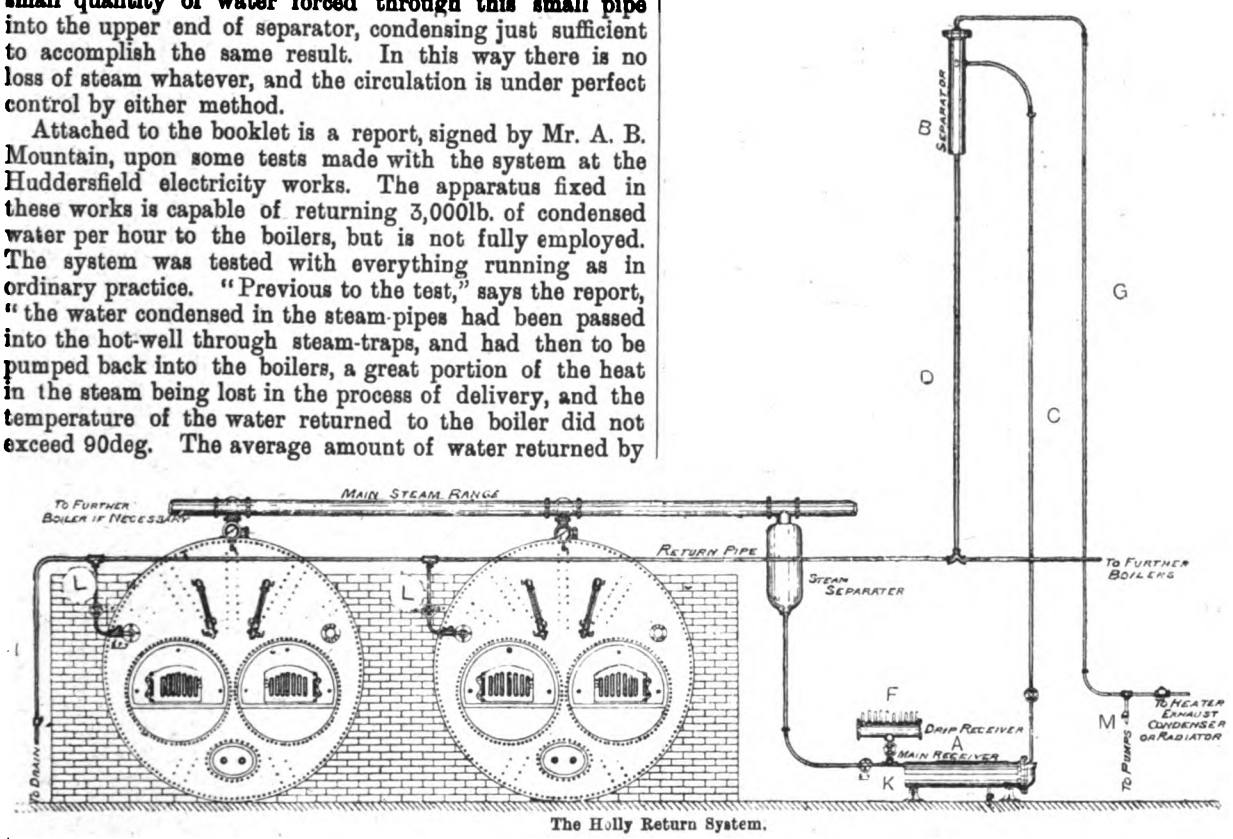
THE HOLLY GRAVITY-RETURN SYSTEM.

We have received from the makers, Messrs. Wm. Whiteley and Sons, Limited, Prospect Ironworks, Lockwood, Huddersfield, a very nicely illustrated booklet describing the Holly gravity-return system. The accompanying diagram and description taken from the booklet will explain the system: The drip receiver, F, is a vessel for collecting drips from all parts of a plant, and should be placed below the lowest point to be drained. From

Digitized by Google

this receiver it flows into the main receiver, A, through a specially designed suction tee, K. The forcing end of the suction tee is connected to one or more adjacent steam separators I, and this condensation is also delivered into the main receiver, under the initial or boiler pressure. The whole is then swept up the riser pipe, C, in sections or finely-divided particles (due to the special discharge head on one end of main receiver) into the separator, B, where it falls into the return pipe, D, which is capable of feeding any number of boilers. The water, in its upward flight, is carried with the steam that is required to maintain the circulation, and occupies some vertical position above the water-line of boilers, in the return pipe, D, where the included column, plus the pressure in separator, will weigh more than the pressure carried in the boiler, thus producing a continuous feed to the boilers at practically boiler temperature. The object of the small pipe, G, and reducing valve, R V, is to place the engineer-in-charge in absolute control of the circulation between the receiver and separator; it permits an atmospheric escape of steam just sufficient to ensure this result, and it may be adjusted for varying quantities; this escape is so very small as to be infinitesimal, and in nearly all cases it is utilised in the heater, condenser, hot-water tank, or in heating by radiation. Should there be no convenient method of utilising the steam passing though valve, R V, the pipe is connected to the feed pump discharge, M, and a small quantity of water forced through this small pipe into the upper end of separator, condensing just sufficient to accomplish the same result. In this way there is no loss of steam whatever, and the circulation is under perfect control by either method.

Attached to the booklet is a report, signed by Mr. A. B. Mountain, upon some tests made with the system at the Huddersfield electricity works. The apparatus fixed in these works is capable of returning 3,000lb. of condensed water per hour to the boilers, but is not fully employed. The system was tested with everything running as in ordinary practice. "Previous to the test," says the report, "the water condensed in the steam-pipes had been passed into the hot-well through steam-traps, and had then to be pumped back into the boilers, a great portion of the heat in the steam being lost in the process of delivery, and the temperature of the water returned to the boiler did not exceed 90deg. The average amount of water returned by



The Holly Return System.

the system per hour was 384lb. The temperature of condensed water returned to the boilers was 363deg. The heat saved per pound of water per hour was therefore 273 heat units. The heat emitted by a pound of coal in evaporating 7lb. of water equals 6,842·5 heat units per hour. Heat saved per year therefore equals 918,328,320 heat units, representing 59 9 tons of coal, which at 12s. per ton equals a total saving by the 'Holly system" of £35. 18s. 9d. The advantage of the system is that it is not necessary for a man to open any taps connected with the steam-pipes previous to admitting steam, and there is no chance of the steam-piping becoming waterlogged. The water can only flow from the steam-pipes in one direction, and in the event of a steam-pipe being shut off for repairs the check valves upon the system automatically stop the return. The cost of the system is about £100, and the saving shown by the foregoing tests amounts to about 36 per cent. on this outlay, but as the test was made during the hot weather, it is only fair to assume that the saving would be almost double during the winter. The cost of working the system is difficult to ascertain, but the small quantity of steam required to be condensed in the top separator, which creates the vacuum and causes the automatic working of the apparatus, should undoubtedly be covered by 10 tons of coal per annum."

It may be mentioned, in conclusion, that the system has found extensive application in America.

QUESTIONS AND ANSWERS.

Questions.

293. Is it possible to wind the shunt and series winding of a compound dynamo on separate formers in such wise that it shall be possible to remove either the shunt or series field winding without disturbing the other?—E. R.

294. Is there any electrical device that will automatically keep the pressure constant with varying loads on battery-regulating cells? If so, describe and illustrate same.—F. L. Watson.

Answers.

Question No. 287.—Give particulars and explain any arrangement for the abatement of smoke from station chimneys you may have had practical experience with, and state result.

Best Answer to No. 287 *(awarded* 10*s.)*.—Among several types of smoke-consuming furnace that have come under the writer's notice, the three here described produced the best results. Fig. 1 shows part of the brickwork setting of a well-known combination of Lancashire and marine type boiler. In this boiler the end plates act as tube plates for a large number of tubes, which at the front end terminate

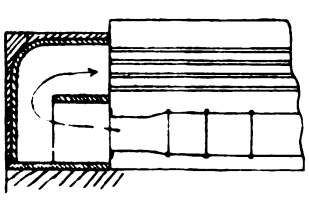


Fig. 1.

in a smoke chamber, from which the gases are led to the chimney through two external flues. The shell is set in the brickwork in such a way that the main internal flues end in a combustion chamber lined with firebrick and provided with deflecting arches. When the boiler is in full

Digitized by Google

work this deflecting chamber becomes practically white hot, so that any free carbon and unburnt gases passing from the internal flues through the chamber up to the return tubes stand a good chance of thorough combustion. The writer has seen a boiler of this class fired with long flaming bituminous coal, the amount of smoke escaping being very small.

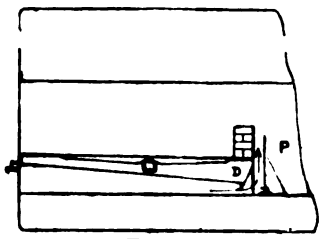
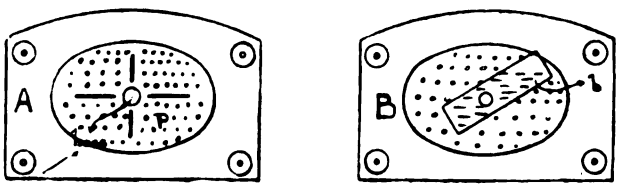


FIG. 2.

Fig. 2 shows another arrangement. In this case air is admitted from the ashpit through a small door, D, underneath the bridge. This door is connected by means of a bar and lever to the firedoor, so that on opening for charging the door, D, is also opened. Air enters, and is deflected upwards by means of the baffle-plate, P, and is thus mixed with the unburnt gases, etc. The door is gradually closed by moving the connecting bar back notch by notch, the closing of the firedoor having no effect on the back stroke. This arrangement was fairly good from a smoke-consuming point of view, but the presence of a body of comparatively cold air in the flues just beyond the bridge was not conducive to the well-being of the boiler. Another disadvantage of this arrangement is the fact that it is not automatic, though this defect might be overcome by the use of a weighted door and suitably arranged pulleys and balance weights. Fig. 3 shows the third and most satisfactory arrangement. Air is here admitted through the furnace doors, and the supply automatically reduced and finally cut off after every charge.



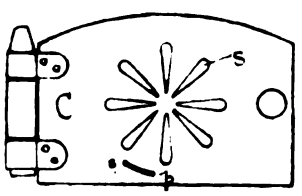


FIG. 3.

At A is shown the perforated back plate of furnace door, the outer cover being removed. Between this back plate and outer cover is mounted an oblong cast-iron box (shown at B) in such a way that it is free to swing in a vertical plane. Fixed to this box is a circular plate (not shown), with slots coinciding with those in the outer cover of door shown at C. The distance through which the box and attached shutter plate can swing in either direction is controlled by the length of the radial slot, S, through which a pin projects from the shutter plate immediately behind. The box, *b*, is filled with mercury up to such a level that when the furnace door is open, and consequently cold, the weight of mercury swings the box and shutter plate over until the pin, *p*, reaches the lower end of slot, S. The slots, S, in outer cover are now fully open. The charge is now thrown on and door closed. Air enters freely through slots, S, and is distributed through perforations in plate, P. Heat from the fire causes the mercury in the box to expand. As its centre of gravity alters, the box swings over, gradually closing the slots, S, by means of the shutter plate which moves with it. This arrangement is simple, and not likely to get out of order, neither is the regularity of its action dependent upon the caprices of the fireman.

The writer has, however, come to the conclusion that a good mechanical coking stoker, the absence of necessity for forcing the boilers, and the services of a good fireman are the most satisfactory means of preventing smoke troubles.—P. S. T.

Answer to No. 287 (*awarded* 5*s.*).—The production of smoke is caused by the mixing of particles of unburnt carbon with the gases of combustion from the furnaces. The reason that these particles have been allowed to escape may be either lack of oxygen wherewith to combine, or else too low a temperature to effect the combination. Methods of smoke prevention based on both of the above reasons have been brought forward by boiler-makers and furnace-builders. One of the simplest device is to cut an opening in the firedoor above the level of the fire, and to cover this opening with a door so arranged that the amount of opening can be regulated. By this means a current of air flows over the glowing coal, mixing with the particles of carbon, and if the temperature of the mixture be raised sufficiently by contact with the fire the carbon will be consumed. The objection to this method is that by admitting a quantity of cold air the temperature of the furnace gases is lowered, and the boiler does not work so economically as before. It may be noted, by the way, that smokeless combustion is by no means synonymous with highest economical consumption of fuel. Another method of securing sufficient air to ensure complete combustion is to force the air through the firebars, either by forced or induced draught. There are losses of power due either to mechanical driving of fans (as in the case of induced draught) or direct consumption of steam, as in the Meldrum or Bennis systems of forced draught. Provided, however, that careful attention to firebars and furnace linings be given, on account of the high temperatures attained by these methods, these systems answer well. It is also claimed by makers of this type of furnace that the passage of the cold air through the firebars preserves these. I have noticed, however, that with some classes of coal extensive clinkering is sure to occur with forced draught, giving a lot of trouble with firebars unless they are constantly moving. It may also be pointed out that the failure of a fan in the main flue would be a very awkward occurrence at any time when the boilers were particularly required.

A "coking" stoker is a very good device for prevention of smoke. In this the "green" fuel is placed at the front of the fire, and gradually worked back to an ashpit at the back of the firebars. By this means the combustible elements of the fuel are given off in regular sequence—first, the light volatile gases, together with any moisture in the fuel; then the heavier hydrocarbons, succeeded by solid carbon. The coal is now reduced to a glowing surface of coke having very little free carbon in it, and being at a very high temperature. The combustible elements, together with air, sweep over this incandescent surface, and the exceedingly high temperature, added to their own temperature, ignites them and ensures complete combustion. This is probably one of the most satisfactory ways of dealing with fuel rich in free carbon. An analogous method for use in ordinary furnaces of dealing with "rich" coals, is to mix them with coke or anthracite. A higher state of incandescence is thus produced, and the particles of carbon in the rich coal burnt. I have, however, noticed that it is a mistake to attempt to blend large, lumpy coal with anthracite slack or small coke, as the fire burns unevenly into holes. Where a good draught is available the burning of anthracite coal is a preventive of smoke nuisance, as this coal gives a bright, clear fire of great heat, consuming its own smoke and producing very little clinker. The only drawback is that it is a very difficult coal to start a fire with, and will not burn well unless with a strong draught. J. A. S.

Question No. 288.—What current density per square inch is it usual to allow in best engineering practice in switch contacts of the following types: (1) laminated contacts constructed of hard-rolled sheet copper; (2) spring contacts

Digitized by Google

in which the contact surfaces are machined, and the only material used is cast brass—*i.e.*, such as those used in the Bates fuse and Brush trigger switch; (3) flat cast-brass machined contacts, which can be held together under considerable pressure by a nut or set screw. Give sketches.

Best Answer to No. 288 (*awarded* 10*s.*).—The term 'current density" here is evidently to be understood as the surface density at the points of contact of switches, etc. The ratio between the surface density and the cross-sectional density in a switch, for instance, is affected by several considerations, none being more important, in the writer's opinion, than the quality of workmanship the manufacturer is able to command. It is also affected by the different conditions enumerated in the questions (1), (2), and (3). Taking the first case of a switch with laminated closer of hard-rolled sheet copper, with probably gunmetal contacts, it is good practice to work at 400 amperes per square inch. This density, with accurate machinery and fitting, should be ample. It will be noticed that it is advantageous to make the angle θ, in Fig. 1, as small as possible compatible with good design, as in switches of this type the difficulty is to get the required surface area while not wasting any metal in the cross-section. When foliated copper is used, as in the Crompton "S" switch, the density may with safety be raised to 500 amperes per square inch.

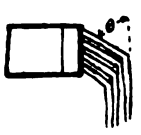


FIG 1.

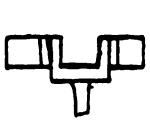
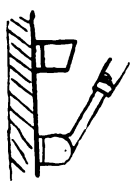


FIG 2.



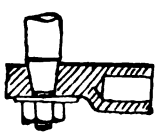


FIG 3.

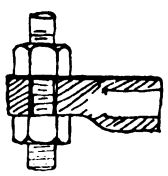


FIG 4.

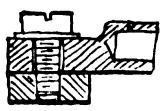


FIG 5.

In the second case, we have a switch differing from the first in two ways. The method of making contact—viz., one machined surface rubbing on another—is obviously not so good, owing to the fact that it requires very skilful fitting to make the surfaces bear evenly. That they very often do not do so (see Fig. 2) will be made evident upon examination of some switches of the knife or chopper type. Also the conducting metal is cast brass as against copper. While copper is run by several large electrical firms at from 880 to 1,000 amperes per square inch, brass will only carry 250 to 300 amperes for the same area. Introducing, then, the factor of safety as in the first case, the surface density is generally taken at about 160 amperes per square inch.

The third case presumably applies to the connecting of cable sockets and the like to switch contacts or 'bus bars, and the features differ materially from the first and second cases. Two methods ordinarily used in making these connections which are maintained under pressure are shown in Figs. 3 and 4. In Fig. 3 the bearing surface is part of a cone, the cable socket being accurately seamed to fit the coned stem. The angle of coning is generally about 9deg. to 12deg., or a decrease of ·15in. to ·2in. of diameter per inch of length. In Fig. 4 the two sides of the socket are relied on for bearing surface against two hexagon nuts, and in Fig. 5 on one side held down to a 'bus bar by means of a set screw. The efficiency of the contacts in Figs. 3, 4, and 5 are greatly improved by turning both surfaces, which, when pressure is applied, become practically a good soldered joint. A feature which enters here into the consideration as to what surface density it is permissible to use is the mass of copper in proximity to the joint, which has the effect of conducting away a great proportion of any heat generated, and this, in conjunction with the above-mentioned, would make it quite safe to work at 200 amperes per square inch.—E. J. EVANS.

LONDON COUNTY COUNCIL TRAMWAYS.

At Tuesday's meeting of the London County Council the following report of the Highways Committee recommending large extensions to the tramway system of London was discussed and adopted. The recommendations of the Improvements Committee in regard to the street widenings were also adopted:

1. We have had under consideration the question of what further extensions and doublings are desirable in connection with (*a*) the Council's northern tramways, leased to the North Metropolitan Tramways Company; and (*b*) the undertaking on the south side of the Thames, known as the London County Council tramways, and worked by the Council itself; and what new lines not to be immediately connected with either system should be constructed. We now, as the result of our deliberations, submit proposals for new tramways, for the construction of which we think the Council should seek for powers by a Bill to be introduced in the next session of Parliament. We have, in accordance with standing order No. 352, consulted the solicitor, who has expressed the opinion that the Council has power to promote such legislation. We regret that owing to the time which we have necessarily had to devote to the consideration of this very important matter, and in connection therewith the time taken up by our negotiations with the Improvements Committee as to the street widenings involved by the various proposals, we have been unable to comply with the standing order No. 350, which requires that proposals for legislation shall be submitted to the Council not later than at the first meeting in June; and in the circumstances, we must ask the Council to suspend the standing orders in order that our proposals may be considered.

Estimates of Cost.—Our proposals, which are dealt with seriatim in this report, are for the construction of new tramways of a total length of about 16¼ miles on the *north* side of the Thames, at an estimated cost, for the tramways and necessary paving and other works in connection therewith, of about £461,300, and for street widenings of about £544,360; while, as regards the *south* side of the Thames, the total length of tramways is about 12 miles, the cost of construction and paving works is estimated at about £374,500, and of the street widenings at about £449,400. As regards the street widenings, we have, as stated above, been in consultation with the Improvements Committee; and we understand that it proposes to recommend (*a*) that the Council do contribute, out of the funds applicable to improvements, sums amounting in the aggregate to £355,006, and (*b*) that the road authorities concerned shall contribute sums amounting in all to £326,688. The remainder of the cost of the street widenings, £312,067, we propose shall be charged to the tramways account as part of the first cost of the several tramways. These three amounts do not, as will be seen by the paragraph relative to scheme *xiv.*, make up the whole cost of the street widenings. The estimates of the cost in the case of each of the proposals is stated in this report.

Systems of Traction to be Adopted.—We propose that those of the new lines which will be intimately connected with the Council's (northern) tramways (leased until Midsummer, 1910, to the North Metropolitan Tramways Company) shall, with one exception hereinafter referred to, be constructed for horse traction, unless in the meantime effect shall have been given to the provisions in the company's lease relating to the conversion of the system from horse to electrical traction. The estimates provide, however, for rails of sufficient weight to permit of their being used for electrical traction when that system shall have been adopted on these tramways. The exception is the tramway (*i.*) in the Archway-road, which will practically be an extension from the Council's tramway terminus in that road to the county boundary, and will probably be joined with the light railways which the Middlesex County Council is seeking powers to construct from that point to Finchley and beyond. As the Middlesex Council proposes to adopt a system of electrical traction for its light railways, we think it expedient that the Council's new Archway-road line should be constructed for a similar system of traction. Those of the new lines which will be intimately connected with the London County Council tramways undertaking, or which, being for the present detached from either undertaking, could be worked by the Council independently of any other system of tramways, we propose shall be constructed for some system of electrical traction. The estimates which we submit of the cost of the several lines have been based on the assumption that in each case, as regards traction, the course proper to each line as indicated above will be followed.

Cartoon Plan and Hand-Maps, showing the Proposals and the Indicating Numbers.—We have given instructions for a cartoon plan and hand-maps to be prepared, showing the various proposals which we submit for the Council's consideration, and which are indicated on the cartoon and maps by the same numbers as are used for that purpose in this report. We think

Digitized by Google

these will be of assistance to members of the Council when they are considering our various proposals.

Suggestions of Road Authorities and Others for New Tramways. We requested the various road authorities in London to make suggestions as to what extensions of, or junctions between, the tramways in their respective districts were in their opinion desirable; and those made we have considered, together with suggestions upon the subject from the North Metropolitan Tramways Company (the Council's lessee), and from the Council's responsible officials. As regards those of the engineer and of the company, we have ascertained as far as possible the views of the respective road authorities concerned, and these are stated below. We submit, for the information of the Council, the following brief statement of the reasons which in our opinion render desirable the various extensions and junctions, for the construction of which we propose that the Council should seek powers.

PROPOSED NEW TRAMWAYS—NORTH OF THE THAMES.

(*i.*) *Archway Tavern* (existing lines) to the *County Boundary*; length, 3 furlongs.—This line is the subject of an application of the Council, now before the Light Railway Commissioners, for powers to construct it as a light railway. In view, however, of the possibility that this application may not be granted, we think that the line should be included in the Tramways Bill of next session. Powers for the necessary street widenings are included in the Council's Improvements Bill now before Parliament. This line would form the link between the Council's (northern) tramways and the light railways beyond the county boundary, for the construction of which the Middlesex Council is seeking powers. The Middlesex Council proposes to use a system of electrical traction on its light railways, and we think that this short piece of line should be constructed for a similar mode of traction. The cost of construction of the line for electrical traction is about £8,400; and current for working it could be obtained (*a*) from the Vestry's electric light station, which is within a short distance, or (*b*) by arrangement with the Middlesex Council.

(*ii.*) *Seven Sisters-road* (existing lines), *viâ* Amhurst-park to *Upper Clapton-road* (existing lines—length, 5 furlongs 1 chain). This proposal was included in the Council's Tramways Bill of this year, but was withdrawn owing to the refusal of the Vestry of Hackney, one of the road authorities concerned, to assent to the construction of the tramways; while the other road authority, the Vestry of Stoke Newington, gave its consent subject to the Council agreeing to pave the whole width of the carriageway, and it has again asked for the same concession as a condition of its consent. We do not, however, propose that this concession should be made, as otherwise there is little doubt that other road authorities would make claims for similar concessions, and we propose to inform the Vestry. Under the Tramways Act, 1870, the obligation laid upon the Council as a tramway owner is only to maintain the road between the tramway rails and for 18in. beyond the outer rail on each side, and we do not think that the Council would be justified, except in very special circumstances, in agreeing to do anything more than the Act requires. In the hope that the road authorities concerned may eventually consent to the construction of the line, we have included the proposal amongst the others. No street widenings will be required, and the estimated cost of construction of the tramways, for horse traction, is £11,250.

(*iii.*) *Mildmay Park* (existing lines) westwards to *Balls Pond-road* (existing lines); length, 2 chains.—This is a short junction line, suggested by the engineer after consultation with the managing director of the North Metropolitan Tramways Company, as an alternative to a proposal of the Vestry of Islington for the construction of tramways, which would involve expensive street widenings, along Newington Green-road. The junction would be a great convenience to the tramway traffic, and the company considers that the formation of this junction would be of greater benefit than the construction of the line proposed by the Vestry. The Vestry does not consider the alternative proposal entirely satisfactory, but we think that, having regard to the fact that the alternative would involve no street widenings, it should be adopted in preference to the other. The estimated cost of the construction of this short piece of line, for horse traction, is about £400.

(*iv.*) *Harlesden* (near the county boundary), *viâ* Scrubbs-lane, Wood-lane, Shepherd's Bush-road, Brook Green-road, and Fulham Palace-road to *Putney Bridge*; length, 4 miles 7 furlongs.—This line, which was suggested by the engineer, we consider would be very valuable from a traffic point of view, as providing much-needed and urgently required means of transit; and we are informed that the Housing, etc., Committee is of opinion that the line would be of great assistance from the housing point of view. It would start in a thinly-populated district, which is, however, ripe for building, and there is a great probability that if the proposed tramways were constructed, and means thus provided for communication with the business parts of Fulham and Hammersmith, many persons to whom the tramways would be a boon would reside near to the tramways starting-point, just within the county boundary. The construction of a double line along the route indicated would necessitate certain street widenings, the estimated cost of which is £139,250. The Improvements Committee is prepared to recommend the Council to carry out these widenings, subject to one-third of the cost being borne by the road authorities concerned—namely, the Vestries of Fulham and Hammersmith, one-third being charged to the account of the improvement, and the remaining third to the tramways account, and with this proposal we concur. The Improvements Committee is in communication with these Vestries, but has not yet received their final decisions with reference to the matter. The cost of the construction of the tramways for electrical traction is estimated at £146,250, and for horse traction at £73,050. These tramways could be worked by the Council in connection with other extensions of its system.

(*v.*) *Uxbridge-road* (near the railway station), *viâ* Richmond-road, Netherwood-road, and Westwick-gardens, to *Shepherd's Bush-road*; length, 3 furlongs.—This suggestion is also made by the engineer. This short piece of line would form a useful adjunct to the tramways, *iv.*, at Shepherd's Bush-road, of which the line would, indeed, practically form part. We are advised that these tramways would probably be remunerative, and would also be of great convenience to the public. Some small street widenings would have to be carried out, the estimated cost of which is £8,700. In this instance the Improvements Committee does not see its way to recommend the Council to contribute out of improvements funds; so that the whole cost will have to be borne by the tramways account, unless the Vestry of Hammersmith, with which that committee is in communication, can be induced to make a contribution. The cost of the construction of the line for electrical traction is estimated at £11,250, and for horse traction at £5,500.

(*vi.*) *Brook-green-road*, at its intersection with Hammersmith-broadway, *viâ* that thoroughfare to the London United Tramways at *Glenthorne-road*; length, 5 chains.—This was proposed by the engineer as a connecting link between the proposed tramways, *iv.*, and the London United Tramways. The Vestry of Hammersmith, the road authority concerned, has not yet expressed any definite opinion with regard to the proposal. We propose that this line, in common with *iv.* with which it will be in connection, shall be constructed for electrical traction, the estimated cost being £2,000. No street widenings will be necessary, as the road is sufficiently wide for a double line of tramways.

(*vii.*) *Victoria-embankment* (Blackfriars end), *viâ* the Embankment, Victoria-street, Buckingham Palace-road, Commercial-road, Bridge-road, and the Chelsea-embankment to near *Battersea Bridge*; length, 4 miles 3 furlongs.—It is suggested that the line should be continued along World's End-passage to and over Putney Bridge, and this proposal is dealt with in a separate paragraph. The Council is the road authority as regards the Victoria-embankment, and therefore, although part of the tramways would be situated in the Strand district and the parish of St. Martin-in-the-Fields, the consent of the Vestry and the District Board would not be necessary. The road authorities whose consent would have to be obtained are the Vestries of St. Margaret and St. John, Westminster, St. George, Hanover-square, and Chelsea. The first-named Vestry is not hostile to the scheme, and may probably assent to it; the Vestry of St. George has signified its approval, and no decision has yet been come to by the Vestry of Chelsea. We are of opinion that these tramways, if constructed, would prove of great benefit to the travelling public, as they would afford means of communication in almost a direct line between Chelsea on the one hand and the City on the other. There is little doubt that, for this reason, the tramways would prove a profitable investment for the Council, as well as providing much-needed and efficient facilities for locomotion. No street widenings will be needed in connection with this line, the estimated cost of the construction of which for electrical traction is £132,000.

(*viii.*) *Battersea Bridge*, *viâ* Chelsea-embankment, World's End-passage, King's-road, New King's-road, and Putney Bridge-approach, *to* and *over Putney Bridge*; length, 2 miles 1 furlong 2 chains.—The line, which is in continuation of *vii.*, would involve the widening of the whole length of World's End-passage, and also widenings in King's-road and New King's-road, the cost of which is estimated at £396,410. The road authorities concerned are the Vestries of Chelsea and Fulham. The Vestry of Chelsea has not yet decided whether it will contribute or not, but the Vestry of Fulham states that it does not consider that the expenditure for widenings would be of benefit to the parish. The Improvements Committee is prepared to recommend the Council to undertake the street widenings, and to pay out of improvement funds one-third of the cost, provided that the two road authorities concerned will, together, contribute another third, the remaining third being borne by the tramways account. The continuation of the tramways along the route indicated would certainly be very desirable from a traffic point of view, as the two together would form a continuous line seven miles in length along districts at present without facilities of communication, and there is little doubt

Digitized by Google

that the route would be popular and, therefore, remunerative. Having regard, however, to the large expenditure which would have to be incurred for street widenings which are desirable for other than tramways purposes, we do not think that the construction of this extension of the line *vii.* should be undertaken by the Council unless the road authorities concerned will agree to make the contributions suggested by the Improvements Committee. It is to be remembered that if the Council should obtain powers for the construction of the tramways, it is under no obligation to exercise them; and we have, therefore, included the proposal among the others. If the arrangements proposed by the Improvements Committee as regards the street widenings be adopted, £132,137 will be contributed by the Council out of the funds applicable to the improvement, and a similar sum out of the tramways account, while the remainder will be paid by the road authorities concerned. The cost of the construction of the tramways for an electrical system of traction is estimated at £65,000.

(*ix.*) *Hampstead-road* (tramways terminus), across Euston-road, and along Tottenham Court-road to *Oxford-street*; length, 5 furlongs 4 chains.—This was suggested by the engineer after no street widenings will be necessary to permit of the construction of a double line.

(*x.*) *Theobald's-road* (tramways terminus), *vid* Vernon-place, Bloomsbury-square, Hart-street, across Oxford-street, and along Shaftesbury-avenue to *Cambridge-circus*; length, 4 furlong 7 chains.—The suggestion first made by the Vestry of St. James's, Westminster, was that this line should extend to Piccadilly-circus; but the Vestry afterwards suggested that the line should, on account of the large number of places of entertainment near Piccadilly-circus, and the consequent large cab and other traffic at that point, stop short at Cambridge-circus, and this suggestion we have adopted. The St. Giles District Board, through whose district parts of the tramway would be laid, has refused consent to any tramways being constructed in its district, and the Holborn District Board has not expressed any opinion with regard to the proposal; but we think that the line would be of such value to the public that we include it among other proposals, in the hope that those bodies may be induced to assent to it. No street widening will be necessary in connection with these tramways, and the estimate of the cost of construction for horse traction is £8,800.

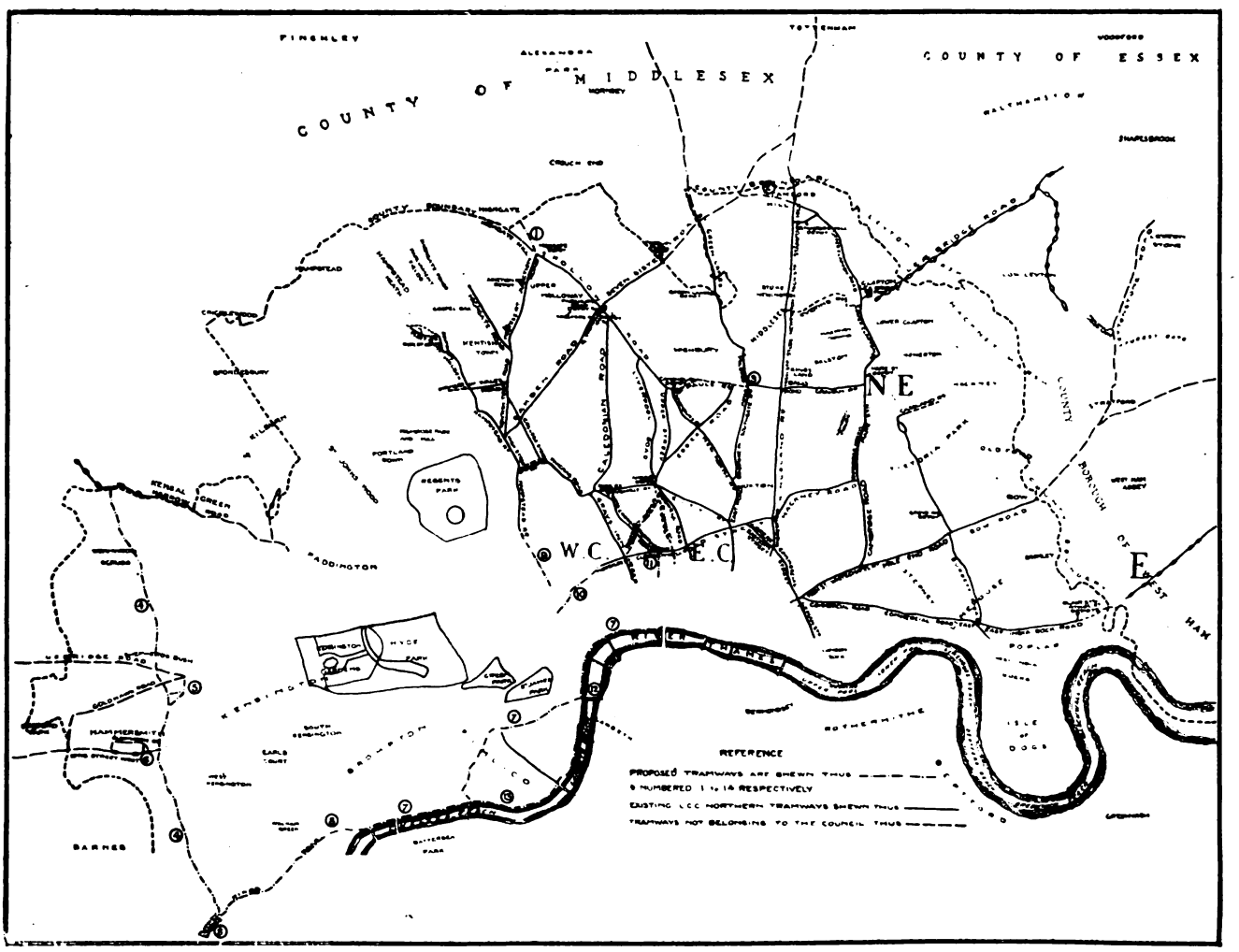


Diagram of Tramways North of the Thames.

consultation with the North Metropolitan Tramways Company, the Council's lessee. The Vestry of St. Pancras and the St. Giles District Board, the road authorities concerned, have both refused their consent, the Vestry stating that it cannot consider the proposal to extend the tramways along Tottenham Court-road until the southern end of Hampstead-road, which is very narrow, shall have been widened. There are already at the point indicated two lines of tramways coming up close to the Euston-road, and we think that, instead of the extension of these tramways as proposed causing congestion of traffic, it will rather tend to relieve it, owing to the fact that the stopping place for cars, instead of being, as now, close to the junction of the Hampstead and Euston roads, could be in Tottenham Court-road, where the carriageway is considerably wider. We think that there is little doubt that the new line, if constructed along Tottenham Court-road to near its junction with Oxford-street, where, owing to the removal of Bozier's-court, the carriageway is very wide, and quite suitable for a tramways terminus to be placed there, would prove a great boon to the public; and, by adding to the receipts of the Council's lessee, be remunerative to the Council. As may be seen from the foregoing remarks, we consider the construction of these proposed tramways to be very desirable in the public interest. The cost of the construction of this line for horse traction is estimated at £10,200, and

(*xi.*) *Farringdon-road* (tramways terminus), along that road to the *City Boundary*; length, 2 furlongs 4 chains.—This was suggested by the engineer, but his proposal was that the line should extend to a point near Ludgate-circus. The City Corporation was not prepared to assent to the tramways being laid within the City area; and our proposal is, therefore, that the line shall stop short at the City boundary. The Vestry of Clerkenwell is not unfavourable to the extension of the tramways, but is of opinion that, owing to the road being used as a costermongers' market on the one side, and to the unloading and loading of goods at warehouses on the other, it will be somewhat difficult to work tramway traffic along the road. We think, however, that, notwithstanding, the experiment might be tried. The road is sufficiently wide for a double line of tramways, and the estimated cost of construction is £4,500.

(*xii.*) *Victoria-embankment*, *vid* Westminster Bridge, to the London County Council tramway terminus in *Westminster Bridge-road*; length, 3 furlongs.—This suggestion was made by the engineer. The Vestry of Lambeth, the only road authority concerned, approves the principle of the proposal, and has expressed itself as strongly in favour of the extension of tramways over the bridges. The Council is itself the road authority for Westminster Bridge and the Embankment, and has on two or three occasions endeavoured, without success, to obtain

Digitized by Google

powers to construct tramways over the bridge; but we think that a further endeavour should be made to obtain the powers, as we are convinced that the extension of the tramways across the bridge would be of great benefit to a very large percentage of the users of the Council's tramways. No street widenings would be necessary, and the estimated cost of the construction of the tramways for electrical traction is £11,250, and for horse traction £5,600. We submit in this case alternative estimates, as we are informed that it is doubtful where there is sufficient space under the carriageway of Westminster Bridge to permit of the laying of the electrical conduit system.

(*xiii.*) *Chelsea Bridge* (north end), *vid* Grosvenor-road, to a point near *Lambeth Bridge*; length 1 mile 4 furlongs 8 chains.—This was suggested by the Vestries of Battersea and St. George (Hanover-square), and the other road authority concerned, the Vestry of St. Margaret and St. John (Westminster), does not disapprove of the proposal. This line would not at first be in connection with the London County Council tramways, although there is little doubt that it would eventually be so connected; and we think that it should be constructed for electrical traction. As this suggestion meets with the approval of the road authorities concerned, and the tramways manager is of opinion that the line would pay, we think that it should be adopted. The estimated cost of construction of the line for electrical traction is £50,000, and no street widenings would be necessary.

PROPOSED NEW TRAMWAYS—SOUTH OF THE THAMES.

(*xiv.*) *York-road, Wandsworth* (South London Company's lines), *vid* the new street 50ft. wide, in course of formation between York-road and Red Lion-street, along Red Lion-street, across High-street, along South-street, Garratt-lane, and Defoe-road to *High-street, Tooting* (London County Council lines); length, 2 miles 7 furlongs 8 chains.—The original proposal of the Wandsworth District Board was that the tramways, the whole of which will be in its district, should start from High-street, Wandsworth (South London Company's lines) and be taken as far as the London County Council lines in High-street, Tooting; but the District Board has since urged that the widening of Red Lion-street should be included among those in connection with the tramways proposals, so that the new tramways may extend from York-road along the route indicated above. The new street above referred to is being formed at the joint cost of the Council and the District Board, and it seems to us reasonable that the proposed widening, estimated to cost about £37,750, of Red Lion-street, so as to make it practically a continuation of the new street, should be carried out on the same terms. We believe that the District Board would be willing to contribute one-third of the cost of the widenings of Red Lion-street, South-street, Garratt-lane, and Defoe-road, provided that these thoroughfares be made 54ft. wide instead of 50ft. as first proposed, and on which assumption the original estimate of £188,500 was based. The adoption of the width required by the District Board will add £47,700 to the cost of the street widenings, being £25,900 for acquisition of property and £21,800 for paving, etc., works in the extra width of 4ft. from High-street, Wandsworth, to High-street, Tooting. The cost of the street widenings, including that of Red Lion-street, in connection with the whole proposal is estimated to amount to £273,950. We understand that the Improvements Committee has agreed to the extra width, and proposes to recommend to the Council that one-third of the cost of the street widenings shall be charged to the account of the improvements, one-third be contributed by the Wandsworth District Board, and the remaining third charged to the tramways account. We have already expressed our opinion with regard to the Red Lion-street widening, and although we are prepared to agree to one-third—namely, a sum not exceeding £63,000, of the cost of the other widenings to 50ft., according to the original estimate of £188,500—being charged to the tramways account, we are not prepared to go further than that, and we have so informed the Improvements Committee. From estimates which have been submitted to us it would appear that the prospective profits of the line would at first only be sufficient to pay interest and sinking fund on about £25,000 for street widenings and £90,000 for construction of the tramways, and, even if the charge to the tramways account for street widenings were only, as we propose, £63,000, nearly half of the charges for interest and sinking fund would have to be met from profits on other parts of the Council's tramways undertakings. There is little doubt that the proposed tramways, which are approved by the District Board and by the tramways manager, will be of great advantage to the district through which they will pass, and it is very probable that they will be valuable in connection with the housing of the working classes, besides becoming ultimately a safe and remunerative investment to the Council as a tramways proprietor. The estimated cost of the construction of these tramways for electrical traction is £90,000.

(*xv.*) *St. John's-hill*, near Clapham Junction Station (South London Company's lines) *via* Strath-terrace, Bolingbroke-grove and Bellevue road to the *Surrey Tavern*, at the junction of that road and *Trinity-road*; length, 1 mile 3 furlongs 1 chain.—The suggestion made by the Vestry of Battersea was that the proposed line should extend to, and join with, the London County Council lines at High-street, Tooting. This suggestion if adopted would, however, have involved extensive street widenings in Wandworth, to the cost of which the District Board did not see its way to promise to contribute; and we have therefore decided to recommend the construction of the tramways only as far as the Surrey Tavern, and for this purpose street widenings, estimated to cost £20,000, will have to be carried out. The consent of the Vestry of Battersea and of the Wandsworth District Board will be required to the construction of the tramways along the portions of the route within their respective districts, and we are informed that the Improvements Committee is prepared to recommend that, subject to these consents being given, and to the Vestry of Battersea agreeing to pay one-fourth of the cost of the street widenings in the parish, the Council shall undertake the street widenings, one-fourth of the cost being charged to the account of the improvements and the remaining half to the tramways account. With this arrangement we are satisfied, as we are of opinion that the proposed line will be sufficiently appreciated by the public to make it a remunerative investment for the Council as a tramways enterprise, even on these terms. The cost of the construction of the tramways for electrical traction is estimated at £47,500.

(*xvi.*) *Battersea Park-road* (South London Company's lines), *vid* Albert-road, to the foot of *Albert Bridge*; length, 4 furlongs 8·8 chains.—This is a suggestion of the Vestry of Battersea, and is supported by the tramways manager. He is of opinion that it would be of advantage to the Council to have powers to make the extension to Albert Bridge when it shall have acquired the company's lines, for the purchase of which, under the forty-third

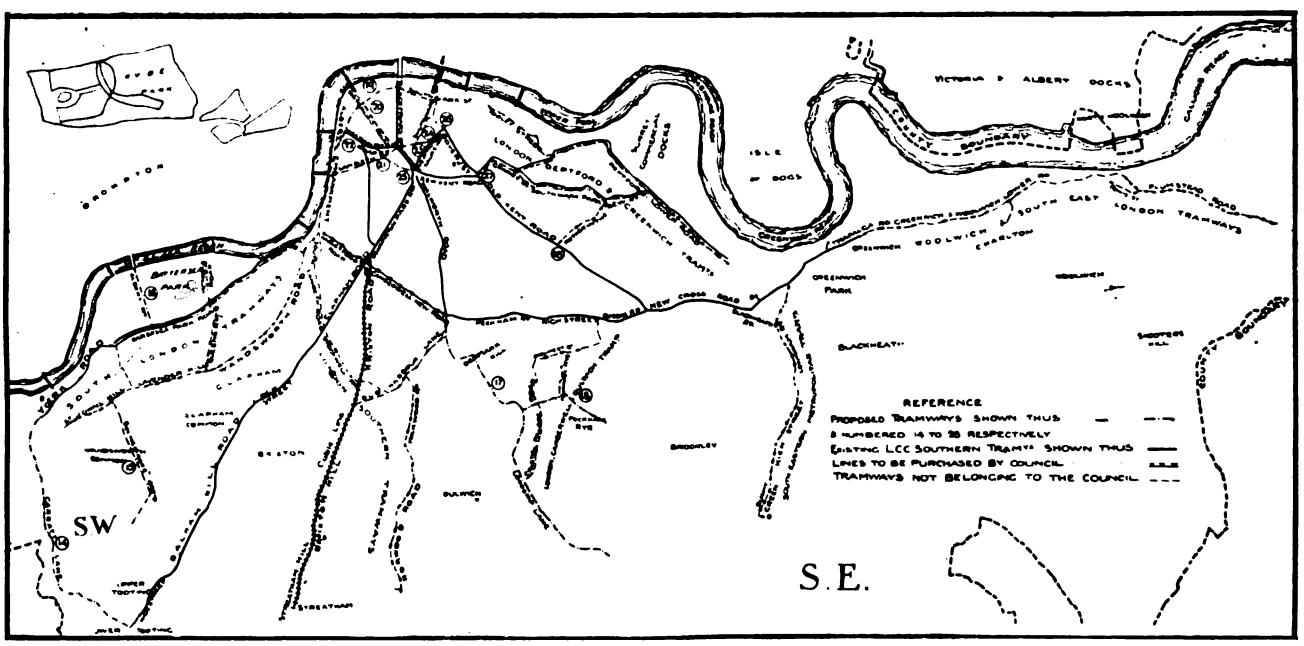


Diagram of Tramways South of the Thames.

Digitized by Google

section of the Tramways Act, 1870, the Council has decided to serve notice. The estimated cost of the construction of the lines for electrical traction is £18,500.

(*xvii.*) *Camberwell-green* (London County Council lines), *vid* Denmark-hill, Champion-park, Grove-vale, Lordship-lane, and London-road to *Devonshire-road*, near Forest Hill railway station; length, 3 miles 4 furlongs 6 chains.—This was suggested by the Vestry of Camberwell, one of the road authorities concerned; the others being the Vestry of Lambeth, which approves the proposal, and the Lewisham District Board, which has refused its consent. The manager is of opinion that this may be regarded as a trunk line, which would give to residents in Lordship-lane and Forest Hill direct means, which they do not now possess, of tramway communication with London; and, moreover, extensions could hereafter be made from this line into districts now totally without, but in great need of, tramway facilities. Some extensive street widenings would have to be effected before the tramways could be laid, and the cost of these widenings is estimated at £155,450. Of this amount the Improvements Committee proposes that the road authorities concerned should contribute one-third, that one-third should be paid out of the funds applicable to the improvement, and that the remaining third should be charged to the tramways account. The committee is prepared to recommend the Council to carry out the street widenings on this basis, with which proposal we agree. The estimated cost of the construction of the line for electrical traction is £107,000.

(*xviii.*) *Goose Green*, *vid* East Dulwich-road and Peckham Rye, to the junction of *Hall-road* and *Stuart-road*, *Peckham*; length, 1 mile 4 chains. The Vestry of Camberwell submitted a suggestion for the construction of tramways from Goose Green, to start from the proposed new line *xvii.*, to Inverton-road, Honor Oak, and the manager approved of this. We found, however, that the construction of a double line of tramways beyond Stuart-road would involve a considerable outlay for street widenings; and, after consultation with the manager, we have decided to recommend that the line shall go only as far as Stuart-road, up to which point no widening would be necessary. We are informed that there is every prospect of the line proving remunerative in conjunction with the line of which it would be an extension, and that it would be of benefit in affording facilities of access to the parts served by the Council's other tramways in the district of Camberwell, and also to London. The estimated cost of the construction of the line for electrical traction is about £31,500.

(*xix.*) *Southwark-street*, at Hop Exchange Corner (South London Company's lines), *vid* Southwark-street, Stamford-street, and York-road, and across Westminster Bridge-road, thence (single line) to *Lambeth Palace-road* (same company's lines), and returning *vid* Stangate over a proposed connection (*xvii.*) between the London County Council's lines and the company's lines near *Westminster Bridge*; length, 1 mile 2 furlongs 7·7 chains.—This was proposed by the St. Saviour's District Board, and is approved by the Vestry of Lambeth. We are advised that this line, if constructed, would afford additional travelling facilities most urgently required, and would be keenly appreciated by the public, and as a necessary consequence would prove remunerative to the Council. The carriageway in some parts of Stamford-street is not wide enough to admit of the statutory width of 9ft. 6in. being left between the outer rails of the tramways and the kerb, and, that being so, it will be necessary, in order to avoid having to effect street widenings which would be very costly, before the line can be constructed to obtain the consent of two-thirds of the owners and occupiers of property abutting upon the street at these points. We anticipate, however that there will be little difficulty in obtaining the necessary consents, as a space of about 8ft. would be left beyond the outer rail, and this would probably be sufficient to allow of a large-sized van standing at the side of the carriageway. The estimated cost of the construction of the line for electrical traction is £45,000.

(*xx.*) *Waterloo-road* (London County Council tramways terminus), along that road to a point opposite the *York Hotel*; length, 1 furlong 7·1 chains.—This is a very desirable extension of the lines in Waterloo-road, recently purchased by the Council from the South London Tramways Company. There is little doubt that the removal of the tramways terminus to a point nearer to Waterloo Bridge will be a decided advantage to the traffic, and will probably cause an increase in the number of passengers using the lines. The Vestry of Lambeth, the road authority concerned, approves of this extension. The cost of the construction of this piece of tramway for electrical traction is estimated at £6,500.

Proposed Junction Lines between London County Council Tramways and other Tramways.

(*xxi. to xxviii.*) The tramways manager has suggested that it is desirable that the Council should obtain powers for the construction of certain short junctions which will give facilities for interchange of traffic between the London County Council tramways and other tramways likely to be acquired by the Council within a short period. We think that the Council should endeavour to obtain powers to construct these junctions, particulars of which are given below, but we may point out that the powers, if obtained, need not be exercised until the tramways belonging to the companies concerned shall have come into the Council's possession:

(*xxi.*) From Westminster Bridge-road along St. George's-road to Lambeth-road—length, 1 furlong 4·2 chains; estimated cost, £5,500.

(*xxii.*) From Westminster Bridge-road (terminus) along Albert-embankment to Stangate (terminus)—length, 4·5 chains; estimated cost, £1,700.

(*xxiii.*) From Newington-causeway along Dantzic-street to Southwark Bridge-road—length, 3·9 chains; estimated cost, £1,500.

(*xxiv.*) From Newington-causeway along Borough-road to Borough-road at junction with Southwark Bridge-road—length, 1 furlong 2·9 chains; estimated cost, £4,900.

(*xxv.*) From Newington-butts along St. George's-road to St. George's-road—length, 1 furlong 3·3 chains; estimated cost, £5,000.

(*xxvi.*) From St. George's Church along Marshalsea-road to Southwark Bridge-road—length, 1 furlong 8·3 chains; estimated cost, £7,000.

(*xxvii.*) Great Dover-street to Bermondsey New-road—length, 4·4 chains; estimated cost, £1,700.

(*xxviii.*) Old Kent-road to St. James's-road—length, 3 chains; estimated cost, £1,200.

We recommend (*a*) that the standing orders of the Council relative to applications to Parliament for powers be suspended, in order that the Council may consider the following recommendation; (*b*) that the Council do make application, in the next session of Parliament, for powers for the construction of the undermentioned new tramways:

NORTH OF THE THAMES.

Archway Tavern (tramways terminus) to the county boundary in Archway-road.

Seven Sisters-road (existing lines), *via* Amhurst-park, to Upper Clapton-road (existing lines).

Mildmay-park (existing lines), westward, to Balls Pond-road (existing lines).

Harlesden (near the county boundary), *via* Scrubbs-lane, Wood-lane, Shepherd's Bush-road, Brook-green-road, and Fulham Palace-road, to Putney Bridge.

Uxbridge-road (near the railway station), *via* Richmond-road, Netherwood-road, and Westwick-gardens, to Shepherd's Bush-road.

Brook-green-road, at its intersection with Hammersmith-broadway, *via* that thoroughfare to Glenthorne-road (London United Tramways).

Victoria-embankment (Blackfriars end), *via* Victoria-embankment, Victoria-street, Buckingham Palace-road, Commercial-road, Bridge-road, and Chelsea-embankment, to the northern end of Battersea Bridge.

Battersea Bridge, *via* World's End-passage, Chelsea-embankment, New King's-road, King's-road, and Putney Bridge-approach, to and over Putney Bridge.

Hampstead-road (tramways terminus), across Euston-road and along Tottenham Court-road, to a point near Oxford-street.

Theobald's-road (tramways terminus), *via* Vernon-place, Bloomsbury-square, Hart-street, across Oxford-street, and along Shaftesbury-avenue, to Cambridge-circus.

Farringdon-road (present line), along that thoroughfare, to the City boundary.

Victoria-embankment, over Westminster Bridge, to Westminster Bridge-road (London County Council's tramways terminus).

Chelsea Bridge (north end), *via* Grosvenor-road, to a point near Lambeth Bridge.

SOUTH OF THE THAMES.

York-road, Wandsworth (South London Company's lines), *via* the new street in course of formation between York-road and Red Lion-street, along Red Lion-street, across High-street, along South-street, Garratt-lane, and Defoe-road, to High-street, Tooting (London County Council's lines).

St. John's-hill (South London Company's lines), *via* Strath-terrace, Bolingbroke-grove, and Bellevue-road, to the Surrey Tavern, at the junction of that road and Trinity-road.

Battersea Park-road (South London Company's lines), along Albert-road to the foot of Albert Bridge.

Camberweli-green (London County Council's lines), *via* Denmark-hill, Champion-park, Grove-vale, Lordship-lane, and London-road, to Devonshire-road, Forest Hill.

Goose Green, *via* East Dulwich-road and Peckham Rye, to the junction of Hall-road and Stuart-road, Peckham.

Southwark-street (South London Company's lines) at Hop Exchange Corner, *via* Southwark-street, Stamford-street, York-road, and across Westminster Bridge-road, thence (single line) to Lambeth Palace-road (same company's lines), and returning *via* Stangate over a proposed connection (No. 22), between London County Council's lines and the company's lines near Westminster Bridge-road.

Digitized by Google

Waterloo-road (London County Council's tramway terminus), along that road, to a point opposite York Hotel.

JUNCTION LINES.

Westminster Bridge-road (London County Council's lines), *via* St. George's-road, to Lambeth-road (South London Company's lines).

Westminster Bridge-road (London County Council's tramways terminus) to terminus at Stangate (South London Company's lines).

Newington-causeway (London County Council's lines), *via* Dantzic-street, to Southwark Bridge-road (South London Company's lines).

Newington-causeway (London County Council's lines) to Borough-road (South London Company's lines), at junction with Southwark Bridge-road.

Newington-butts (London County Council's lines) to St. George's-road (South London Company's lines).

St. George's Church (London County Council's lines), *via* Marshalsea-road, to Southwark Bridge-road (South London Company's lines).

Great Dover-street (London County Council's lines) to Bermondsey New-road (London, Deptford, and Greenwich Company's lines).

Old Kent-road (London County Council's lines) to St. James's-road (London, Deptford, and Greenwich Company's lines).

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

The thirty-second ordinary general meeting was held on Tuesday last at Winchester House, E.C., Mr. C. G. Mott presiding.

The **Chairman** expressed his disappointment at meeting the shareholders again with a reduced dividend, and believed that it would only prove temporary, it having been caused by exceptional circumstances which would not occur again. The report and accounts, containing the financial results, number of passengers, etc. (which appeared in last week's issue) were then presented. The cause of the lift accident which happened at London Bridge was, he stated, due to the breakage of one of the large steel shafts owing to the existence of a small flaw in it. The safety appliances attached to the lifts should have prevented such an accident as occurred to the cage, but the men employed by the contractors had been experimenting with the lifts and had taken off the safety balance. The accident had arisen from a combination of circumstances which was not likely to occur again. It had been arranged that the steel shafts in the lifts should now be 8in. in diameter, although this additional precaution really seemed to be unnecessary. The line had been worked for nearly 10 years without any previous accident to the lifts. Their platforms were connected with those of the Central London Railway by a subway, and another to connect them with the London Bridge Station of the Brighton Railway Company was being constructed. The extension to Islington was progressing favourably. He then referred to the capital and revenue accounts, and afterwards stated that the traffic was showing a satisfactory increase. For the first time the average receipt per passenger had exceeded 2d., the actual figures being 2·02d. When their line was first opened the uniform fare was 2d., but this had had to be altered owing to the omnibus competition for short distances. The Central London Company had also started with a uniform fare of 2d., but he feared that they would find it necessary later on to introduce modifications in their charge. The dividend recommended and agreed upon was 1¼ per cent. per annum for the half-year.

The motion for the adoption of the report was seconded by **Mr. C. S. Grenfell**, and carried.

EDISON AND SWAN ELECTRIC LIGHT.

The seventeenth ordinary general meeting of this Company was held on Tuesday at Cannon-street Hotel, E.C., Mr. J. Staats Forbes presiding.

The **Chairman** spoke of the large amount of stock which had accumulated owing to the establishment of branches in such a large number of towns. The articles in stock increased very largely from year to year, growing in proportion to the amount of the turnover. There was no occasion for alarm in this, but the Board had thought it necessary to make a very serious alteration in the stocktaking, and to revise the method of taking stock. They therefore came to the conclusion that they should close the year for the stocktaking by the month of June, which would give them something like absolute knowledge as to the nature of the stock. This had turned out to be a longer job than they had anticipated, but as far as it had gone the directors had every reason to believe that the stock, as stated in the account, was well within the actual saleable value of it from day to day. The profit and loss account showed that the stock was put down at £201,648 as an asset of the Company. This would not occur again, as they would have the stocktaking well up to the mark in 12 months' time. The report stated the amount available for distribution, after paying interest which had accrued. They had already paid something in the nature of a provisional dividend for the first half-year, and they proposed to pay at the same rate for the second half, making up a dividend of 6 per cent. for the year, carrying forward the balance of £6,199. Having ascertained since the accounts were made up that the stock carried into the balance-sheet was £6,000 at least more valuable than it was credited at, it would be seen that the balance might have been over £12,000 instead of £6,000. But the auditors, although they knew the stock was there, as the trade vouchers had not come in, would not give any credit for this, though there was no doubt that the money was there. The business of the Company had largely increased. For the corresponding period last year it was £241,400, while this year the turnover had been £285,500 The stock on May 31, 1900, amounted to £201,648, while the corresponding figure was £160,000. The item for depreciation on plant, etc., amounted to £13,936. The balance brought into the year was £10,599. The business had increased from £241,000 to £285,000, the stock had increased from £160,000 to £201,000, and the interest accruing from investments and other sources had increased by about £1,100. Against that there was the fact that the stock in hand at July 1, 1899, was £160,000; the wages, purchases, etc., amounted to £272,112; the salaries, directors' remuneration, etc., were £12,076. The depreciation on plant was £13,936, as against £9,000, and the balance of the profit and loss account was £43,388, as against £44,792. If they added the £6,000 which represented the value of the stock at its right amount, they would see that the balance was really £49,388, and it ought to be so but for the objection of the auditors. They had had to spend a good deal of money this year, and for that purpose they had raised fresh capital. This had come into charge, bringing the extra amount for interest up to £1,994. It cost them less to pay this interest than to pay the bankers for loans, and they had a considerable surplus to go on with. There was a rather heavy sum standing against sundry debtors and debit balances—£143,959, as against £90,000 in the preceding term. The Company gave long credit, and could not collect their money for some time, therefore the amount was brought in as approximate income for the month.

Mr. J. W. Swan, F.R.S., seconded the adoption of the report, which was carried unanimously.

On the motion of the **Chairman**, a dividend was declared at the rate of 6 per cent. per annum for the second half-year, making a dividend for the year of 6 per cent. per annum. The Chairman then said that he had reason to believe a combination existed amongst "B" shareholders and other dissatisfied shareholders in the Company, and he had taken upon himself the responsibility of issuing a circular sounding a note of warning, and to which the shareholders had responded in large numbers, so that there were no adverse proxies. He also took the opportunity of suggesting to the shareholders not to be in too great a hurry to part with their shares at a large discount. The directors knew when executors realised an estate, or when a shareholder sold his shares. The Board knew where they went to and upon what terms, and, therefore, they had thought it their duty to say that there was no reason for shareholders to part with their shares at less than their par value.

The meeting closed with a vote of thanks.

NATIONAL TELEPHONE.

The twenty-sixth ordinary general meeting of this Company was held last week at Cannon-street Hotel, E.C., Mr. J. Staats Forbes presiding.

In moving the adoption of the report and accounts (which appeared in our issue for July 20) the **Chairman** said that the net income had increased by £88,000, and the working expenses by £77,000, while the net result for the half-year was £227,262. The working expenses had gone up from 60·22 to 64·02 per cent., but that included the £25,000 of exceptional expenditure as the result of the snowstorm. The amount brought forward was about £2,000 less; the debenture and other interest had increased by £14,913, because in the interval the directors had issued debentures, and the interest on them had been paid up to date; and the preference and ordinary dividend was larger by £5,000, a portion of the ordinary shares sanctioned by the shareholders having been issued. The sum transferred to the reserve fund was £5,000 less than in the June half of 1899, and the amount carried forward was about £6,000 less. The directors proposed to pay the dividends upon the first, second, and third preference shares, and a dividend of 6 per cent. per annum, less income tax, on the ordinary shares; and they would carry £55,000 to the reserve fund.

The motion was seconded by the **Right Hon. Lord Harris, G.C.S.I.**, and adopted.

NOTTING HILL ELECTRIC LIGHTING.

An extraordinary general meeting of this Company was held at Winchester House on Wednesday last, when the following resolutions were adopted: "That the capital of the Company be increased to £200,000 by the creation of 10,000 new shares of £10 each, such new shares to rank as ordinary shares"; "That 2,200 of the new shares be issued forthwith at a premium of £2 per share, 1,100 to be offered *pro rata* to the holders of the founders' shares, and the remaining 1,100 *pro rata* to the holders of the ordinary and ordinary preference shares"; and "That the remainder of the new shares shall be issued at such times, and at such price, and under such conditions as the directors shall from time to time think fit, but so that the proportion thereof to be offered to the holders of the Company's founders' shares shall be the same as the proportion now offered under the last preceding resolution."

Digitized by Google

ANGLO-AMERICAN TELEGRAPH.

The half-yearly meeting was held on July 31 at Winchester House.

Mr. F. A. Bevan, who presided, stated that the ordinary receipts for the past half-year had been remarkably similar to those for the corresponding period of 1899, the difference in favour of the half-year under review having been £983. He observed that when the new German Azores cable was laid there would be no fewer than 13 cables across the Atlantic. Last year they earned over £19,000 from the repairing ship "Nina," but this year the amount had been reduced by £17,975. They had been laying a new cable between France and England; for many years they had a cable running from Salcombe to Brest, but it became worn, so the directors made a new line from Cuckmere to Havre. The new German Azores cable line was heavily subsidised by the German Government. This was to be opened on Sept. 1, and would then take a large portion of the outward traffic from Germany and America. With reference to the old subject of the French law-suit, he had been requested by their solicitor to ask the shareholders not to press this question on the present occasion. Matters were proceeding, but he could not prophesy what the result would be.

CROMPTON AND CO.

The ordinary general meeting of this Company was held on Monday last at Cannon-street Hotel, E.C., Mr. John Trotter presiding.

The **Chairman** gave a *résumé* of the report (which appeared in our last week's issue), and recommended the payment of a dividend at the rate of 9 per cent. per annum for the half-year, free of income tax, making with the interim dividend paid in January last 7½ per cent. for the year, and to carry the balance, £3,729, forward.

The report was adopted.

BIRMINGHAM AND ASTON TRAMWAYS.

Colonel E. J. L. Twynham presided at the meeting of the Birmingham and Aston Tramways Company, Limited, on the 27th ult., and drew attention to the increased cost of fuel.

Replying to an enquiry, **Mr. C. E. Mathews**, as solicitor to the Company, explained the position as to the possible handing over of the undertaking to the public authority. At present, he said, the Aston Council had a Bill under which they had powers to buy the line, and the Company might expect to hear from that body at any time. The notice to acquire would have to be a double one, for the Aston people could not buy one part of the line without buying the other.

The **Chairman**: At all events, we shall meet next year.

Messrs. C. Osborn and Lewis Richards, the retiring directors, were re-elected.

DUBLIN UNITED TRAMWAYS.

At the half-yearly meeting held on July 31, the **Chairman** (Mr. Wm. M. Murphy) declared that they had not yet arrived at the most economical basis for the production of electrical current, owing to the delay in the delivery of multiphase generating plant. They had to keep Ballsbridge station open for the present, but when they shut it down and supplied all the current from Ringsend that would represent the saving of £2,400 in a half-year. A dividend of 7 per cent. per annum was declared on the ordinary shares, an increase of 2 per cent. over last year. Nearly 18 million passengers were carried during last year, the number in 1891 being 8¼ million.

At a subsequent special meeting the Company was authorised to increase its borrowing powers by £300,000, to be issued as second debentures.

RAND CENTRAL ELECTRIC WORKS.

The annual general meeting was held on July 31 at Winchester House.

Sir C. Rivers Wilson, who presided, observed that, with reference to what passed at the meeting last year as to reserve fund, the directors had fulfilled their obligations by setting aside the small sum of £83, being 10 per cent. of the profit. Small progress was made as contrasted with that of the two previous years. In 1897 they worked at a loss of £16,000. In 1898 the loss was £5,472, and last year, working under favourable circumstances for three quarters of the year only, they came out with a small profit of about £840.

The report (already published in our last issue) was adopted, and it was resolved that, conditionally on Messrs. Siemens and Halske paying the Company in London within seven days £21,872. 8s. 1d., the proposed agreement referred to in the report be approved, and the directors authorised to carry the same into effect.

BRITISH ELECTRIC TRANSFORMER.

The report for the year ended 30th ult., to be submitted to the meeting to day, shows that, after paying all expenses and providing for repairs and depreciation, there remains a net profit of £6,184, which, with the amount brought forward from last year, makes a total available balance of £6,442. The Board proposes the payment of a dividend at the rate of 10 per cent. per annum on the subscribed capital, and a bonus of 2½ per cent. for the half-year, £2,120; to reserve fund, £2,500; to carry forward, £1,802.

LIVERPOOL OVERHEAD RAILWAY.

Abstract of the report of the directors, to be presented at the twenty-fourth ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Aug. 14:

In presenting the half-yearly statement of capital and revenue accounts to June 30, 1900, the directors have to report that the gross revenue receipts amount to £38,124. 1s. 2d., and the working expenses to £25,113. 3s. 9d. The number of passengers carried during the half-year ending June 30, 1900, is as follows: first-class, 635,449; second-class, including tramways, 2 477.025; workmen, special return tickets, 1,575,388—total, 4,687,862. There has been considerable delay in completing the Waterloo and Crosby tramways owing to the difficulty experienced by the local authorities in obtaining delivery of material. The line is now opened as far as Waterloo, and it is expected it will be completed to Crosby in about two months. The traffic on the portion opened has been satisfactory. The Bill in Parliament, promoted by the Company for the purpose of extending the main line to the Seaforth Station of the Lancashire and Yorkshire Railway, has passed both Houses of Parliament, and will, in due course, receive the Royal assent. The capital authorised at the last half-yearly meeting was offered to the shareholders on June 25 last in 5,000 ordinary £10 shares at £8 per share, and applications were received for considerably more than the amount required. The directors recommend the declaration of dividends at the following rates (less income tax), payable on and after Aug. 16 next: 5 per cent. per annum on preference shares, £3,000; 3 per cent. per annum on ordinary shares, £6,750; leaving a balance of £4,452. 12s. to be carried forward to next half-year.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Maintenance of way, works, and stations	3,993	3	0
Locomotive power	7,188	18	1
Repairs and renewals of carriages	444	3	6
Traffic expenses	9 276	12	0
General charges	2,143	15	3
Law charges	70	9	6
Compensation	16	6	9
Rents, rates, and taxes	1,905	4	10
Government duty	74	10	10
	25,113	3	9
Balance carried to net revenue account	12,909	7	9
	£38,022	11	6

Receipts.	£	s.	d.
Passenger traffic	37,404	5	5
Parcels, etc.	40	5	7
Rents	565	2	8
Transfer fees	12	17	10
	£38,022	11	6

CENTRAL LONDON RAILWAY.

The report of the directors for the half-year ended June 30 last states that the expenditure for the half-year amounted to £185,712, the total to June 30, 1900, being £3,353,596. The directors hoped to be able to open the railway for traffic in the early part of July, but their expectations were not fully realised, some modifications in the plant being found necessary during the experimental working, as explained in the engineer's report. The approval of the Board of Trade having been given, the railway was opened for traffic on Monday, July 30. In anticipation of the opening, H.R.H. the Prince of Wales, at the request of the directors, kindly inaugurated the undertaking by accompanying them, and other gentlemen connected with the company, in the first train that carried passengers over the whole length of the line. His Royal Highness was much interested, and cordially wished success to the new enterprise. As a commencement a week-day service of trains will be run from about 5 a.m. to 12 p.m., at intervals of five minutes, but more frequent trains will be provided, especially during the busiest hours of the day, as soon as practicable. A reduced service will be run on Sundays. Provision has also been made for the conveyance of workmen, in accordance with the company's Acts of Parliament.—*Financial News.*

WATERLOO AND CITY RAILWAY.

The report for the half-year ended June 30, to be submitted on the 9th inst., shows a total capital outlay of £589,073. A further expenditure of £25,000 is provided for by the capital powers of the Company. The gross receipts, less Government duty, amounted to £14,133. From this amount the London and South-Western Company retained £5 398 in respect of working expenses, leaving £8 735 payable by them, in order to provide, under agreement, for a dividend at the rate of 3 per cent. per annum, payable 11th inst., on the Company's ordinary and borrowed capital. The number of passengers carried during the past six months, exclusive of season-ticket holders, was 1,868,737, an increase of 152,912. The season-ticket holders on June 30 last numbered 911, as against 747.

Colchester.—The Town Council have entered into a contract with the War Office to light the barracks at 4½d. per unit for the first 50,000 units and 4d. per unit afterwards.

Digitized by Google

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Halifax.—Tenders for incandescent lamps are required by the Corporation.

Lincoln.—The Town Council invite tenders for wattmeters and demand meters. Tenders by Sept. 14.

Sofia.—The District Treasurer invites tenders for the supply of telegraph material. Tenders by Aug. 6.

Hamburg.—Two 30-ton electric cranes are required. Enquiries may be made at the Town Hall. Tenders by Sept. 10.

Warrington.—Tenders are required by the Corporation for installation of mains and fittings at town hall and market.

Barcelona.—The Public Works Department, Madrid, invite tenders for a system of electric tramways in Barcelona. Tenders by Aug. 18.

Accrington.—The Corporation invite tenders for the wiring of their electricity works, Argyle-street, for electric lighting. Tenders by 10th inst.

Belfast.—The Electricity Committee invite tenders for the supply and erection of an auxiliary feed-water heater with pipe connections. Tenders by Aug. 15.

Stockport.—The Tramways Committee invite tenders for 20 double-deck tramcars, complete with electric equipment for overhead traction. Tenders by Aug. 31.

Bradford.—The Guardians invite tenders for the installation of electric lighting at their union workhouse. Tenders by Aug. 13. Details in our advertisement columns.

St. Petersburg.—The Posts and Telegraphs Department invite tenders for the working of the telephone systems in St. Petersburg, Moscow, Warsaw, Odessa, and Riga for 18 years from Nov. 1, 1901.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of lighting cables, tramway feeders, and street lighting. Tenders by Aug. 13. Details in our advertisement columns.

Barnes.—The Urban District Council invite tenders for the supply and erection of pipework, condensers, etc., and overhead travelling crane. Tenders by Aug. 14. Details in our advertisement columns.

Paris.—The Association des Industriels de France contre les Accidents du Travail offer a prize of £40 for the best insulating gloves for the use of those employed in electric works. Particulars must be supplied by Dec. 31.

Newcastle-on-Tyne.—The Corporation invite tenders for the laying down in Newcastle of about five miles of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. Tenders by Aug. 22.

Edinburgh.—The Lord Provost, Magistrates, and Council are prepared to receive tenders for coal-conveying machinery for Dewar-place station, contract No. 54. Tenders by 13th inst. Details in our advertisement columns.

Leeds.—Tenders are invited for the lighting of St. George's Church, Leeds, with electric light. Particulars can be obtained by sending names to Mr. Henry Walker, architect, 8, Upper Fountaine-street, Leeds, before 8th inst.

Glasgow.—The Corporation invite tenders for the work in connection with lifting off roofs and other alterations to Maryhill tramway depôt. The whole of the work, which is principally joiners' work, will be let to one contractor. Tenders by Aug. 10.

Portsmouth.—The Corporation invite tenders for the supply, delivery, and erection of the whole of the plant and apparatus necessary to completely equip for electric traction their proposed power station at Vivash-road, Fratton-grove, Portsmouth. Tenders by Sept. 4. Details in our advertisement columns.

Torquay.—The Corporation invite tenders for two water-tube boilers, with superheaters, two inductor alternators and Willans engines, pipework, surface condensers, etc., extension to high-tension switchboard, wattmeters, etc., and transformers. Tenders by Aug. 6. Full details in our advertisement columns.

Grimsby.—The Corporation invite tenders to specification for the supply and delivery, in connection with the electric lighting of the borough, for additional steam dynamos: Section 1, engine; Section 2, dynamo; and extension of switchboard for dynamo No. 7, and traction work. Tenders by 18th inst. Details in our advertisement columns.

Aberdeen.—The Town Council invite alternative tenders for the supply of 650 tons steel girder straight-track tramway rails, weight about 100lb. per lineal yard; 150 tons steel girder curve-track rails, weight about 104lb. per lineal yard, in standard lengths of 60ft. or 45ft., as may be decided; also for 60 tons fishplates, weight about 75lb. per pair. Tenders by 24th inst. Details in our advertisement columns.

Grays.—The Urban District Council invite tenders for the supply, delivery, and erection of the following work in connection with the electric lighting of the district: (Section A) two Lancashire boilers and pipework; (B) two 100 kw. steam dynamos, with boosters and balancer; (C) fuel economiser; (D) switchboard; (E) battery; (F) travelling crane; (G) mains and street lamp fittings. Tenders by Aug. 9.

Hanley.—The Electric Lighting Committee invite tenders for the supply, delivery, and erection complete of two Lancashire boilers and fittings, including steam receiver; water-tank, girders, and pumps; fuel economiser, with engine or motor; smoke chimney, exhaust fan, with engine, etc.; feed-water heater; forced-draught fittings, firebars, or other appliances to boiler furnaces; and coal conveyor and bunkers. Tenders by 25th inst.

London, S.E.—The Directors of the South London Electric Supply Corporation, Limited, invite tenders for the supply and erection at their works at Bengeworth-road, Loughborough Junction, S.E., of a complete condensing plant for dealing with 28,000lb. of steam per hour, comprising surface condenser, steam-driven air and circulating pumps, cooling tower, and pipe connections. Tenders by 14th inst. Details in our advertisement columns.

London, W.—The Central Electric Supply Company invite tenders for the supply, delivery, and erection of (Specification 2A) dry-back marine boilers, 11ft. 6in. diameter and 14ft. long, gangways, feed and drain pipes, etc., complete, as required for each of three blocks of boilers. Each or all of the blocks can be tendered for, each block containing six boilers. Tenders are also to be submitted for mechanical stokers, with the shafting and gearing for driving them. Alternative tenders are invited for (Specification 2B) water-tube boilers as an alternative to the dry-back marine boilers, including the mountings, feed and drain pipes, etc. Copies of the specifications, with forms of tender, drawings, and general conditions, can be obtained from the General Manager, 19, Carnaby-street, Golden-square, W., on payment of £3. 3s., to be returned on receipt of a bona fide tender. Specifications and drawings can be seen at the office of Prof. Kennedy, 17, Victoria-street, S.W. Tenders, on the prescribed form, endorsed on the outside "Electric Plant—Tender to No. — Specification," must be sent to Mr. F. J. Walker, general manager, before 10 a.m. on Aug. 20.

London, E.C.—Tenders are invited by the Pacific Cable Committee on behalf of her Majesty's Government and the Governments of Canada, New South Wales, Victoria, New Zealand, and Queensland for the manufacture and laying in the Pacific Ocean of 3,272 nautical miles of telegraph cables between Vancouver and Fanning Island, Fanning Island and Fiji, Fiji and Norfolk Island, Norfolk Island and New Zealand, Norfolk Island and Queensland. It is proposed to divide the whole undertaking under three distinct contracts, for any one or more of which contractors may tender. Each of these contracts will include a clause under which the contractor guarantees the good electrical condition and working order of the cables for 30 consecutive days after the completion of the laying. A fourth contract is also proposed for surveying and sounding the whole route before the cables are laid. Forms of contract, specification, and tender may be obtained of Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street, E.C., at whose offices charts showing the proposed route of the cable and the positions where soundings are to be taken may be inspected. The last day for the reception of tenders is Aug. 14. They must be enclosed in sealed covers, marked "Tender for Pacific Cable," must be addressed to Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street, E.C., and must be delivered by 12 noon on that day.

RESULTS OF TENDERS.

Croydon.—Tenders have been accepted for the reconstructed tramways, motorcar equipments on the overhead principle, at £176,540.

Hampstead.—The Lighting Committee recommend that the tender of W. T. Glover and Co. be accepted for the supply of electric cables for the next 12 months.

Larne.—The Urban District Council have accepted the tender of the Larne Electric Light Works for the public lighting of town and boundaries for the ensuing three years from Aug. 1, at £535.

Hull.—The Corporation have accepted the tender of the Walsall Electrical Company, Liverpool, at £210, for the electric lighting installation and fittings for the Springhead pumping station, near Hull.

Newcastle.—The following tenders have been accepted: British Insulated Wire Company, trolley wires, £6,118. 15s. 7d.; S. Easten, 277, Westgate-road, Newcastle, for erection of the power station at the Manors, £32,544.

Hackney.—The Vestry have accepted a modified tender from J. Greenwood, Arthur-street, London Bridge, at £31,589. 8s. 6d., for the erection and construction of buildings, foundations, and chimney shaft for the Hackney electricity works.

London County Council.—The tender of Messrs. Pink and Moon to execute for £170 the alterations necessary to adapt a cowhouse at Farmfield as an engine-house, in connection with the electric light installation, has been accepted.

Hull.—The Electric Lighting Committee have accepted the tender of T. Parker, Limited, Wolverhampton, at £5,985, for the supply and erection of five high-tension continuous-current rotary transformers, with switch gear and accessories.

Beckenham.—The Urban District Council have received the following tenders for the erection of six brick transformer stations, 11ft. by 11ft. in size internally: F. W. Green, 62, Beckenham-road, Beckenham, £868; Foster Bros., St. Mary's-road, South Norwood, £737 (accepted).

Chelmsford.—The Town Council have accepted the tender of the Chelmsford Electric Lighting Company for lighting the public lamps in the borough, for a period of five years, at the following prices: for arc lamps £25. 5s. each per annum, and for incandescent lamps £3. 3s. per annum.

Bootle.—The Town Council have accepted the tender of Callender's Cable and Construction Company, Limited, London,

Digitized by Google

to supply and erect the arc lamps, cables, etc., required for the electric lighting of Derby, Rimrose, and Knowsley roads for the sum of £6,855. 1s. 5d., together with the further sum of £80 per annum for the maintenance of the cables for 10 years.

Hammersmith.—The following tenders are recommended for acceptance: Callender's Cable and Construction Company, for low-tension distributor cables and boxes (estimated total), £4 062; W. T. Glover and Co., for high-tension feeder cables (estimated total), £1,151; Watson, Gow, and Co., for 200 tons of 2in. cast-iron pipes at £7. 5s. per ton, £1,450, and 4 tons of specials at £9 per ton, £36.

Cardiff.—The Corporation have received the following tenders for the manufacture of about 1,000 tons of steel tramway rails; also for fishplates, sole-plates, tie-bars, bolts and nuts, points and crossings, drain rails, copper rail bonds, etc.: Dick, Kerr, and Co., rails and fishplates £8,522, tie-bars £565; Ibbotson Bros., fish-bolts and nuts, £170; Bayliss, Jones, and Bayliss, sole-plates, £508; Askham Bros., points and crossings £267, two crossings £88, drain rails £378; Felten and Guilleaume, copper bonds, £618. These tenders have been recommended by the committee for acceptance.

Dublin.—The Electric Lighting Committee, acting on the advice of Mr. Robert Hammond, M.I.C.E., the consulting engineer, have recommended the Council to accept the following tenders for the plant for the new electricity works at Pigeon House: Polyphase generators, with compound engines—General Electric Company, Limited, London (D. Stewart and Co., Glasgow, engines; Oerlikon, Switzerland, generators), £33,061. Boiler-house plant—Holdsworth and Sons, Lancashire boilers, £6,653; Holdsworth and Sons, economisers, £1,060; Babcock and Wilcox, Limited, water-tube boilers, £5,278.

BUSINESS NOTES.

TRACTION.

Central London Railway.—This line was opened to the public on Monday, and 84,500 passengers were carried on that day, and 90,000 on Tuesday.

Paisley.—Mr. Murphy's Tramway Bill has now been dropped. No further attempt will be made to revive the Bill during the present session of Parliament.

Aberdeen.—An enquiry has been commenced into the alleged refusal of tramway conductors to stop at the stations when there were people waiting to get on the cars.

Norwich.—Lieutenant-Colonel H. A. Yorke, R.E., made an official inspection of the Norwich tramway system on behalf of the Board of Trade on Thursday last week. The whole system was in full working yesterday.

Barrow.—The negotiations for the running of the present steam trams by electricity are making progress. It is expected that a complete system of electric trams will be running within 12 months in the town, also to the docks and Furness Abbey.

Oldham.—At Wednesday's meeting of the Town Council a resolution was carried empowering the town clerk to apply for leave to borrow £280,000 for the construction and equipment of the tramway scheme and the necessary works and buildings.

Chalk Farm.—The County Council on Monday informed the Hampstead Vestry that it has decided for the present to abandon the proposed tramway from Chalk Farm to Edgware-road, as the Vestry has not agreed to contribute to the cost of the necessary public improvements.

Manchester.—The Council have authorised the Tramways Committee to obtain tenders for the erection of temporary car-sheds and stables, and for the supply of the requisite horses, cars, and other equipment for working the tramways by horse traction until such time as the electrical system is complete.

Blackpool.—It is expected that everything will be in readiness for the work of laying the new electric tramway round Marton being rapidly proceeded with during the coming autumn and winter. The Tramway Committee have accepted tenders for the supply of rails and the complete electrical equipment for the whole route.

Sunderland.—Some of the new cars for the Sunderland electric tramway service, which is to be opened shortly, have arrived in the town. A trial was made on the 31th ult. of one of the new electric cars on the route from Christ Church-to Roker section. The journey was made in nine minutes, and the trial went off without hitch.

Adelaide.—We learn from the *New South Wales Railway Budget* that the South Australian Government will oppose any measure which proposes to hand over the city and suburban tramways to any private ownership for an indefinite time, or to any corporation or group of corporations, to the detriment of the rest. The Premier has asked the Railway Commissioners to report to him on the probable cost of acquiring the existing lines and converting them into electric trams.

Southwark.—At the last meeting of the St. Olave's Board of Works a letter was read from the London County Council, expressing their intention to seek powers to form an electric tramway along the new southern approach to the Tower Bridge when parliamentary powers had been obtained. They, however, proposed to proceed with the laying of the rails in anticipation of parliamentary sanction being obtained in order to prevent disturbance of the roadway when complete. The proposal was approved subject to wood paving being laid instead of stone.

Sheffield.—The electric car service on the Abbeydale-road section was commenced on the 28th ult. For some time the route has been electrically equipped, but the sanction of the Board of Trade has not been obtained. The Board of Trade having recently intimated that they are unable at present to send an inspector to examine the electric appliances, and if the Corporation deem it expedient they can run the electric cars at their own risk, the Tramways Committee decided to adopt this course.

Derby.—The proposed new tramways will be 13 miles 1 furlong 2 21 chains. The routes have been fixed, and the Tramways Committee have decided to recommend the Council to take powers for the compulsory acquisition of property near the electric lighting station, containing an area of about 6,030 square yards, as a site upon which to erect buildings for the generation of electricity. The Council has been recommended to approve the scheme, and to sanction the insertion of clauses in the next Bill in Parliament for alteration of the existing system, for the proposed extensions, for the scheduling of land proposed to be acquired for street widening and for generating station.

Southampton.—At a recent meeting of the Borough Council, the Sheriff expressed his regret to the inhabitants of Shirley for the bad tramway accommodation they were receiving. The committee had had new wheels put to the trailers, so that the latter might be utilised on the route, but even with them it was impossible for the committee to cope with the traffic. When they saw there was a jump from 50,000 to 120,000 passengers per week, and there were only 12 cars, they would not be surprised at the committee's inability to give an efficient service under the present circumstances. They had urged on the contractors, but he was afraid they would not have the additional cars for some time.

Stoke-on-Trent.—At a recent meeting of the Town Council the town clerk was instructed to draw the attention of the Potteries Electric Traction Company to the decision of the Court of Appeal in the case of the borough of Hyde *v.* the Oldham, Ashton, and Hyde Electric Tramway, Limited, the British Electric Traction Pioneer Company, Limited, and others, and to ask them whether, in the face of that decision, they still refused to sign the agreement as to the cables prepared by the town clerk and previously submitted by him. Proceedings were ordered to be taken against the Electric Traction Company, Limited, for the nuisance caused by the emission of black smoke from the chimney of their works in Bewstead-street.

Maidstone.—At a meeting of the Town Council on Monday, the General Purposes Committee recommended the desirability of application by the Town Council for a provisional order for the establishment of an electric tramway through convenient parts of the borough. The acquisition of an order would prevent adventuring companies making efforts to obtain one. Trams would give the working classes better facilities for reaching their homes. It was also urged that one of the great drawbacks to the electric light was that they would not have sufficient work in the daytime. Tramways would meet that difficulty. The report was adopted, formal resolutions in favour of making the application, and instructing the Electric Lighting Committee to have plans prepared, being carried.

Folkestone.—At the last meeting of the Council the minutes of the proceedings of the Tramways Sub Committee were read. From the same it appeared that the borough surveyor had been instructed to prepare the necessary plans for deposit in connection with parliamentary proceedings for powers to construct tramways for Folkestone. The sub-committee were also of opinion that it was not desirable that tramways should be constructed along the whole length of the Lower Sandgate road, but recommended that the Corporation scheme should include a line from the harbour, past the north side of the Pavilion Hotel, along Marine-terrace, Marine-parade, and the Lower Sandgate-road as far as the entrance to the Victoria Pier. The town clerk reported that the parliamentary agents recommended Messrs. Kincaid and Co. as an eminent firm of tramway engineers, and it was resolved to apply to them for their terms for submitting an estimate of the cost of the proposed tramways. This was done, and Messrs. Kincaid, in reply, undertook to furnish the Council with a report giving them an estimate of the cost of the construction and equipment of the tramway suitable to the requirements of the town for 50 guineas, together with travelling and hotel expenses. It was reported that an expert of Messrs. Kincaid's had visited the town for the purpose of making a report, and had been met and shown round by the mayor and the town clerk. After a lengthy discussion the matter was deferred until Lord Radnor's agents had been approached, and the Council had received the report and plan from the expert.

Birmingham.—From the report of the Public Works Committee, presented at the quarterly and special meeting of the City Council on July 31, we gather that after experimenting with sample poles and brackets the committee came to the conclusion that the wires should be suspended from centre poles along the Horse Fair and Bristol-street as far as Bromsgrove-street, and that in Suffolk-street and between Bromsgrove-street and the city boundary the wires should be suspended from poles with side arms. The wire is to be 5ft. 6in. from the kerbstone, except in the length between Wellington-road and Priory-road, and in the case of a few trees between Wellington-road and Belgrave-road, where it is to be 8ft. 3in. from the kerbstone. The type of car approved by the committee for use on the line is a four-wheeled double-decked car of the pattern known as the Liverpool pattern. It will accommodate about 46 passengers, and will be comfortably fitted up and well lighted. The bonding of the rails with copper bonds will be

Digitized by Google

carried out by the company, and the electric feeders will be laid by the committee under the supervision of Mr. Vaudrey, the city electrical engineer, to an approved specification and at the cost of the company. A formal agreement, embodying the terms already reported to the Council, has been entered into with the company, and the town clerk has been instructed to join the company, on behalf of the Corporation, in any application that may be necessary for the sanction of the Board of Trade to work the tramways on the overhead system. Negotiations are pending with reference to the application of the Birmingham and Midland Tramway Company for permission to equip, on the overhead electric system, the tramways leased to them, between Lionel-street and the city boundary in Dudley-road.

Bournemouth.—The General Purposes Committee's report, adopted without discussion at the last meeting of the Council, reads as follows: "The report by Messrs. Lacey, Clirehugh, and Sillar (the consulting engineers) and Mr. F. W. Lacey (borough engineer) on the tramway scheme was read. (*a*) Mr. Lawson proposed, Mr. Hawker seconded, to recommend that the joint report of the electrical engineers and borough engineer be adopted and carried out; and it was so unanimously resolved. (*b*) Mr. Lawson proposed, Mr. Newlyn seconded, to recommend that a committee be appointed to carry out the scheme as set out in the report, including the electric lighting mentioned in it, to consist of the Mayor, Aldermen Davis and Mattocks, and Councillors Abbott, Beckett, Gunning, Hawker, Hoare, Lawson, Mate, and Stockley; and it was so unanimously resolved. (*c*) Mr. Davis proposed, Mr. Hawker seconded, to recommend that application be made to the Urban District Council of Winton for their consent and assistance to the Corporation constructing a tramway in continuation of the Corporation tramway No. 11, along the Wimborne-road, to a point to be agreed on in the urban district; and it was so resolved. (*d*) It was resolved to recommend that the necessary steps be taken to apply for a provisional order under the Tramways Act, 1870, to supplement the order for the present session by authorising the construction of the additional tramways recommended in the above report, and the extension of tramway No. 11 to Winton. Land in Southcote-road.—Mr. Lawson reported negotiations with the owners of land in Southcote-road adjoining the Corporation depôt there. Recommended that the Tramway Committee be authorised to enter into a provisional contract for the purchase of the property in the Southcote-road known as the Cumberland Estate, through Messrs. Bicker and Pettitt, in connection with the tramway scheme."

Croydon.—At the last meeting of the County Borough Council the Tramways Committee reported: "The committee recommend that paragraph 2 of their report of May 31 last be rescinded, and that the tender of the British Thomson-Houston Company for the supply of 35 car bodies of the type made by Messrs. G. and F. Milnes and Co., of Birkenhead, be accepted in lieu of that made by the Brush Electrical Engineering Company. With reference to paragraph 6 of the report of this committee of Jan. 18 last, the committee recommend that a double line of tramway be laid from the Swan and Sugarloaf, Brighton road, to the borough boundary at Purley, and from the Thornton Heath Pond to the borough boundary at Norbury. The committee have had a conference with the Roads Committee with regard to the wood paving of the roads, but are unable without further information to make any definite recommendation to the Council with regard to this work. They propose again to meet the Roads Committee on Monday, and hope at the meeting of the Council to lay a definite proposition before them. Subject to the committee being able to do this, and to the acceptance of their recommendation by the Council, they recommend that the following tenders be accepted: British Thomson-Houston Company, Limited, motorcar equipments, feeders, test wires, road work, and overhead construction; J. Smith and Sons, Limited, additional car-sheds, Thornton Heath depôt; Mr. E J. Saunders, Brighton-road depôt buildings." Subsequently the Roads Committee met, and recommended no tender for the reconstruction of the track, but that it be done by the Tramways Committee in conjunction with the Roads Committee, these committees being empowered to advertise for and accept tenders for materials, and engage such labour as would be necessary. The amended estimates, therefore, were: reconstruction of track and paving, £102,000; overhead equipment contract, less a reduction (estimated) of £1,000 in connection with the use of the trolley poles for arc lighting, £20,045; feeders, test wires, and road work, £12,963; car bodies (35), £9,680; motorcar equipment, £13,052; excavation and guard wires, £1,400; car-sheds, £9,400; engineer's commission, £3,000; contingencies, £5,000—total, £176,540. The reports were agreed to.

LIGHTING AND GENERAL.

Metropolitan Electric Supply Co.—The transfer registers will be closed from 4th to 13th inst. inclusive.

Rand Central Electric Works.—Mr. H. Rogers has been appointed secretary vice Mr. H. Militz, resigned.

Shoreditch.—The Vestry have obtained from the London County Council a loan of £42,400 for electric lighting purposes.

Potteries Electric Traction Co.—The transfer books of the preference shares will be closed until the 15th inst. inclusive.

Castner Electrolytic Alkali Co., U.S.A.—Letters of allotment of the £200,000 £5 per cent. first mortgage debentures have been passed.

Guernsey.—The works of the Edmundson Corporation, Limited, at Amballes, were inaugurated last week by Sir T. G. Carey, bailiff.

Crewe.—At Wednesday's meeting of the Town Council it was decided to spend an additional £10,000 upon electric lighting.

London Gazette.—A receiving order has been made out *re* W. V. Scott, Shaftesbury-road, East Hammersmith, on creditors' petition.

British Electric Traction Co.—The transfer books and register of members of the preference shares will be closed until the 15th inst. inclusive.

Meyra Electric Co.—We have received from this Company a new price-list giving particulars of their dry batteries for electrical purposes.

Electric Automobile Syndicate, Limited.—A general meeting of members of this syndicate is announced for Oct. 3 to receive the liquidators' statement.

Thurlstone.—It has been arranged for a deputation to meet the Penistone Council and the Guardians on Aug. 9, to discuss the question of electric lighting.

Atlantic Cable.—The German Atlantic Telegraph Company will shortly lay the second section of the German-American cable from New York to the Azores.

Southgate.—The Council is taking steps to join with the other local authorities in approaching Parliament with a view to securing an order for the supply of electric light.

Battersea.—The foundation stone of the central electric generating station in Lombard-road will be laid on the 18th inst. by Mr. W. Mathews, J.P., chairman of the Vestry.

Cardiff.—It appears that negotiations are about to be reopened between the Public Works Committee and the National Telephone Company for the laying down of underground wires.

Twickenham.—The Council have given their formal consent to the application of the Department, dated Oct. 10, 1899, for permission to lay a system of underground pipes in the district.

Partnership.—We are informed that Messrs. F. E. and A. S. Elmore have entered into partnership as consulting electro-metallurgists, and have opened offices at 4, Bishopsgate-street Within, E.C.

Crystal Palace.—The effects of the recent accident were quickly alleviated by means of the plant kept in reserve within the building. This was brought up to 1,100 volts, and nearly three-quarters of a mile of cable were laid as temporary mains.

Leicester.—The total output of electric current from the central station for the half-year ending June 30 last was 489,055 Board of Trade units, as against 342,327 units in the corresponding period of last year, being an increase of 146 728 units, or 42 86 per cent.

Reno Inclined Elevator Syndicate.—The directors of this syndicate propose to hold a private view of their Reno inclined elevator at the Crystal Palace to day, this being the first time in which this patent electric stairway has been worked in the United Kingdom.

Lancaster.—The price for electric current is to be advanced as follows: for motor purposes, from 3d. to 3½d. per unit; for lighting purposes, 4½d. to 6d. per unit. It is stated that the electric lighting will be extended to North Ward as soon as there was a sufficient request from the applicants.

Accrington.—The Electric Lighting Committee propose to ask Messrs. Glover upon what terms they would be prepared to put in the house services from the mains to the meter previous to deciding whether they will employ Messrs. Glover to do the work instead of at once appointing a staff of wiremen.

W. T. Henley's Telegraph Works Co.—Interim dividends for the six months ended June 30, 1900, will be paid on Sept. 1, 1900, as follows: on the ordinary shares at the rate of 8 per cent. per annum, less income tax; on the preference shares at the rate of 4½ per cent. per annum, less income tax.

Patent Decision.—The Thomson-Houston Electric Company have obtained a decree, with costs, in the United States Circuit Court, South District, of New York, U.S.A., for an injunction against the Lorain Steel Company against the infringement of their claims 1, 2, 3, and 4 of the patent motor switch interlocks (Knight, Patent No. 428,169).

Bradford.—Mr. John Brigg, M.P., has given notice in the House of Commons to ask the Secretary to the Treasury, as representing the Postmaster-General, if he will explain why one part of the telephone district around Bradford is allowed to communicate by telephone with the post office at Bradford, while other parts of the same telephone district are not allowed the same privilege.

Appointments Vacant.—The Electric Lighting Committee of the Hull Corporation are prepared to take two electrical improvers into their electric light works for a period of two years, at a premium of £30.—The Tramways Department of the Glasgow Corporation require the services of a first-class mechanical engineer to take charge of the steam plant and general oversight of their power station.—Applications are invited for the post of senior demonstrator of electrical engineering at the South Western Polytechnic, Manresa road, Chelsea. Salary, £150 per annum.—Telegraph linesmen are required in Lagos. The engagement is for three years, with possible extension. Salary, £200 per annum Half-pay during voyage out. Free quarters or rent. Travelling expenses in colony. Second-class passages out and home, including rail third-class. After 12 months' continuous service six months' leave, with free passage and full salary. Applications will be received by the Crown Agents for the Colonies, Downing-street, London, S.W., on or before Aug. 13. Full particulars of these vacancies appear in our advertisement columns.—A switchboard, a fitter driver, and a jointer are required at Rochdale electricity works.

Digitized by Google

Walker.—Sanction has been received for the following loans: £8,288 for a refuse destructor; £18,418 for electric lighting, etc.; and £1,700 for electric free wiring. The Newcastle Electric Supply Company's Bill, as amended, has been read a second time in the House of Lords and passed the committee.

Cork.—At the last meeting of the Council the standing orders were suspended for the consideration of a recommendation to the effect that the public lighting of the city by electricity be extended by the erection of 85 additional arc lamps. The motion was discussed at great length, but was finally rejected.

Chester-le-Street.—The Chester-le Street Parish Lighting Company, Limited, intend to apply to the Board of Trade on or before Dec. 21 next for a provisional order authorising them to supply electricity for public and private purposes within the whole of the district of the Chester-le-Street Rural District Council.

Nelson.—Application is to be made for sanction to a loan of £2 500 for battery and switchboard for the electric lighting station. The question of the unsatisfactory state of the electric cables in Netherfield-road and Railway-street has been placed in the hands of Mr. Gibbings, the consulting engineer of the Town Council.

Egremont.—The Bill to confirm the Egremont electric lighting order of the District Council has received the Royal assent. The North British Electricity Supply Company, King-street, South Shields, intend to apply for a provisional order and confirming Bill to authorise them to supply electric energy within the urban district of Egremont.

Holiday Tours.—The Great Eastern Railway Company have issued several well-illustrated and handy booklets which they call annotated time-tables, and which give by the side of the usual figures a description of the places of interest passed by the train. Those we have seen refer to the Aldeburgh and Hunstanton express trains respectively.

Sunbury.—The Twickenham and Teddington Electric Supply Company, financed by the Edmundson's Electricity Corporation, who have just passed a Bill through both Houses for the supply of Twickenham, where they intend to erect their station, are now about to apply for powers to supply a district including Teddington, Sunbury, and Hampton.

Keswick.—The added portions of the Urban District Council—Great Crosthwaite and Chestnut Hill, Brow Top, etc.—were lighted for the first time on Monday. Each pillar is fitted with dual lamps, one only of which is lighted; but there is an automatic arrangement to switch the current on to the other in the case of damage to the filament of the one in use.

Swanage.—The Urban District Council have deferred giving their consent to the application of the Bournemouth and Poole Electricity Supply Company to a proposed provisional order, pending enquiries which are being made from other district councils which have adopted electric light to ascertain whether it would pay the Swanage Council to adopt the system.

Brighouse.—At last week's meeting of the Town Council a letter was read from the North British Electricity Supply Company, giving notice of their intention to apply for powers to supply electrical energy for public and private purposes within the borough of Brighouse, and the Gas and Electricity Committee were instructed to take the necessary steps when the Bill was deposited.

Newmarket.—The postal authorities having submitted a tracing showing the course of the proposed trunk telephone line between Bury St. Edmunds and Newmarket, the Council decided to refuse the sanction to the erection of poles and wires in the main thoroughfares of the town. They agreed to draw attention to the fact that already the telegraph wires are carried underground until they are outside the town.

Removal.—We are informed that the Edison and Swan Company, owing to the expansion of their business, have removed their supply department to large warehouses, 27, College hill (almost immediately opposite their head offices and showroom in Queen-street), where there are departments for the supply of accessories, electroliers, bell goods, glass, wires, and cables, etc., of which there are large and varied stocks.

Harrow.—A committee of the Council has under consideration the specification of the Harrow Electric Light Company for the wiring of the offices. They have agreed to recommend that instead of having a big centre 10 light fitting as described in the specification, that a three-light centre piece and five single pendants be fixed over the tables at a cost of £4. 5s. instead of £10, this meaning a saving of £3 in the wiring contract.

Brompton and Kensington Electricity Supply Co.—The directors have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares and an interim dividend of 5 per cent. per annum on the ordinary shares for the half-year to June 30 last. The transfer books of the ordinary and preference shares respectively will accordingly be closed until 7th inst. for the preparation of dividend warrants payable 8th inst.

Aberdeen.—Mr. Bell has submitted plans showing how he proposes to lay out the ground at Dee Village for the purpose of the new electrical station, and they have been remitted to Mr. Smith (gas manager) and Mr. Bell for a report on the whole subject. Tenders will now be issued for additional plant, consisting of two 200 kw. sets and one 420 kw. set. The new plant has to be ready to meet the demands for electric lighting in the autumn and winter of 1901.

Metropolitan Asylums Board.—At the meeting of the Board on Saturday last, letters were read from the Local Government Board promising to issue an order authorising an additional expenditure of £1,280 on the electric light installation at the North-Western Hospital—the amount to be obtained by a loan which should be repaid in 10 years—but adding that they are advised that the amount of the electrical expert's charges in connection with the work was extraordinarily high.

Stourbridge.—The Urban District Council have adopted a report of their Destructor and Electric Powers Committee on the question of the utilisation of the provisional order obtained by the Council for the supply of electricity within the area of the urban district, advising that steps should be taken to lay down a plant sufficient to supply the present needs of the town. The committee also recommended that the application for a provisional order by the Midland Electric Corporation be opposed. The committee only proposes to supply a restricted area with electricity.

Tunbridge Wells.—The town clerk has received notice of an appeal by the National Telephone Company against the recent decision giving the Tunbridge Wells Corporation power to prevent the laying down of underground telephone wires. The Lighting Committee recommend the Council to at once proceed to erect an additional chimney, at an estimated cost of £3,500, and to obtain tenders for the execution of the work, which is to be carried out under the superintendence of Mr. Maxwell, the borough surveyor. A new flue and economiser, estimated to cost £1,000, which are rendered necessary by the erection of the new chimney, are also to be provided.

Fire.—On Friday night the lightning set fire to the Post Office telegraphs and telephones testing station and stores at Weedon. Within this testing station meet 172 main-line wires from Ireland, Scotland, and all parts of England, and pass through a delicate and expensive testing apparatus, which immediately and exactly locates a fault on any of the lines. The fire was soon extinguished, but many of the wires were fused and the testing apparatus was seriously damaged. The Post Office electricians at Weedon immediately set to work, and by joining the wires, without running them through the station, succeeded in restoring all communications by daybreak the next morning.

Stock Exchange.—The Stock Exchange Committee have ordered the British Aluminium Company's 20,000 7 per cent. cumulative preference shares of £10 each, fully paid, Nos. 1 to 20 000, to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the Castner Electrolytic Alkali Company's (of the United States of America) £200,000 5 per cent. first mortgage sterling debentures of £100 each, and the County of London and Brush Provisional Electric Lighting Company's provisional certificates for £100,000 4½ per cent. debenture stock, and to appoint a special settling day in the Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each. Application has also been made for Crompton and Co.'s further issue of 21,902 ordinary shares of £3 each, fully paid, Nos. 32,099 to 54,000, to be quoted in the official list.

Chichester.—The *Hampshire Telegraph* says: "The Chichester Town Council is now in a curious position with regard to the question of supplying electricity for lighting purposes. After one or two preliminary debates, and a report from a firm of electricians, it resolved more than two years ago to apply for a provisional order giving power to carry out electric lighting work to the exclusion of private companies. The order was obtained at an expense of nearly £300, but was for two years only. Since then the Council has considered a scheme proposed by the city surveyor, and approved, with some modifications, by Mr. Price, electrical expert, of Portsmouth, but at the last moment postponed the consideration of it, a further expense of 50 or 60 guineas being incurred. The order expired on July 1, and immediately the Council were apprised by the North British Electricity Supply Company of South Shields that they intend applying by memorial to the Board of Trade for a provisional order to authorise the company to supply electrical energy for public or private purposes within the city."

Dover.—We learn that 35 Dover Electric Light Company £5 shares were sold by auction recently by Messrs. Worsfold and Hayward. Ten sold for £7l. 5s., 20 for £135, and five for £33. 15s. The company has been in existence five years, and the amount above par realised in these shares is equal to 7½ per cent. on the investment for the whole period, without reckoning the 3 per cent. dividend received from the company last year. The Dover Electricity Supply Company have agreed to reduce the cost of lighting the Granville Gardens from £25 to £10, though the former amount is under the estimated cost, but the company desire that electric light should become popular. The National Telephone Company have made application for permission to lay underground telephone wires in various streets, etc., which will be sanctioned subject to their being laid under footways, to the proviso that if the municipality of Dover should afterwards obtain a license that the Telephone Company should agree to inter-communication over their wires, and that the company should pay a substantial sum for the concession.

Condensers.—We have received from Messrs. T. Ledward and Co., of 35, Queen Victoria-street, London, E.C., one of their latest catalogues, which gives a great deal of useful information relating to condensers, both of the ejector and evaporative types, manufactured under Ledward's patents. The advantages of condensing, as compared with non-condensing, engines are incidentally pointed out, while full directions are given for fixing the apparatus illustrated. Some excellent diagrams taken from engines working in conjunction with Ledward's patent ejector condensers are also given, together with numerous testimonials as to the efficiency of the apparatus supplied by the firm and a long list of electrical and other engineering works, etc., which have adopted the condensers.

Digitized by Google

A quantity of other useful information and tables relative to the expansion of steam, properties of saturated steam, strength of cast-iron pipes, diameters, areas, and circumferences of circles, etc., are included. The catalogue should be found exceedingly useful both by those wishing to instal condenser plants and those wishing merely to learn something about condensers.

Hammersmith.—The Electricity and Lighting Committee on Wednesday submitted a report with regard to the proposal to obtain a supply of water from the River Thames to the electricity station for condensing purposes, and the installation of a new system of condensing plant more applicable to the great advances anticipated in the capacity of the generating station in the future, the estimated cost of the works as approved by the Vestry on that date being as follows: excavation of road and laying pipes, £1,750; sewer, £2,200; penstocks, £150; cast-iron pipes, £1,800; sundry work to surface of road, £150; pumping station, £300—making £6,350; to which is added pumps, motors, and cables, £1,300; condensers and pipes, £1,250; contingencies, £1,100—bringing the total estimate to £10,000. The committee stated that they had approved plans prepared by the surveyor showing the various details included in the foregoing estimate of £6,350, and recommended that the plans be adopted, and that the surveyor be instructed to prepare specifications of the work, and that the matter be referred back to them to obtain tenders and report.

Parliament.—In the House of Lords during the past week the London, Walthamstow, and Epping Forest Railway (Abandonment) Bill was read a second time. The following Bills were read a third time and passed: Liverpool Corporation, Exeter Corporation, Christchurch and Bournemouth Tramways, Metropolitan District Railway, South Wales Electrical Power Distribution, and Plymouth, Stonehouse, and Devonport Tramways, West Ham Corporation, West Bromwich Corporation, South Lancashire Tramways, London County Tramways (No. 2), Newcastle-on-Tyne Electric Supply, Durham (County of) Electric Power Supply, Lancashire Electric Power. In the Commons the following Bills were read a third time: Rotherhithe and Ratcliff Tunnel, Ipswich Corporation Tramways, Great Grimsby Street Tramways, Roe's Patent, South Shields Corporation, Walsall Corporation, Rotherham Corporation, Whitechapel and Bow Railway. The Brompton and Piccadilly-circus Railway Bill was withdrawn. The Lords amendments to the following Bills were considered and agreed to: Aberdeen Corporation Tramways, Burnley Corporation.

Air-Compressors and Hoists.—Messrs. Reavell and Co., Limited, of Ranelagh Works, Ipswich, have sent us a nicely-executed and well-illustrated catalogue of the air-compressors and hoists manufactured by them under Reavell's patent. Amongst many others, an air-compressor of the "Quadruplex" single-acting type arranged for electrical driving is shown. The motor and the compressor are connected together by gear wheels, which run in an oil bath. This arrangement makes a combined plant, which can be moved about from place to place if the requirement of the work render this desirable All of the standard sizes quoted are adapted for electrical driving, and for the latter purpose the firm undertakes to supply motors when particulars as to the voltage available are given. The compressors are of the high-speed type, especially designed to work quietly at a fairly high speed, and to give a continuous supply of air, so as to reduce the size of the reservoirs which at present are used with pneumatic equipments. They are suited for supplying compressed air at 80lb. to 100lb. pressure for working all kinds of pneumatic tools in workshops, and the electrically-driven type is eminently adapted for colliery and quarry work, where compressed air is employed for rock drilling, etc. Full descriptions and dimensions, besides the prices of the different standard sizes, are given.

City of London.—At Thursday's meeting of the Court of Common Council a report was adopted on applications from the Postmaster-General to open up certain streets in the City, and erect stagings in support of wire cables. It was pointed out that the Postmaster-General wished to use, without the payment of any rent, the subways owned by the Corporation. According to the resolution passed on Thursday, the Corporation are reserving the right to charge such a rent as it might be entitled to. A similar application by the National Telephone Company in regard to the subways in front of the Mansion House was rejected. The following recommendations on the proposed erection of a generating station at Marsh Gate-lane, Bow, were agreed to: "(1) That the purchase money to be charged against the City undertaking for the portion of the site required for the erection of the City generating station be determined *pro rata* to the cost of the whole site; (2) that the Charing Cross and Strand Electricity Supply Corporation shall not acquire any interests in adjoining land without the previous consent of the Corporation being obtained, such consent, however, not to be unreasonably withheld; (3) that the Corporation agrees to allow the company the necessary running powers over the proposed line of railway shown on the plan submitted, subject to a nominal rental, and without prejuice in any way to the rights of the Corporation to use or alter such line of railway."

Morecambe.—Arrangements had been made by which the Electric Launch Power Syndicate was to obtain power for their launches from the Urban District Council's works at 3d. per unit, but this appears to have been only a temporary concession, as the Urban District Council recently attempted to increase this charge to 7d. per unit, which would be prohibitive. The directors have now succeeded in again getting this price reduced to the original 3d. The current is supplied to the generating station at the end of Calton-terrace at a pressure of 220 volts, and by means of a motor-dynamo the current is transformed to the voltage required by the boats. The cables are then conveyed by an iron main laid underneath the stage to an iron standard erected above the ordinary high-water mark at the foot of the landing-stage, where by means of cables attached to watertight boxes at the top of the standard the boats can be charged at their moorings. As a beginning two boats have been provided. The "Lady Ada," specially built for the company by the Vril Launch Company in the Isle of Wight, is 28ft. long, with a draught of 2ft. 6in., and carries 30 passengers; whilst the "Lady May," which was built on the Thames, is 40ft. long, with a draught of 2ft. 6in., and carries 45 passengers. Both are very handsome screw boats, capable of travelling 7½ knots, or about 10 miles, an hour, and a peculiarity is their great safety even in rough weather. The machinery, weighing about 2½ tons, is exactly in the middle of the boat, so that the danger of capsizing even when broadside on in a high sea is reduced to a minimum.

Bristol.—The Electrical Committee recently submitted a statement of the accounts of the electrical undertaking for the year ended March 25 last. The number of consumers on March 25, 1900, was 1,215, being an increase of 248 during the year. The number of lamps connected was 85,956 (of 8 c.p.), as compared with 68,536 at the corresponding period of the previous year. During the year a number of motors have been connected with the mains. The use of electricity for motive power in Bristol is in its infancy, and judging by its extensive use for similar purposes in other towns, the committee anticipate a much larger demand when its advantages are better known. The number of units sold was 1,812,511, being an increase of 449,725. An examination of the accounts will show that the financial results of the year have been satisfactory, considering that the effect of the reduction in the charges for private lighting made on Oct. 1, 1898, and for public lighting made on Jan. 1, 1899, has been felt throughout the year, whilst only a part of the previous financial year was affected. The gross receipts amounted to £31,717. 14s. 2d., and the gross expenditure to £17,962. 1s., leaving a gross profit of £13,755. 13s. 2s., from which has to be deducted interest on loans and bankers' overdraft, £6,019. 15s. 8d.; repayment of money borrowed, £7,590—£13,609. 15s. 8d.; leaving a balance of £145. 17s. 6d. The following statement exhibits the financial position of the undertaking at March 25, 1900: total capital expenditure, £252,588. 7s. 2d.; mortgage debt, £228,750; less paid off or set aside, £30,110—£198,620; balance at credit of reserve fund, £5,000; balance at credit of depreciation account, £2,024 17s. 7d. The accounts have been audited by Mr. Edwin John Richards, A.C.A., and Mr. Solomon Hare, F.C.A., city auditors, and their certificate is appended. A report from the city electrical engineer, statements as to the financial and commercial progress, and an historical note of the undertaking, were appended.

Gravesend.—In view of supplying the town of Gravesend with electric light and power, Mr. W. H. Trentham, consulting electrical engineer, has prepared a report for the chairman and members of the Electric Lighting Committee of Gravesend. As it is not easy to keep apart the two questions of light and power for tramway traction, Mr. Trentham proposes to combine them, but to keep the question of a refuse destructor apart. He gives figures concerning the electric lighting of 12 towns of a similar size as Gravesend, in which 10 show a profit, in one instance of nearly £2,500, while only two show a loss on the working. The following were the principal objections with which Mr. Trentham dealt with, one after the other, in a satisfactory manner: (1) that there is no demand for the electric light; (2) that electricity is very much dearer than gas; (3) that profits have only been made in much more populous towns than Gravesend; (4) that the light is not yet perfected, and that the time has not yet arrived for such an undertaking to be embarked upon; (5) that residents having already gone to the expense of having their premises fitted up with gas will not incur the, to some at all events, comparatively heavy cost of putting in wires and fittings for electricity. As soon as the electric supply is available the tramway company will require 280,000 units per annum, and if a charge of 1·63d., the rate paid at Wrexham, be made, the revenue under that head will be £1,925, but it is proposed to charge 1·75d., considering the present price of coal, which would bring this revenue to £2,041. It is proposed to erect a destructor to deal with 5,000 tons of refuse per annum, or about one ton per hour, at a cost of £3,500. The site proposed is near the gasworks. The lighting would only be done in the principal streets only at first by 800-c.p. arc lamps, 23ft high, and placed 65ft. apart. The following points were successfully proved: (1) that as electric lighting pays well in other towns of similar size, it should also pay in Gravesend; (2) that the addition of the tramway load would enable the undertaking to pay at an early date; (3) that if a destructor be established it should be in combination with the generating station.

Hornsey.—The Electrical Committee of the Urban Council at the last meeting recommended that Mr. Robert Hammond be appointed engineer to carry out the scheme for the supply of electrical energy for lighting and other purposes in the Hornsey district, subject to an agreement to be prepared by the Council's solicitor embodying Mr. Hammond's duties and remuneration as set out in the following particulars: Duties—to attend all necessary conferences with the Electricity Supply Committee in order to settle details of scheme; to draw specifications and prepare plans of plant, buildings, and works for public tender; to conduct all necessary correspondence with, or attend at, the Board of Trade to obtain "sanction of system"; to prepare necessary plans, data, etc., for the Local Government Board; to attend Local Government Board enquiry in connection with their granting sanction to loan; to report to the Electricity Supply Committee on the tenders received for the plant, buildings, etc.; to settle

Digitized by Google

technical details of contracts; to settle contract drawings and tabulate same; to inspect the plant in course of manufacture at makers' works; to inspect the progress of the work during execution on site; to prepare the maps of completed mains in accordance with the requirements of the Board of Trade; to keep the records of the accounts with contractors, measure up the work on site, and certify payments due to contractors as the work progresses; to undertake testing of plant on completion, and certify as to conformity of same with specification; to act as arbitrator in case of dispute under the contracts; to undertake all general engineering duties connected with the carrying out of the works, and to advise the Electricity Supply Committee throughout progress of works in all matters connected with the contracts and with the establishment of the undertaking. and to attend meetings of committee when necessary. Mr. Hammond's remuneration to be 5 per cent. on the cost of the executed work except buildings and any other work done by the Council's surveyor, payable as follows: 2½ per cent. on the amount of the contracts as they are from time to time given out, and the balance in the form of 2½ per cent. on the amount of certificates issued from time to time as the work proceeds. And in addition to the above fee of 5 per cent. an allowance to be made of such sums as the Council may on the recommendation of the Electricity Supply Committee from time to time consider reasonable, during the execution of the works to cover the services of clerk of works to be employed in superintending the carrying out of the work on the site thereof, and also an allowance for all reasonable travelling expenses incurred in the inspection of plant during construction. The report was adopted. The plans for the buildings are to be prepared by Mr. Lovegrove, the engineer to the Council.

Victoria Embankment.—On Tuesday the Highways Committee of the London County Council reported as follows: "We have, under the authority given to us by the Council on Feb. 15, 1898, invited tenders by public advertisement for the supply of the lamp standards which will be required in connection with the electric light installation for the Victoria embankment and Westminster Bridge; and the tenders received were opened at the meeting of the Council on July 10, and referred to us. It was stated in the advertisement that each person tendering was to submit his own design for the standards, or if he so desired he might submit alternative designs; and the specification contained an intimation, for the guidance of persons tendering, that the price considered adequate was about £30 per standard complete. The tenders sent in were as follows: A. Brown and Sons, Londonderry, £27 per lamp; Mackenzie Bros., Edinburgh, £28. 5s.; J. Allen and Son, Glasgow, £29. 10s.; W. Macfarlane and Co., Glasgow (two designs), £29. 10s. or £31; R. Carr and Co., London (two designs), £30; W. A. Baker and Co., Newport, Mon. (two designs), £32. 10s. or £35; W. Lucy and Co., Oxford, £34. 10s.; W. Singer and Co., Frome, £35; T. Brown and Co., Birmingham, £39. 10s. We have carefully examined the designs submitted, and have had the advice of the architect and the chief engineer with reference to them. Those submitted by Messrs. Macfarlane and Co. appeared to us to be the most satisfactory, and we asked them to submit a further design embodying what we considered to be the best points of each of those submitted with their tender. We have given instructions for all the designs, including the amended one sent in by Messrs. Macfarlane and Co., to be on view in the lobby of the Council chamber when this report is under consideration. Messrs. Macfarlane and Co. are willing to manufacture and supply the lamp standards which will be required, about 65 in number, at the price £30 each, making £1,950 in all, and to commence delivery within 100 working days from the date of order and to complete the delivery within 134 working days. The period allowed in the specification for the delivery of the standards was three months from date of order, and the time asked for by Messrs. Macfarlane and Co. is somewhat more, but we think that this may be conceded. It will be seen that other tenders were of less amounts than the price asked by Messrs. Macfarlane and Co.; but we would point out that in a matter of this kind, where the artistic character of the designs is a factor which must be considered, the small difference in price should not be allowed to stand in the way of the best design being adopted. Provision for the expenditure for, among other things, the lamp standards was made in the estimates, amounting in all to £25,000, approved by the Council on July 13, 1897, and Feb. 15, 1898, in respect of the electric light installation; and we recommend that the Council accept the tender of Messrs. W. Macfarlane and Co., for the supply of about 65 arc lamp standards, at the price of £30 each, required in connection with the electric light installation for the Victoria-embankment and Westminster Bridge, such standards to be completed in accordance with the design submitted to, and approved by, the Highways Committee on July 26, 1900."

LEGAL INTELLIGENCE.

TELEGRAPH LINES UNDER THE STREET.

Builders have an additional enemy to encounter. Telegraph lines under the street level have to be carefully guarded against. In the Edinburgh Small-Debt Court the first case of its kind in Scotland was heard recently. The Postmaster-General claimed £9. 8s. 1d. from Adam Loch, contractor, Shardwick place, Edinburgh, in respect of damage done to the telegraph line below a street in Leith, where defender was carrying on building operations. It was stated on behalf of the head of the Post Office that the telegraph line was melted by the heat from a tar-boiler which defender was using, and it was contended that under the Telegraph Act Mr. Loch was liable. Authorities from the English Courts were quoted in support of the contention.

Defender's plea was that as he did not know that the telegraph line was there, he should not be held liable. He had only carried out his operations in accordance with the recognised custom of the trade.

The Sheriff held that defender was liable, and accordingly gave decree for the amount sued.

ACTION DISCONTINUED.

The action between the Jandus Arc Lamp and Electric Company, Limited, and Mr. William James Davy has come to an abrupt ending by the action of the plaintiffs, who have notified that they wholly abandon their case.

THE POTTERIES TRAMWAY CONTRACT.

The case of Fell *v.* the British Electric Traction Company was further heard on Monday in the Queen's Bench Division of the High Court before Mr Justice Kennedy and a special jury. Mr. Lyttelton, Q.C., and Mr. Richards appeared for the plaintiff, and Mr. Pickford, Q.C., and Mr. H. Davies for the defendants. The case was to allow Mr. J. Fell, contractor, the plaintiff, to recover £5,872 alleged to be due to him under contract. This claim was denied by defendants. Some further evidence was heard on both sides, and the jury found a verdict for the defendants, and judgment was given accordingly for the defendants with costs.

PROVISIONAL PATENTS, 1900.

JULY 23.

13249. Improvements in and connected with the electrical transmission of images and in the recording of images. William Friese-Greene, 55, Chancery-lane, London.

13280. Improvements in arc lamps. Johann Friedrich Ackermann, 40, Chancery-lane, London. (Complete specification.)

JULY 24.

13293. Overhead railway signal by contact alarm. John Ephraim New, 29, Milton-villas, Clodeshall-road, Upper Saltley, Birmingham.

13356. Improvements in telephonic relays. William Phillips Thompson, 6, Lord-street, Liverpool. (Josiah Tice, William Grant Urmson, John William Parsons, and Henry Augustus Bell, United States.) (Complete specification.)

JULY 25.

13375. Improvements in or relating to electric ignition plugs Harry Frederick Atkins, 18, Hertford-street, Coventry.

13385. Improvements in the method of and means for medically applying electricity. Charles Thayer Driggs, Fife House, Kingston-on-Thames.

13401. An improved electrical converting transformer. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par L'electricité, France.)

13406. Improvements in or relating to insulating materials. Friedrich August Gottlieb Kirchberg, 111, Hatton-garden, London.

13415. Improvements in and in the manufacture of electric insulators. Carlos Alfonso López, 36, Chancery-lane, London. (Complete specification.)

JULY 26.

13447. An improved electric tramway system employing alternating currents, preferably polyphase. Claud Carew-Gibson, Hampden House, Phœnix-street, London.

13448. Electricity used in tanning. Axel Theodor Wedelin, 18, Eldan-street, London.

13472. Improvements in telegraphic transmitting, receiving, and translating arrangements. Alexander Muirhead, 323, High Holborn, London.

13478. Improvements in electric motor starting and regulating switches and cut-outs. Herbert Francis Hunt, 11, Burlington-chambers, New-street, Birmingham.

13479. Improvements in and relating to aerial conductors and like apparatus for transmitting and receiving electromagnetic impulses. James Tarbolton Armstrong and Axel Orling, 40, Vartry-road, South Tottenham, London.

13482. Improvements in current collectors for electric traction. Emile Bede, 4, South-street, Finsbury, London.

JULY 27.

13496. Improvements in electric switches. Walter Frederick Jones, Albert Works, Hammersmith, London.

13515. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, or the like. Robert Hacking, 111, Hatton-garden, London.

Digitized by Google

13533. Improvements relating to electric motor vehicles. Edmond Draullette, 45, Southampton-buildings, Chancery-lane, London.

13538. Improvements in or connected with current arresters. James Grieve Lorrain, Norfolk House, Victoria-embankment, London. (Peter C. Burns, United States.) (Complete specification.)

13539. Improvements in or connected with current arresters and alarms. James Grieve Lorrain, Norfolk House, Victoria-embankment, London. (Peter C. Burns, United States.) (Complete specification.)

13540. Improvements in electric igniting arrangements for internal-combustion engines. Pierre Mauguin, 47, Lincoln's-inn-fields, London.

JULY 28.

13573. Improvements in apparatus for electrically lighting railway trains. Edwin Thorley Parker, Prince's-chambers, Wolverhampton.

13585. Improvements in electric ignition devices for internal-combustion motors. Pierre Mauguin, 47, Lincoln's-inn-fields, London.

13592. Improvements in or relating to electric light fittings. Henry Hill, 111, Hatton-garden, London.

13698. A new or improved current receiver or trolley for electric railways with overhead current conducting system. Georg Nast, 18, Buckingham-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on August 18.

1899.

13274. Manufacture of accumulators. Schanschieff.

15268. Electric lamps. British Thomson-Houston Company, Limited. (Rice.)

15911. Electromagnetic apparatus. Jones.

16382. Spindles and the driving of the same by electricity. Lorrain. (Sawyer and Robb.)

17257. Apparatus for generating electrical pressure. Adams.

17953. Means and appliances connected with air-tight electric arc lamps. Rathbone.

19129. Means to be employed in the electrolytic manufacture of chlorates. Imhoff, Raschen, and United Alkali Company, Limited.

21562. Separator for plates of secondary batteries. Leitner.

22338. Electrical switches. Evered and Co., Limited, and Evered.

1900.

5727. Electric heating and apparatus therefor. Trudeau.

6703. Magneto-electric machine for igniting purposes. Bergmann.

3866. Electric signalling apparatus. Newton. (Carleton.)

9373. Electric motors, batteries, and connections thereof for propelling automobiles and like vehicles. Hewitt, Lindstrom, and Hewitt.

10323. Telephone cables and apparatus for producing same. Cassirer.

10711. Electric signalling apparatus for railways and the like. De Filippi.

11190. Switches for high-tension electrical currents. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	July 28	959	717	+ 231	6,136	5,386
Birmingham Tramways Co.	,, 28	4,637	4,506	+ 131	128,866	121,539
Blackburn Corp'rat'n	,, 28	456	488	+ 31	11,478	13,084
Blackpool Corporatn.	,, 26	1,225	873	+ 352	11,577	8,870
Blackpool-Fleetwood	,, 28	1,350	1,119	+ 231	4,592	4,453
Bradford City Trams	,, 29	592	418	+ 174	8,543	6,743
Bristol Tramways Co.	,, 27	3,544	3,404	+ 140	—	—
City & South London	,, 29	1,610	958	+ 652	5,905	3,721
Cork E. T. and L. Co.	,, 26	526	504	+ 22	11,615	10,398
Dover Tramways	,, 28	270	253	+ 17	5,563	5,212
Dublin U.T., elec. care	,, 27	4,001	1,367	+2,634	—	—
Dublin S.D. Electric	,, 27	1,252	1,175	+ 77	—	—
Halifax Corporation	,, 30	893	628	+ 265	13,073	9,894
Hull Corporat'n E.S.	,, 28	1,360	520	+ 840	20,502*a*	2,208*d*
Liverpool Corporat'n	,, 21*b*	8,884	8,159	+ 725	214,726	188,973
Liverpool Overhead	,, 29	1,671	1,597	+ 74	6,864*c*	6,339
Sheffield Corporation	,, 29	3,536	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. *b* Partly electrical. *c* Since July 1. *d* Since July 5.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11½-12½
—— 6 per cent. Cum. Pref., 1-27,500	5	..	5½ 6½
—— 5 per cent. Mortgage Debentures	100	—	95½-100½
British Electric Works, Ordinary, 50,001-95,000	1	—	⅞-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	15/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2½
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	—	101-106
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	13-14
—— 5 per cent. Pref.	5	—	5½-5¾
Crompton and Co.	3	—	3¾ 4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	2-2⅛
—— 5 per cent. Debentures	5	—	5¼-5¾
—— 4 per cent. Deb. Stock, Red.	100	—	91-93
—— 5 per cent. Second Deb. Stk., Prov. Crts. 70 p.ct. pd.	—	..	68 72
Electric Construction	2	—	2-2¼ xd
—— 7 per cent. Cumulative Pref.	2	—	2⅛-2⅜ xd
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5½-5¾
—— 4½ per cent. Debentures	100	—	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	85-89 xd
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-5¾
Willans and Robinson, Ordinary, 1-80,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 80,001-60,000	5	—	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	8-8½
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	6½-7½
—— 4½ per cent. Debentures	100	—	107-110
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	..	11½-12½ xd
—— 5 per cent. Debenture Stock	100	..	123-128
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	10-10½
London Electric, Ordinary	3	..	1-1½
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-100
Metropolitan, Ordinary	10	..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1⅛-1⅜
—— £5 Shares	5	..	7⅛-7⅜
—— £4½ Shares, New	4½	..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-90 xd
South London, Ordinary	3	—	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15 xd
—— 7 per cent. Pref.	5	..	8-9 xd
Westminster, Ordinary	5	—	12 13
Electric Railways.—			
Central London, Ordinary	10	..	9½-10
—— Pref. Half-Shares	5	..	4½-5
—— ,, ,, deferred	5	..	4½-5
City and South London, Consolidated Ordinary	100	—	56-59
—— Ordinary	10	—	6-7
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, ,, '96	100	—	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	18½-18¾
Waterloo and City, Ordinary	100	—	93 96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	17-18
Brisbane Tramway	100	—	103-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10⅝
British Electric Traction, Ordinary, 1-80,000	10	..	14-15
—— 60,001-75,000	10	—	14-15
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	123-126
—— ,, ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¼-4½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	—	103-106
Isle of Man Electric Power, 1-95,000	1	..	1/16-⅛
—— 6 per cent. Preference, 100,001-170,000	1	—	1/16-⅛
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. Pref.	5	..	4¼-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— 5 per cent. Cum. Pref.	10	..	10⅝-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
Telephones.—			
National Telephone, Ordinary	5	..	4¼-5
—— 6 per cent. Cum. First Pref.	10	..	12-14 xd
—— 6 per cent. Cum. Second Pref.	10	..	12-14 xd
—— 5 per cent. Non. Cum. Third Pref.	5	..	4¼-5¼ xd
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	—	⅜-½

Digitized by Google

NOTES.

Books Received.—We have received from Messrs. Longmans, Green, and Co. a copy of a book by Mr. Thomas Willans, entitled "The Life of Sir James N. Douglass, F.R.S.," formerly engineer-in-chief to the Trinity House.

Wireless Telegraphy.—We mentioned last week that experiments in wireless telegraphy were to be conducted between Ilfracombe and the Mumbles. The pole used is very tall, measuring 115ft. in height, and the apparatus is the ordinary Marconi coherer, the messages being taken on Morse printing instruments. The engineer in charge of the installation is, we learn, Mr. C. Harris, sectional engineer at Exeter Post Office.

French Automobiles.—We gather that there has been a split in the camp of the French automobilists, owing to one section of the French Automobile Club complaining that the other section did not do enough to encourage the use of automobiles in France. The dispute has resulted in the formation of a new club called the Moto Club of France, and we expect to hear soon that the employment of automobiles is going ahead at a high speed.

Japanese Railways.—We learn from the *Electrical World* of New York, that private advices from Japan state that the long projected railway from Nagoya to Seto will soon be an accomplished fact, and that it has been virtually decided that the motive power will be electricity. The capital of the enterprise, which has been furnished by the Japanese, has been increased from £25,000 to £40,000. Specifications are about to be prepared, and the electric equipment of the road will, it is estimated, mean an expenditure of £16,000.

The Sydenham Explosion.—The effects of the boiler explosion at the Crystal Palace Company's works do not appear to have been entirely got over yet. Thus during last week one side of Westow-hill and parts of Sydenham were plunged into darkness, and shopkeepers have had to resort to oil lamps, candles, and other primitive methods of illumination. It is not, we gather, expected that the electric light will be in working order for some little time. An inquest has been held on the bodies of the victims, another death having resulted from the explosion.

Feilden's Magazine.—The first birthday number of this magazine has just been issued. The number is a very good specimen of the whole of the numbers for the year which has just ended, and is very well illustrated and printed. It contains articles on "Railway Rolling Stock of High Capacity," the Simplon Tunnel, the Paris Exhibition, and the London Tramways and Light Railways Exhibition. There are also other articles and short notes, besides the usual review, called "Industrial Progress," which contains commercial notes gathered from all sources. The cover for this birthday number is unusually gay, but is at the same time very well executed.

A Right Decision.—The Brooklyn Rapid Transit Company are to be congratulated on the conviction of the three men who have lately done so much damage in attempting to depress the market value of the company's stock by spreading false reports. The charge brought against them was that of conspiring to depress the Brooklyn Rapid Transit stock, and one of the jury was offered a bribe to hold out and prevent an agreement as to guilt. The jury, however, found the prisoners guilty, and one was sentenced to six months' imprisonment and the other two to three months', the former having to pay also a fine of £100 and the latter two £50 each.

Electro-Embalming.—It is stated in the Portuguese Press that Dr. Variot, of Paris, has discovered a process for embalming bodies which he hopes will prove a great success. He not only embalms, but metalises the bodies by electroplating them. In this manner they can be preserved indefinitely and in such perfection that the most imperceptible wrinkles and lines are reproduced, and the embalmed body has the appearance of a metal statue. In order to electroplate a body it is given a bath in pure carbolic acid, and being strongly rubbed with nitrate of silver, the body is submerged in a galvanic bath, after which a slight layer of nitrite is applied to it.

Electric Cartridges.—We see it noted in *Commercial Intelligence* that a native of Italy has invented an electric cartridge, which he offers as a substitute for dynamite and smokeless powder in mines, rock blasting, and for heavy ordnance. The composition used in the cartridge is made up of carbonates of potash and chloride of ammonia, the proportion varying according to the use. The discharge is effected by an electric spark, which produces electrolytic effects upon the chemicals. The inventor claims that the cartridges, until subjected to the effect of electricity, are entirely inoffensive and perfectly safe; so that there will be no necessity for isolating the magazines where they are stored.

Colours in Artificial Light.—It is interesting to note that in matching colours the best substitute for daylight is the electric arc. In an article on the subject, the *Upholstery Trades' Review* states that after the arc light comes the magnesium flame, and under favourable atmospheric conditions the colourist, by examining his shades in the light of burning magnesium, may get their true daylight aspect. The aspect of colours under the electric arc light is, in nearly every case, identical with good daylight. There are, however, a few special cases where the dyed colours are extremely sensitive to any variation in the purity of light, and in these a slight difference is noticed between their daylight and electric light aspect.

A Large Electric Crane.—What is stated to be the largest electric crane in England has just been erected at the new armour-plate works of Messrs. Armstrong, Whitworth, and Co., at Openshaw. The crane, which is an overhead travelling machine, has been erected in the armour-plate casting department. It has during the last week or so been subjected to severe tests as to its lifting capacity, and during one test lifted a load of 135 tons. The span possessed by the crane is 100ft., and it is operated by means of four large electric motors, which can be easily switched on and off. On the whole, Messrs. Vaughan and Son, Limited, the makers of the apparatus, have every reason to be proud of so successful a piece of work.

The Cincinnati Strike.—We are pleased to find that the threatened strike of the employés of the Cincinnati Street Railway Company is not to take place. This is one of the instances recently where both employers and employés have agreed to consider in a fair and open way the questions raised. Owing to this, what threatened to be a serious disturbance of the traffic in Cincinnati has now been got over without any straining of the relations of the two parties interested. Amongst the reforms which have been agreed to, the company will reduce the hours of their motormen and conductors, and will allow employés in plain clothes to ride free on production of their badges. The company have also promised to arrange a system whereby the employés will be paid a regular dividend on an amount equal to their annual wages at the same rate as the shareholders receive on the shares they hold.

Institution of Junior Engineers.—The annual summer meeting is this year to be held at Newcastle-on-

Digitized by Google

Tyne from Monday next, Aug. 13, till Friday, Aug. 17. On Monday a reception will be held by the Mayor in the town hall, and visits will be paid to the works of Messrs. Swan and Hunter, and to those of the Electric Supply Company. On Tuesday Messrs. W. G. Armstrong, Whitworth, and Co.'s Elswick works, the engineering department of Durham College of Science, and the works of the Newcastle and District Lighting Company will be visited; and on Wednesday a trip will be taken down the river to inspect the Tyne Commissioners' works. On Thursday a visit will be paid to the works of the Wear Commission, and on Friday the United Alkali Company's works and the Corporation tramway works will be inspected. The summer dinner will take place at the County Hotel on Friday, the president (the Hon. C. A. Parsons, F.R.S.) in the chair.

Loud-Speaking Telephones.—Those who listened to the paper on "Wireless Telegraphy" which Dr. Lodge read some time ago at the Institution of Electrical Engineers, could not fail to have been struck by the way in which his telephones in relays gradually increased the sounds, and finally made a very loud noise indeed. An Hungarian has apparently hit on something the same principle, and the *Daily Mail* publishes an interview with him, in which he explains that he has nearly brought his instruments to such perfection as to telephone 1,000 miles, and at the far end to speak very loudly. His invention, he thinks, would be a great improvement on the electrophone, as instead of holding the telephone to the ears, one can sit and listen to all that is happening at the theatre in the same way that the sound in the phonograph can be heard. The inventor also hopes to use the system on board ship. The captain will be able to sit in his cabin and speak his orders to the crew, while the machine is roaring them out 10 times more loudly on deck.

Electric Traction and Trees.—We gather that complaints have been made against the new underground electric railway in New York, the reason given being that the excavations for it are hurting the trees in the streets. This is a variation of the usual lament that the overhead trolley is injurious. As to this matter one cannot speak with authority, but it is curious that while such complaints are being made, in Ireland electricity is said to have such a good effect on plant life that potatoes can be grown by the bushel where they previously only grew by the peck, in consequence of an arrangement of electrical circuits being conducted through the crops. The present complaint is, however, made before the railway has really had time to do much damage even by excavations, and it is difficult to see in what way the damage is effected. An American contemporary in mentioning the matter remarks that possibly the fading of the trees is caused by an entirely different cause—namely, the leakage of gas from the gas-mains. Our contemporary remarks that if this is the case, the obvious remedy for the killing of the trees is the use of electricity instead of gas for lighting.

Boston New South Station.—The paper read by Mr. Walter C. Kerr, entitled "The Mechanical Equipment of the New South Station, Boston," before the American Society of Mechanical Engineers, New York, has been reprinted and issued in the form of an attractive booklet by the British Westinghouse Electric and Manufacturing Company, Limited. We have received a copy of the paper, and in it a full and clearly-written account is given of this large well-equipped railway station. At the close of last year 737 trains were entering and leaving the new station daily, 65 of these within an hour in several instances, and in one case six trains depart and three arrive in less than two minutes. The equipment, which was entirely supplied by the Westinghouse Company, has been divided in the paper into 12 parts, and each of these parts is dealt with in detail. The divisions consist of the power-house, interlocking switch and signal system, the electric plant, heating and ventilation, disposal of drainage, roof drainage, icemaking, refrigerating and water-cooling plants, car-heating in sheds and yards, air-brake charging, steam and hot-water supply, fire protection, baggage and express lifts and elevators. The article is well illustrated, both from photographs and sectional drawings, and it should be worth the while of engineers in general to obtain a copy.

Automatic Tramway Brakes.—The report of the New York State Board of Railroad Commissioners has just been published on official tests made with automatic brakes for street railroad cars, to take the place of the old hand brakes such as are now mostly used in New York. The Board states that while nothing has been brought forward that will revolutionise the manner of stopping a car, the opportunity is afforded to present to the railway officers and to the public facts and figures showing what the best appliances known can do in the matter of stopping a car quickly. While the results are stated to be very satisfactory, there is still room for much improvement. After carefully considering the various points in each system and adding to or taking from the mechanical standing of the different brakes, as given in the report of the electrical experts, the Board gives the several brakes their proper order of merit, the Electric Selector and Signal Company, the Peckham Motor, Truck, and Wheel Company, and the Sterling Supply and Manufacturing Company being the first three. Their value, however, alters considerably in accordance with the work they have to do, and the order given cannot be looked upon as absolutely correct for every circumstance. On the subject of electrical brakes the Board consider that in almost every case these should replace the hand brakes now used.

Institution of Electrical Engineers.—The river party to which the American guests of the Institution of Electrical Engineers are invited will be given at Henley, electric launches taking a short run (probably to Shiplake and back) before the lunch, which will be at The Red Lion. After lunch the party will proceed to Boulter's Lock by launch, and will return to town by train from Maidenhead. The dinner on Aug. 13 will be at 7 for 7.30 p.m. at the Princes' Restaurant, Piccadilly. During the morning of the same day visits will be made to the laboratories of the Board of Trade, or (alternatively) to the Telegraph Department of the General Post Office, and in the afternoon to the Central London Railway and to the Davies-street station of the Westminster Electric Supply Corporation. On Aug. 14 the party will visit the School of Military Engineering and the Royal Dockyard at Chatham, and will partake of the hospitality of the Royal Engineers' mess at lunch. The members of the party have been most kindly invited to a reception by Lady Fraser in the afternoon. With respect to the grants of £5 to students of the Institution towards the expenses of a visit to the Paris Exhibition, which we announced in a previous issue, the following students of the Institution have been selected: J. F. Avila, A. Buckney, F. H. Clough, R. Fisher, A. J. L. Hurst, J. T. Irwin, T. L. James, F. K. Jewson, L. R Lester, C. N. Nettley, R. L. Pearson, M. Solomon, C. T. Stephenson, H. J. Thomson, W. A. Toppin, A. J. Tracey, S. A. Tunbridge, G. E. Turnbull, J. H. West, F. P. Whitaker.

Telegraph Engineers.—The annual conference of the Amalgamated Association of the Postal Telegraph Engineering Department was held at Leeds on Monday. The chairman was Mr. T. Landrick, of Leeds, and delegates

Digitized by Google

were present from most of the principal telegraph centres in the kingdom. The general secretary, Mr. George Young, of Northwich, reported that the association was in a stronger position then than it had ever been, this being mainly due to the increased membership. The expenditure had been unusually heavy owing to the large amount paid to the joint committee of the federated associations, but the committee had undoubtedly done excellent work. It was owing to the action of the committee that their claims had been brought before the House of Commons by Mr. Steadman. Since the last conference both Cardiff and Belfast had seceded from the association, although repeated efforts had been made to retain them. It was hoped that both these districts would return to the association. During the year they had had the welcome addition of Edinburgh, Coventry, and Holloway, all of whom had proved warm supporters of the cause. Holloway was exceptionally strong, and was making vast strides. A paper dealing with the Holloway men's grievances had been forwarded early in the year to the proper quarter, and much good was expected as the result. The officers for the ensuing year were afterwards elected, and several matters of importance to this branch of the postal telegraph service were discussed. It was decided to hold the next conference in Birmingham.

Technical Education.—In the *Technical Education Gazette* for July are given the full particulars of the special courses which have been arranged by the Technical Education Board of the London County Council for the coming session at University College, King's College, and Bedford College. At the University College, Gower-street, a course of 10 lectures intended for those engaged in the electrical or allied trades is to be given by Prof. J. A. Fleming, F.R.S. This course will comprise a theoretical and practical treatment of advanced methods in electrotechnical measurements, of the character required in electrical works and factories, in connection with electric lighting and electric power transmission. They will cover such subjects as the measurement of resistance, current, potential or E.M.F., electrical power, energy, and alternating-current measurements (single and polyphase). The lectures will be given between Oct. 17 and Dec. 19, the fee for the course being 5s. A course of lectures by Prof. Carus Wilson on the "Electric Motor and its Application to Electric Traction," will also be given between Jan. 23 and March 20 next, the fee being the same as in the previous course. At King's College, Prof. E. Wilson will deliver a course of lectures dealing with "Direct and Alternating Currents," the lectures commencing on Oct. 8, the fee being £1. 1s. The syllabus includes practically every point connected with the working of machines for both direct and alternating currents. There are numerous other courses at both the above-mentioned colleges, including mechanical engineering, chemistry, civil engineering, etc. The classes at the Bedford College are for women teachers only.

Northern Tramways.—We notice in the *Newcastle Daily Chronicle* an article dealing with the progress of the tramway undertakings in the Newcastle and neighbouring districts. Thus it is announced that in a few weeks the inhabitants of Sunderland will be the proud possessors of of an up-to-date system of electric tramways. The first section to be completed is the Christ Church-Roker route; but although this part has been finished for a few days, and highly successful trials have been made, it was found impossible to open the route to the public on Bank Holiday, as was anticipated. The trials made on Tuesday last were again highly satisfactory, the cars and drivers negotiating the traffic, which is considerable on this route, with great success. The section was inspected by the Board of Trade yesterday, and, if passed, is expected to commence passenger traffic on Aug. 15. We also learn that steady progress is being made with the work of relaying and extending the tramway system in the borough of Tynemouth and adapting it to electric power. The new rails, on a broader gauge than those formerly in use, have been laid over nearly the whole route. The station buildings are finished and awaiting the installation of the machinery, which is now on its way to Tynemouth. The work of relaying the lines was commenced last October, but little could be done during the winter owing to the severe weather. At Darlington we do not find the same felicitous state of affairs, there being at present a deadlock in the negotiations which have been proceeding between the Corporation and the Imperial Tramways Company on questions of the supply and price of electrical energy, street widening, and laying part of the tramlines. Neither party shows any disposition to go back from the position they have taken up, and in the meanwhile the danger of the conflicting views seems to be an indefinite postponement of the improvement, and a consequent retarding of the now rapidly growing borough.

Electricity in Indian Mines.—An announcement was made by Lord Ribblesdale at the meeting of the Road Block Company last week to the effect that an arrangement has been made with the Mysore Government for the transmission of electrical power from the Cauvery Falls to the Kolar Goldfield. The scheme in question will be what one may well call a long-distance transmission scheme, as the power is to be conveyed some 100 miles. The company have adopted an arrangement with the Indian Government, by which we understand the cost of the transmission machinery is to be borne by the Government, and to be gradually repaid by adding a certain sum to that paid for the current. The amount of power which it is expected to use at first is about 4,000 h.p., and even with this the owners of the mines expect to save considerably, and think the cost per horse-power will be much less than with the system now employed. One of the great things in which a saving will be effected is in fuel, as this in India commands a very high price and is comparatively scarce. Another item which will probably be reduced will be labour, as it is well known that wherever electricity is used in place of steam the amount of labour necessary is lessened. Again, in the cleaning and repair of machinery a saving will be brought about. At present, we believe the details of the scheme have not actually been settled, but are on a fair way towards that end. It is, perhaps, natural that electricity, where obtainable, should be preferred to steam for use in mining operations, as, apart from the less amount of time required in attending to the machines, it is very handy, and a motor can be placed in almost any position and in places which it would be impossible for steam power to be available. This announcement is, we hope, only a precedent for a number of other similar ones, as in Northern India especially a great deal might be done with water-power plants for such purposes as that mentioned above.

Automobile Racing.—What promises to be a very interesting and novel automobile exhibition and race meet is, we learn, to take place at Chicago next month under the auspices of the Inter-Ocean Publishing Corporation. The tests, races, and exhibitions are to be held in Washington Park from Sept. 18 to Sept. 22 Races are to take place at night, and great preparation are to be made to illuminate the course for these events. On the opening day a grand parade of some 500 automobiles is proposed to take place, and visitors will be able

Digitized by Google

to examine them at close quarters. On the second day tests are to be made as to the general utility of the vehicles, when vehicles using different forms of power will be classed together, the competitions taking place between vehicles stated to have certain capacities, and the rewards will take place in the ratio of load and weight of vehicle. To test the practical manipulation of vehicles, a series of dummy figures will be introduced on the tracks, some constantly shifting, some remaining permanent as the vehicles pass through them, causing frequent and sudden stops and turnings, to show the safety of the vehicles in crowded thoroughfares. There will also be provided a section of extremely rough and uneven roads, with mud and holes, and country road ruts, with logs, stones, and obstructions, requiring short stops and turns, and including both up and down grades, corresponding to country roads and city streets. These tests, it is thought, will be of great value to the automobile industry. In addition to the above contests are others equally interesting, and after the races are over a grand prize of £200 is to be given for the most valuable invention in automobiles which shall have been practically demonstrated during the exhibition. In all, about £2,000 are to be offered in prizes. The exhibition should be a great attraction to holiday makers, and prove very interesting and of great use to makers and users of motor-cars both for pleasure or for business purposes.

The Pacific Cable.—A Blue-book has just been published by the Canadian Government dealing with the question of the Pacific cable. The book contains a large number of letters and telegrams respecting the interests of Canada and the other Colonies. The period covered by the Blue-book is the eight months from August, 1899, till April, 1900. In one letter Sir Sandford Fleming draws Sir Wilfred Laurier's attention to the unnecessary delay in constituting the Provisional Board of Commissioners, and the consequent time allowed to the Eastern Extension Company to agitate the Australian Colonies against the Pacific cable scheme and in favour of their own Indian Ocean scheme. He also states in another letter that there are many circumstances that have given rise to the impression that the home authorities have unduly favoured the monopoly in its opposition to Canada and the Australian Colonies. A large number of cable messages passed between the Canadian and Australian Premiers, arising mainly from New South Wales and Victoria favouring the Eastern Extension Company's scheme. On March 30 Sir Sandford Fleming issued an address from Ottawa "to the British people in the Australasian Colonies," pointing out the urgent need of the cable to draw the British people in the outer empire nearer together, by bringing Canada and Australasia into direct and less costly communication. He held, he said, that nothing could take the place of the Pacific cable, and he felt it to be in the interests of the British Empire that no new obstacle should be raised to obstruct the immediate accomplishment of that undertaking. While firmly holding to that opinion, at the same time he recognises that there could not be too many cables if they were judiciously established to meet public needs. He was, therefore, unable to see any great reason for objecting to the Cape-Australian cable provided full provision was made for bringing it at any time when required under State control. Under State control it would, in conjunction with the Pacific cable, constitute the major portions of the great Imperial telegraph system.

The Lead Accumulator.—The current number of the *Journal* of the Chemical Society has the following abstract of a paper by Martin Mugdan in the *Zeitschrift Elektrochemie*: "The author shows that, when an accumulator is discharged, lead sulphate separates on both the positive and negative plates in almost theoretical quantity, and that no lead oxide is formed. If sodium sulphate is used as the electrolyte in place of sulphuric acid, however, some lead oxide is formed on the positive plate. A partially-oxidised negative plate takes up sulphuric acid very slowly, whereas a positive plate containing oxide absorbs the acid very rapidly. The potential difference between a negative (spongy-lead) plate and sulphuric acid of given concentration is independent of the quantity of lead sulphate on the plate. The alterations in the E.M.F. of an accumulator during charge and discharge are due to local changes of the concentration of the acid at the electrodes. When at rest the condition of affairs may be represented thus: $Pb,PbSO_4$ | acid | $PbSO_4.PbO_2$. During charge the acids at the electrodes are more, but during discharge, are less concentrated than the main bulk of the acid. The total E.M.F. is therefore obtained by superimposing the E.M.F.'s of two concentration cells on the main E.M.F. The two concentration cells may be represented thus: $Pb,PbSO_4$ | dil. or conc. acid | acid | $PbSO_4,Pb$ and $PbO_2.PbSO_4$ | dil. or conc. acid | normal acid | $PbSO_4,Pb$. The E.M.F.'s of these concentration cells are calculated from Nernst's theory, and compared with actual measurements made by the author. For acids containing less than 0·75 grm.-mol. per litre, the agreement is excellent. A change of concentration at the lead dioxide plate makes about 1·4 times as much difference in the E.M.F. as an equal change at the lead plate. Further, the concentration of the acid at the lead dioxide plate increases or decreases during charge and discharge $1+^{2v}/_{u}$ times as quickly as that at the lead plate (u and v are the relative mobilities of the H and SO_4 ions). The effect of the changes of concentration at both electrodes is to diminish the E.M.F. of the cell during discharge and increase it during charge."

A Flourishing Industry.—The condition of the electrical industry continues in Germany, as elsewhere, in a flourishing state. The principal manufacturing firms are without exception able to render excellent accounts of themselves, hence the rosy report of the Allgemeine Electricitäts-Gesellschaft, both with regard to its actual and prospective accomplishments, may be taken as a fair indication of the general state of the electrical industry in Germany. From this report it appears that the electrical industry has continued to develop satisfactorily, despite the increased price of raw materials and the tightness of money. The practical utilisation of blast-furnace gas has had a beneficial influence upon the construction of large dynamos as has also the rapid increase of high-tension installations, since the problem of running alternating and rotary current machines in parallel was satisfactory solved. The manufacture of small motors has also developed to a greater extent than anticipated. As regards the anticipated influence of the electrical industry upon the construction of machinery in general, this has showed itself in the perfecting of the power motor not less than in the transition to quick driving. In this connection, and having regard to the present coal famine, the solution of the problem of appreciably increasing the efficiency of the steam-engine would be greatly welcomed. According to experiments made at the Berlin Technical College the output of steam-engines might be increased by more than 50 per cent. without a greater consumption of steam. Last year 12,987 dynamo machines and electromotors, representing an aggregate output of 200,000 h.p., were turned out by the Allgemeine Electricitäts-Gesellschaft, besides enormous quantities of arc lamps, measuring instruments, switch gears and meters, etc. In continuance of their endeavours to perfect the Nernst lamp, the firm has introduced further improvements

Digitized by Google

in detail. The latest form of this lamp has, we understand, given satisfactory results after exhaustive tests, which fact has encouraged the firm to make extensive preparations for its manufacture in bulk, so that its early advent on the market may be expected. So far as the production of dynamo machines is concerned, another German firm—namely, Schuckert and Co., of Nuremberg—is able to show even better results for 1899. During the year in question, this firm turned out dynamo machines having an aggregate output of no less than 257,000 h.p., besides 14,000 arc lamps, 17,600 ampere-meters, 205 searchlights, 12,600 voltmeters, and transformers having an aggregate capacity of 15,500 kw., etc., all of which figures show a considerable increase over those for the previous year. As has been pointed out before, and may be pointed out again, practically unlimited capital has contributed mainly to these splendid results. It is to be regretted that the conditions in this respect here do not approximate more closely to those holding in Germany, for it is discouraging to see the development of home concerns retarded for the want of capital judiciously employed.

A Typewriting Telegraph.—Three patents have, we learn, been issued to Mr. Donald Murray, of New York, for an improved form of page-printing telegraph, employing an ordinary form of typewriting machine. The invention combines a recording instrument having a series of independently movable character levers, an electromagnetic perforating instrument, and a tape of paper, which passes through the perforating and recording instruments in succession. The perforator is connected with either a manual or an automatic transmitter at a distant station by a main-line telegraph wire, and a mechanical actuating device is provided whereby the perforated tape is enabled to operate the typewriter or similar instrument. At the receiving station the type machine is provided with a series of independently movable keys, each of which imprints a letter. To operate the typewriter, an actuating device, consisting of a series of notched bars or combs arranged compactly in parallel order and having a capacity for reciprocating motion, is employed, the power being supplied by an electric or other motor. The reciprocating combs are controlled by the perforated tape, which is divided into a series of successive longitudinal sections—say ½in. in length. Each section represents a letter or character, and is divided into a predetermined number of elemental parts. Each subdivision is either perforated or non-perforated. The perforations are arranged in a straight line, and the relative location of one or more perforations in any section determines the letter. The tape is moved along section by section across the ends or terminals of the reciprocating combs of the actuator. The actuator operating to press the perforated slip into contact with the ends of said combs forces one, two, or more of them to take the desired position, properly aligning the slots in the edge of the combs to permit the immediate subsequent operation of the desired one of the series of type-bars of the machine whereby the letter is imprinted. The transmitter, located at the distant station, throws upon the line short current impulses, which operate an electromagnetic perforator at the second station. The tape is fed along through the perforator, and the act of perforating and spacing is the result of a single current impulse of either positive or negative polarity. At the receiving station there is located an electromagnet, operated by a neutral relay in the main line. The armature of the magnet is spring-retracted, and a bar carried by it is in position to engage a simple form of paper punch or perforator. There is a finger capable of being projected in and out between the end of the bar and the end of the punch. When this finger is withdrawn, the armature fails to engage with the punch, and the paper is advanced one step, while the perforator is not operated. This finger or intermediary is controlled by a polarised electromagnet in the main-line circuit. A series of makes and breaks of negative polarity operate the step-by-step mechanism, and the paper is fed along without perforating, while one or more positive current impulses project the finger between the armature and punch, and perforate and space the paper. Each current impulse, whether perforating or spacing, moves the paper a single subdivision, or about ½in.

Cardiff Lighting.—We are sorry to see that, in spite of the power to control the whole of the electric lighting installation which the Cardiff Lighting Committee reluctantly gave Mr. Appelbee a short while since, the friction has not by any means ended. It is, however, this time not between the Lighting Committee and their engineer, but between various members of the staff. Last week, at the meeting of the Lighting Committee, the applications of five members of the staff for increased salaries were considered. In discussing the matter, Mr. Appelbee mentioned that the committee might be interested to know that five members of the staff were seeking employment elsewhere. This brought forth the remark from the Chairman that until the whole of the old staff had been cleared out they would not be able to do anything with the undertaking. Much surprise was, however, expressed when a letter was read from the mains superintendent, who was appointed only last June, also tendering his resignation. The committee questioned Mr. Appelbee on this matter, but however much he knew of the causes leading to the resignation he wisely left it to Mr. Illingworth himself to make all explanations. This gentleman, who could not be found at that particular time, was examined by the committee on Friday last at a meeting held specially for that purpose. The reasons Mr. Illingworth gave for his resignation appeared to be that he was greatly annoyed by the deputy engineer not allowing him to do his work in the way he thought best. He had also made representations as to the faults in the mains, sub-stations, junction boxes, etc., but these had not been remedied, or only very tardily. In this way he could see that in the winter many breakdowns would occur, and his reputation would suffer. The men also who were under him were inclined to be slovenly, and would not do so much work as they should have done. The matter, however, on which the mains superintendent felt most strongly was the interference of the deputy engineer, and Alderman Ramsdale remarked on this point that the agreement of Mr. Illingworth distinctly stated that Mr. Appelbee was his chief, and he did not see why he should be interfered with by the deputy engineer in any shape or form. The agreement intimated that Mr. Appelbee was the only authority. In reply to the criticisms on the management, Mr. Appelbee said he took entire responsibility for the outdoor department, and Mr. Illingworth was only responsible to him. He had received no complaint of the design of the junction boxes, and in regard to the water in the stations the repairs were kept for the public works man to do, and he was on his holidays. There was no danger, and the water was easily kept down. The necessary switch gear for the distributing stations had been ordered, and there was no difficulty in having all that Mr. Illingworth proposed done by next winter. Mr. Appelbee further told the committee that they were responsible for the appointment of the deputy engineer. He had not recommended him, and did not do so then. The final outcome of the meeting was that Mr. Illingworth withdrew his resignation pending a general enquiry which the committee is to hold.

Digitized by Google

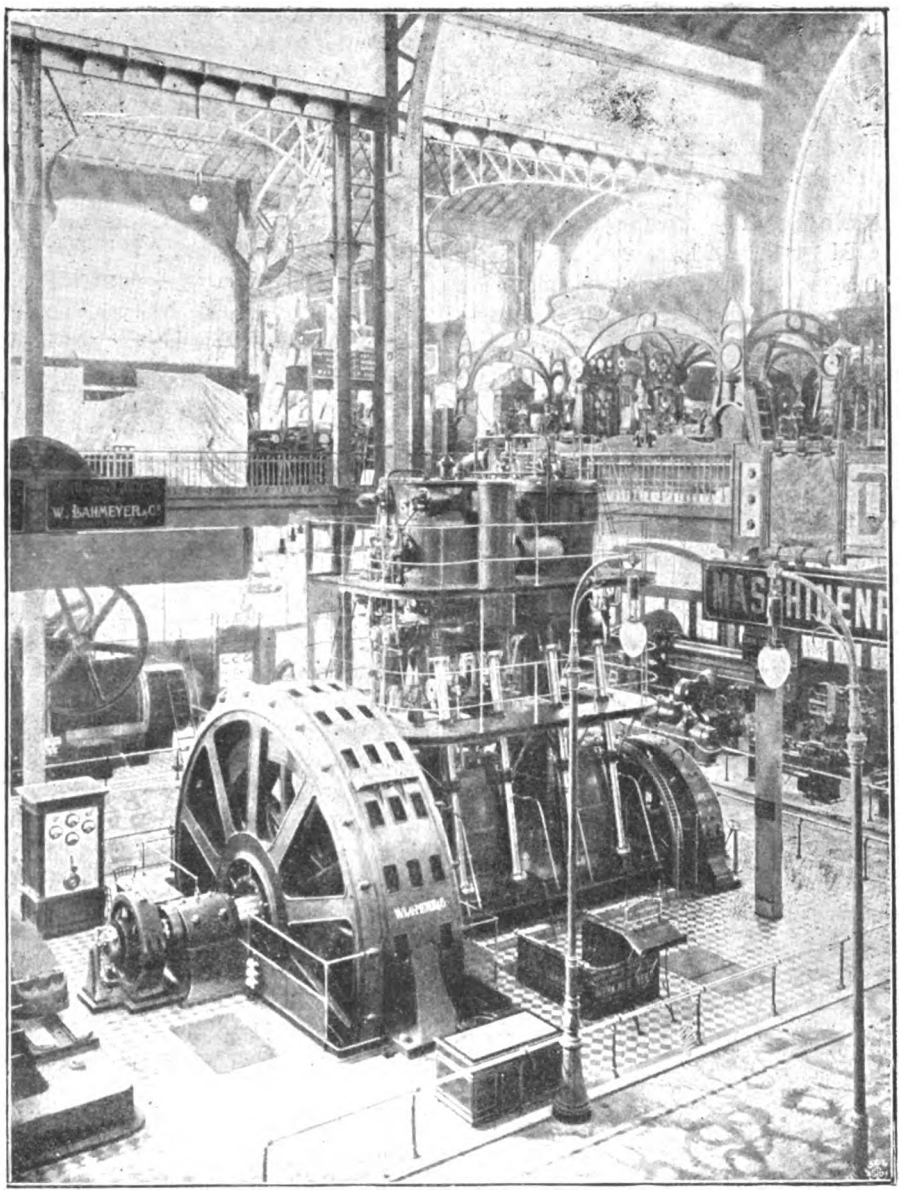
THE PARIS EXHIBITION.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 121.)

The electric exhibit of Messrs. W. Lahmeyer and Co., of Frankfort-on-Main, consists of a 1,500-h.p. compound steam-engine running at 94 revolutions per minute, and two dynamos, one for 1,000 kw. three-phase current at 5,000 volts, the other for 400-kw. (maximum) at 500 volts; both are coupled directly to the engine shaft.

The three-phase generator is of the flywheel type—*i.e.*, the field magnets are fixed on the periphery of the flywheel and the armature on a large frame, which completely encloses the field magnets. The diameter of the rotating part is 5,800mm. (=18ft. 3½in.); the diameter of the centre of gravity of the rotating part, 4,730mm. (=15ft. 6½in.); the energy of the flywheel is 1,018,000 kgm. (= 24,117,000 foot pounds). The speed variation during one revolution is one three-hundredth of the normal speed only. By this combination of dynamo and flywheel it is claimed that the space required for the set is minimised, the material is almost entirely utilised, the magnetic leakage and the armature reaction are very small, and the ventilation is excellent and efficient. The flywheel consists of four pieces held together by bolts and wrought-iron rings. The magnets are of wrought iron, and are fixed by one wrought-iron bolt and one steady pin each, so that each magnet can easily be removed, rendering it unnecessary to dismantle the dynamo. The cross-section of the magnet is circular, so as to give without any excessive pressure drop a minimum of the winding length and, consequently, of loss of energy in the coils. The pole-pieces are almost square, so as to reduce as much as possible the magnetic leakage. They are of solid wrought iron, thus giving a more substantial construction than laminated magnets, and rendering any resonance impossible when the machine is working in parallel with other machines. The eddy currents generated in the magnets help to prevent a "drive" on the machines by their damping effect. Excessive heating of the machine is prevented by great attention to obtain correct dimensions of the air-space and a suitable form of slots in the tunnel-wound armature. Each coil is formed by a rectangular copper ribbon, the width of which is normal to the surface of the magnet. The insulation consists of paper. By so wiring, the space of the magnet is well utilised, and a deformation of the coil by the effect of the centrifugal force is practically obviated. The exciting current is generated by an exciter mounted on the same shaft as the main dynamo, giving 65 volts. The voltage of the three-phase generator is regulated by inserting resistance in the fields of the exciter, this arrangement doing away with the heavy resistances usually employed in the main circuit, so avoiding loss of energy and all risks of heating at the back of the switchboard. The armature is stationary and consists of laminated iron, the segments of which are held together by bolts in a cast frame. Two end plates, reinforced by radial arms, render impossible any vibration of the frame, so that the machine runs almost without noise even at full load. The armature generates current at 5,000 volts between the outers, and is wound in micanite tubes which have been subjected to an insulation



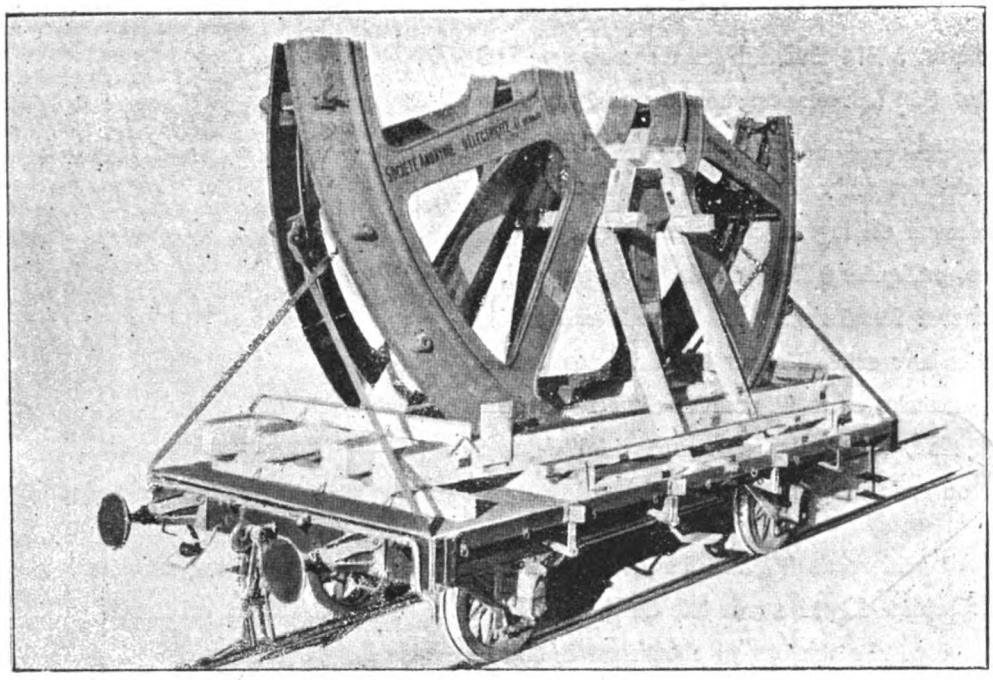
General View of Messrs. W. Lahmeyer and Co.'s Exhibit at Paris.

Digitized by Google

resistance test at 10,000 volts. The tubes and the slots are of circular section. This secures a good insulation, and at the same time the hysteresis and eddy-current losses in the teeth are minimised. The energy losses are as follows:

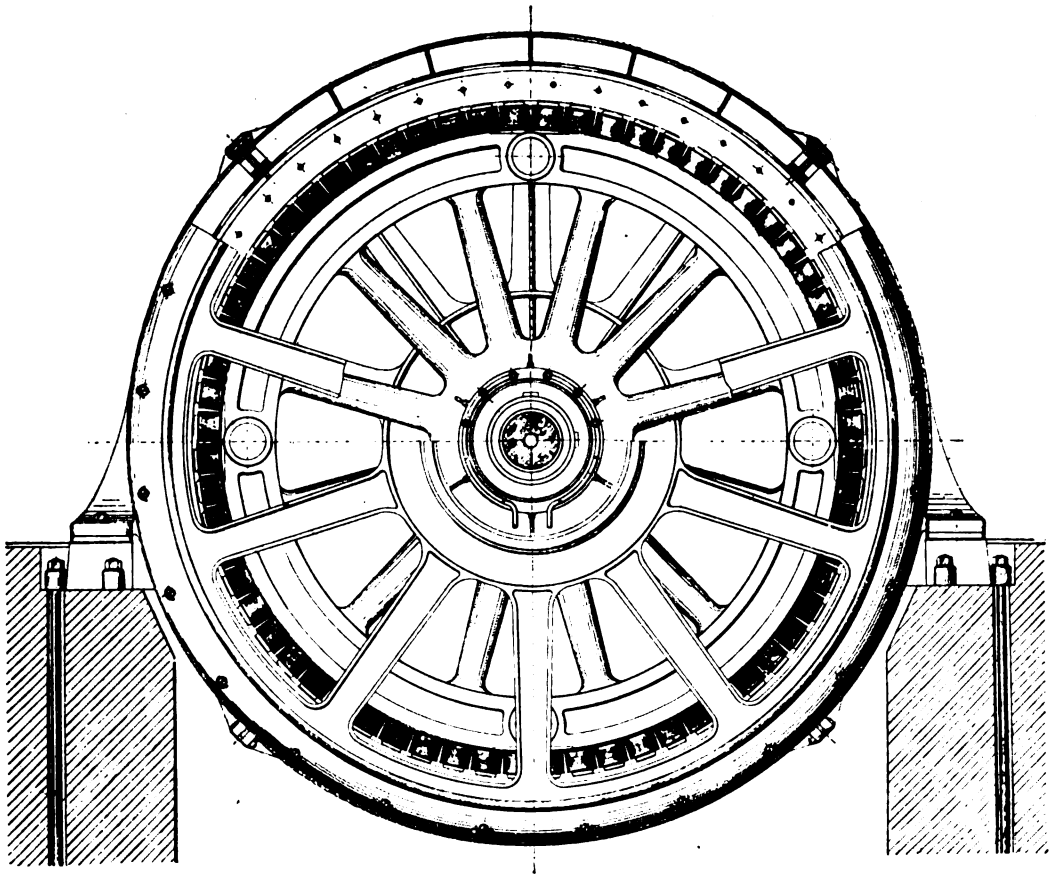
Power absorbed by armature copper.....	13,700	watts.
,, ,, ,, ,, core.....	13,100	,,
,, ,, ,, ,, teeth.....	9,100	,,
,, ,, ,, ,, excitation.....	13,800	,,
Total	49,700	watts.

The electric efficiency is therefore 95 3 per cent. at full load (non-inductive). Special attention has been given to secure a small drop in voltage between full and no load. It is about 6 per cent. for non-inductive load. This result is attained by a strong magnetic field and high saturation of the magnets. The short-circuit current is about 3.5, or four times the current at full load for a constant excitation. The magnetisation of the iron is always beyond the bend of the curve.



Method of Transport of Dynamo Frames.

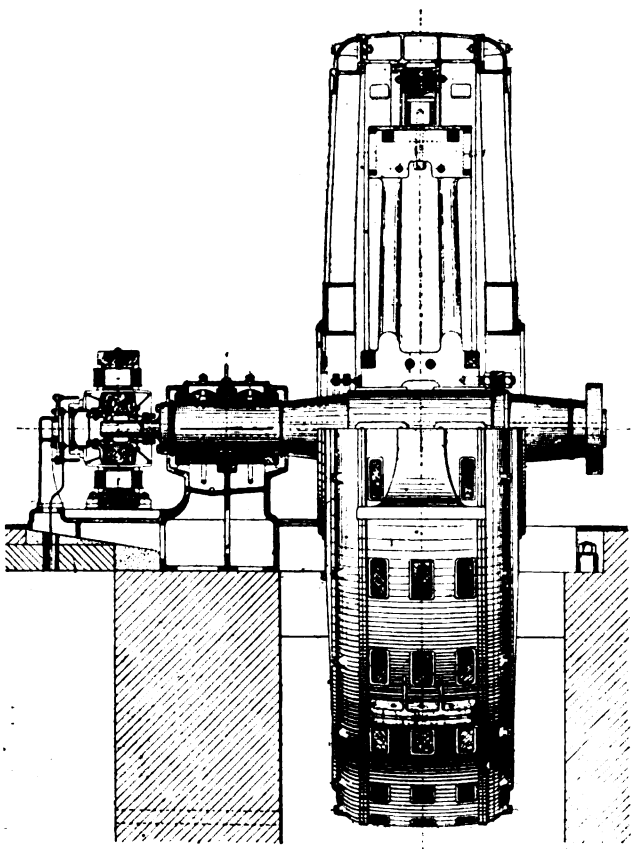
The method of arranging the measuring instruments is patented by Messrs. W. Lahmeyer and Co., Limited. This arrangement excludes any possibility of an accident to anybody in proximity to the instruments, as all readings are taken off a low-tension circuit. In each phase one of the armature coils is separated from the others, and is connected with the primary windings of a special transformer (ratio of windings, 1 : 1), the secondary windings of which are in series with the rest of the coils. All readings are taken in the primary windings, the amperes in these being the same as in the machine. The voltmeter is



Cross-Section of Dynamo.

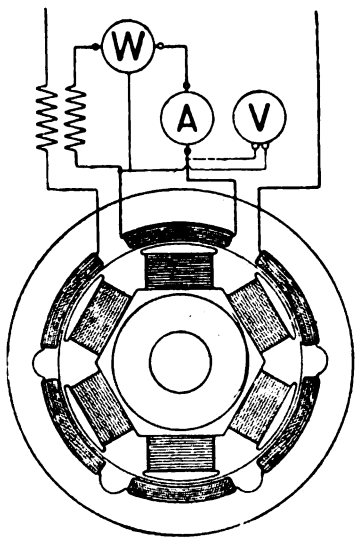
Digitized by Google

calibrated so as to give the voltage of the one coil multiplied by the number of coils, thus giving the voltage of the dynamo. This arrangement gives very exact readings, and the difference of the air-space at the different coils does not influence in any appreciable way the accuracy] of [the] readings. This arrangement has been



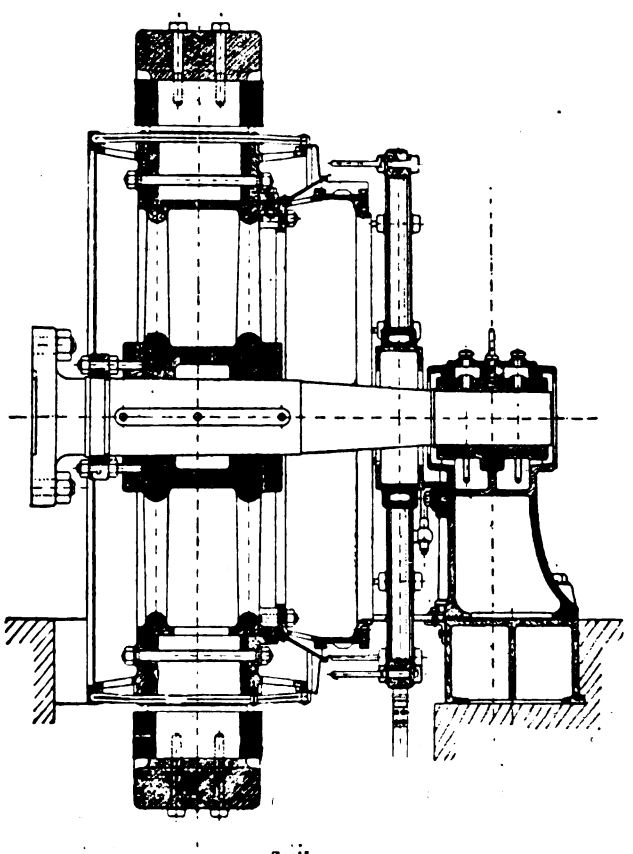
Section of Dynamo.

applied to many machines built by Messrs. W. Lahmeyer and Co., Limited, and has given entire satisfaction. The shaft of the combined set is made in three pieces coupled together by ordinary flanged couplings. The exciter armature is wound on the end of the shaft which extends beyond the extreme bearing on the three-phase side of the set. The exciter fields are bolted to a bracket fitted to the pedestal.



Arrangement of Circuits.

As we have seen above, a direct-current dynamo is coupled to the engine shaft on the other side. This dynamo is built for a normal capacity of 400 kw. at 500 volts and revolutions per minute. The dynamo is of the multi-per type. The yoke consists of two semi-circular parts, on wh 12 cast-steel poles are held, each by two iron bolts. The les and pole-pieces are cast in one piece. The armature of the drum type, and is bar wound in two layers in 609 milled slots, which are insulated with mica. The armature is not banded in the ordinary way, but the conductors are secured by small brass strips, which are held on the periphery by pins. At the back end of the armature all connections are in a piece with the conductors, the bars having been bent on a special former, so that the number



Section.

of sweated joints is reduced to a minimum. The method of fixing the winding by these strips facilitates removal of a damaged bar. The commutator is built up of cold-drawn copper segments with mica insulation. The brush connections are fixed on an I-shaped ring, and are well insulated by ambroine. All screws of the brush-holder which can possibly be got at from the outside are protected by caps of the same material. This machine has been designed for traction work, and is specially adapted for severe overloads and sudden variations of the load without sparking of the commutator. Even at 440 volts—the pressure used at the Exhibition—no rocking of the brushes is necessary. The diameter of the armature is 1,400mm. (=about 55in.), its length 400mm. (=15$\frac{3}{4}$in.). At full load and 530 volts the mechanical and electrical efficiency is 93·2 per cent. The power absorbed by the armature copper is 2 per cent., by the excitation 1·5 per cent. There is very little heating, the rise in temperature being only 30deg. C. for the armature iron and 25deg. C. for the induction coils. The saturation of the iron is such as to give (at constant excitation) a difference in voltage of 10 per cent. only between full and no load. For starting the engine the following arrangement has been devised. A toothed disc has been placed on the shaft, which is engaged by a small pinion driven by a 7-h.p. motor (220 volts, 700 revolutions). This switch pinion disengages itself automatically as soon as the machine is started.

The steam-engine was supplied by the Maschinenbaugesellschaft, Nürnberg. It is a vertical two-crank engine, and develops 1,700 i.h.p., or 1,500 effective horse-power, at 10 atmospheres (147lb. per square inch). The engine is provided with a jet condenser. It is bolted to a bed-plate which consists of two parts. Each part is cast in one piece with two bearings. The shaft has a coupling at both ends for connection with the dynamos. The diameter of the high-pressure cylinder is 865mm. (=34$\frac{1}{16}$in.), and that of the low-pressure cylinder 1,350mm. (=53$\frac{1}{8}$in.), with a stroke of 1,100mm. (=43$\frac{5}{16}$in.). The two air-pumps are driven from the

Digitized by Google

connecting rod by means of a beam with a diameter of 670mm. (=26⅜in.), and a stroke of 350mm. (=13¾in.). The approximate weights are as follows: steam-engine, 120 tons; three-phase dynamo, 124 tons; direct-current dynamo, 31 tons—total weight, 275 tons.

At the Exhibition the oil is supplied by the Vacuum Oil Company, of New York. A serious difficulty was experienced for the transportation of the three-phase dynamo frames. The way in which this difficulty has been overcome is graphically illustrated on the annexed figure. In consequence of the high pressure at which current is generated in the three-phase machine, many very distant points in the Exhibition are illuminated by its agency—for instance, the Alexander Bridge and the main portal of the Exhibition.

(To be continued.)

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

INTRODUCTION.

The equipment of an alternating-current station with an efficient switching apparatus is a most important problem, and when compared with the continuous-current system, the importance is greatly increased by reason of the higher pressures employed, and consequently the difficulties encountered in the provision of effective means of quenching arcs in fuses and switches. A glance at the development of the high-pressure switch gear will no doubt prove of some interest, not so much on the grounds that anything new will be said on the subject (except, perhaps, in dealing with the later types), but that a collecting together of the various forms of gear employed will afford excellent opportunities of comparison, and illustrate the many advances in construction. The rapidity of these advances may be said to have brought about a distinct revolution when compared with the progress of other mechanical apparatus, and when a look is taken at the later types of gear, it is hardly possible to credit the statement that the older examples were in use within such recent times.

In the early days of alternating-current supply, the attention of electrical engineers was almost entirely devoted to the perfection of the generator and its engine, the switchboard problem being considered of a simpler nature. It was accordingly constructed on the most primitive scale. When compared to the dynamo, and considering the demands made upon it, the wonder is that more accidents and "burn outs" did not occur. However, since the construction of dynamos and engines has more or less settled down to standard direct-coupled types, the controlling apparatus has received a greater amount of attention in proportion to its importance, with corresponding excellent results. One of the questions which an engineer of a few years ago had to answer was, What form shall the switch gear take?—*i.e.*, there were two distinct types open to his choice:

1. The isolated gear, generally consisting of a panel or pillar placed (either on a gallery or the floor) opposite each machine to which it was connected.
2. The collected gear, in which all the apparatus was concentrated into a comparatively small space.

Each had their adherents, and the advantages or otherwise of each were as follows:

For the isolated gear it was said that, in case of prolonged arcs and the setting fire to a panel, the disaster was confined to the apparatus controlling one machine, the other units being unaffected thermally, if not electrically. In handling the connections which had been made "dead," there was no possibility of coming in contact with other "live" panels. Against the same gear it was urged that parallel running was rendered difficult by reason of the distance separating the panels; that in case a number of machines were running greater attendance was necessary; and that the scattered nature of the gear did not lend itself in any way to the ornamental appearance of the station. For the collected gear it was said that small space was occupied, parallel running was rendered more simple, less attendance was necessary, and when neatly arranged the apparatus presented an ornamental appearance, and added greatly to the *ensemble* of a station. Against this class of gear it was said that, in case of fire, the accident was liable to affect the entire supply in consequence of the destruction of the whole board, or the rendering necessary of the shutting down in order that the fire might be extinguished; that the connections at the back of the board presented a veritable death-trap to the electrician, who, though protected with rubber gloves on the hands, might stumble against the terminals when working with bare arms, and, in the case of double-pole boards, come to grief. The danger of handling these connections becomes still more evident when it is considered that though the electrician would have made dead the panel on which to work, the proximity of "live" contacts greatly increased the possibilities of accidents.

In spite of the apparent advantages of the isolated gear (on the ground that the supply was less liable to serious interruption), it has developed up to a certain point and gone no further. This is due, not so much to its unsightliness (as it has been made very ornamental), but to the fact that the collected gear possesses more marked advantages, and can be made to meet all the requirements of the alternating-current engineer. The most important developments have taken place with this form of apparatus, and so satisfactory have they proved that the concentrated gear may be said to have come to stay.

It will be seen that the engineer had no mean problem to solve in the provision of a good switchboard for his station in years gone by. His choice of apparatus was very limited, and the conditions to be fulfilled so important, that in some cases the board was designed by the engineer to meet his own special requirements. However be the arrangement of the gear of the isolated or collected class, the switchboard consists essentially of two distinct yet inseparable forms of gear—that dealing with the high-pressure alternating currents, and that controlling the low-pressure or exciter currents. The former is by far the more important of the two, and has presented enormous difficulties in the way of construction, and the latter has proved of equal importance almost, save that more information has been to hand, consequently the difficulties have been more readily overcome. The high-pressure portion of the gear will consist of panels containing fusing, switching, and recording apparatus for a certain number of dynamos and circuits, also the synchronising and pressure recording instruments. The low-pressure section will be fitted with switch ammeter and rheostat for dealing with the currents from the exciter to the alternator field.

The development of these various types of gear has not taken place with any degree of uniformity, so that the improved examples of each type seldom found their way to any one switchboard. The means of controlling the exciter currents on a board might be of a most effective nature, but the high-pressure circuits would be dealt with by dangerous and inefficient apparatus, or the opposite might be the case. It is not until quite recently that efficient apparatus of both sections have been combined on one switchboard. In dealing with the evolution of high-pressure switch gears, it will be necessary to describe well-known types of apparatus, so that nothing particularly new may be looked for in the following lines; but the principal object aimed at will be an illustration of the progress made, and the degrees of safety or efficiency heretofore unattained or unattempted which have been reached. Comparison is the only method available in such a description, so that when the accounts of the earlier examples of gear are perused, they must be taken as necessary to the object in view rather than as illustrations of apparatus hitherto undescribed. The practice of American and Continental engineers will not be dealt with, as it can be said with truth that their designs have had no marked effect on the manufactures of electrical engineers in this country. Moreover, the subject in hand will occupy quite sufficient space without discussing the work of engineers in other countries, whose labours alone

Digitized by Google

would fill a large volume if considered apart from the work of others.

The descriptions following will apply to apparatus used in connection with switchboards for dealing with currents at 2,000 volts pressure, as this voltage has been most commonly adopted in this country, consequently a greater amount of information is available concerning gears controlling it. Extra high-pressure stations, however, do exist, but as the difference in arrangement is mostly one of insulation, the few examples extant will be considered as having no direct bearing on the subject. The drawings are diagrammatic solely, and do not necessarily represent precise details of construction, as they are given to illustrate the principle of the apparatus described. The leading types of switchboard will be dealt with, and the accounts of each will include the high and low pressure gears, as if the description of each section be kept separate, the main object of illustrating the growth of the complete gear will be defeated; moreover, if both are considered together, the statement made above, that the progress of each has not been uniform, will be borne out.

(To be continued.)

SOME NOVEL INVENTIONS OF NIKOLA TESLA.

BY J. WRIGHT.

Most members of the electrical profession associate the name of Nikola Tesla with high-frequency and high-potential currents, and few are acquainted with the fact that he has also invented several novelties for use in other branches of the profession. It is of some of these extraneous productions that I purpose treating in the course of this paper.

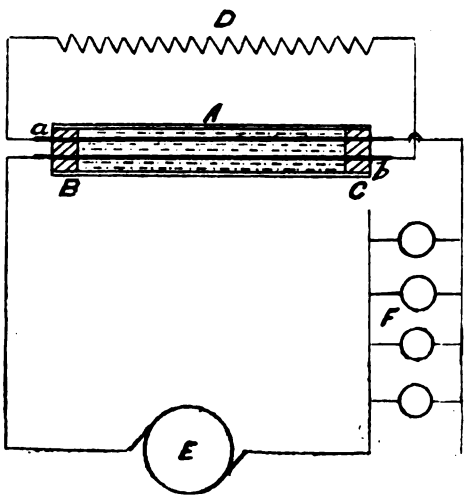


FIG. 1.

The first item consists of an electrolytic meter, the principle underlying the action of which is as follows: A conductor is immersed in a metallic solution, and the current to be measured is passed through it. The action of the current in passing is to remove from or deposit on the conductor a certain quantity of metal, and by so doing alter the electrical resistance of the conductor, which can thus, if necessary, be caused to register automatically when the current passing rises above or falls below certain limits. Fig. 1 is a diagrammatic view of the apparatus. A is the glass containing tube of cylindrical form, sealed at each end by an insulating and watertight plug, B C, through which pass the leading-in wires; *a b* are the active conductors of the apparatus. They are placed parallel to one another throughout the length of the tube, A, and are connected in series through a resistance, D, with the generator, E, and energy-consuming circuits, F, in such a manner that there is an equal difference of potential between them throughout their whole length.

Under the conditions described above a current passing through *a* and *b* will establish a difference of potential between them proportional to the current strength. This gives rise to a leakage between them which is proportional to the potential difference, and therefore to the strength of the current passing through the conductors. Again, owing to the fact that there is a constant difference of potential between the two conductors throughout their entire length, the current density through the electrolyte will also be uniform, and as a natural consequence the metal will be removed at a uniform rate from one conductor and deposited at an equal rate on the opposite one, thus causing an alteration in their electrical resistances proportional to the strength of the current passing through them, from which given quantity the value of the latter can be readily ascertained—in the first instance by experiment, and in the second by comparison. It will be seen that this apparatus is somewhat similar in principle to that of Edison, with this difference—that the results depend in one case on electrical resistance, and in the other on actual weight.

The *modus operandi* of the apparatus is as follows: The two conductors, *a* and *b*, are first accurately gauged and measured for resistance, the results being carefully noted. A fixed current is then passed through the instrument for a certain time, and the respective diminution and increase in the resistance of *a* and *b* is then ascertained. From the facts thus gathered a constant is obtained whereby the instrument is rendered capable of accurately recording any succeeding currents which may traverse the active conductors, *a* and *b*. A test of its accuracy is provided by the separate measurement of the two conductors, when the gain in the resistance of one should equal the simultaneous loss in the other, or, as a further proof, the resistance of the two conductors measured in series with the resistance, D, should be a constant quantity. It is hardly necessary to mention that at certain intervals the direction of the current in the two conductors, *a* and *b*, must be reversed in order to equalise the metallic reduction and deposition respectively. The advantages appertaining to this form of meter are obvious: The readings can be made directly by means of an ohmmeter; the whole of the current may be passed through it provided that the gauge of the two wires, *a* and *b*, be sufficiently large, thus rendering the use of shunts and attendant inaccuracies unnecessary. The accuracy of the instrument is not impaired to any appreciable extent by temperature variations. Above all, it is a cheap form of apparatus for the purpose.

The next inventions with which I purpose dealing are

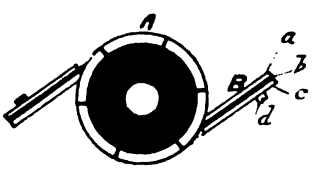


FIG. 2.

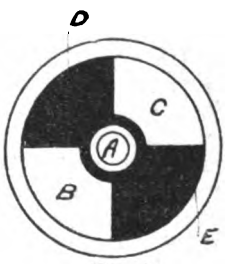


FIG. 3.

those involved in the manufacture of dynamo commutators and brushes, in which sparking is reduced to a minimum or even rendered impossible. Devices for the reduction of this generally necessary evil were no doubt suggested to Mr. Tesla by his marked antipathy to commutators of any description, brought to light by a consideration of his commutatorless motors. Fig. 2, which is a diagram of an anti-sparking brush device designed by him, will help to explain its principle. A is the end view of an ordinary continuous-current dynamo commutator, B being the brush, which is divided into three principal parts: *a*, the metallic brush, as usual; *b*, a plate of mica or other suitable insulating material, such as asbestos paper; and *c*, a flexible spring, which regulates the pressure of *b*, and is governed by the set screw, *d*. The principle of the device will no doubt be understood from its construction. The formation of an arc or spark between the brush, *a*, and the commutator segment which is just leaving it is prevented by the contact made between the insulating strip, *b*, and the corresponding insulating material of the commutator. In some forms of this brush two separate strips of insulating material have been introduced at *b*, instead of one, with advantage.

In another device designed with the same object in

Digitized by Google

view—viz., the elimination of sparking between commutator segments and collectors—both apparatus take the form of discs with their faces well surfaced revolving accurately against one another. Fig. 3 is a diagrammatic end view of the commutator disc of one of these devices. A is the dynamo shaft; B and C are the metallic sectors; D and E the corresponding sectors of insulating material, this being only a simple two-part commutator. The whole surface of the disc in Fig. 3 is accurately faced and smoothed, so that both metallic and insulating sectors are flush with one another. The collector disc is the facsimile of that shown in Fig. 3, but is not keyed to the shaft of the dynamo.

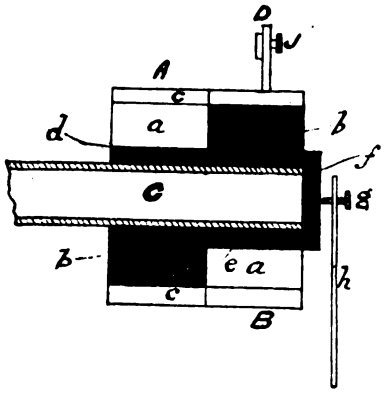


FIG. 4.

A general idea of the complete apparatus may be gained by a study of Fig. 4, which represents a longitudinal section of the commutator, A, and B, the collector; *a a* represent two metallic and *b b* two insulating sectors; *c c* are insulating rings which surround the outside edges of the sectors, and prevent a dissolution of partnership on the ground of centrifugal force; C is the dynamo shaft, through the tubular extremity of which are brought the wires from the armature coils; *d* is an insulating collar placed between the sectors and the shaft to prevent contact, and revolving with the latter; *e* is a similar insulating sleeve for the collector, and the dynamo shaft revolves inside it; a cap, *f*, is screwed on the end of this movable sleeve, and the pressure of a set screw, *g*, on the end of a stiff steel spring, *h*, serves to maintain good surface contact, between the commutator and collector surfaces; D is a quadrant for adjustment with a set screw, *j*, which takes the place of the ordinary brush-rocker, and serves to set the angle of the collectors. The advantages of this form of dynamo commutation will also be readily seen. The short-circuiting interval is reduced to a minimum by the simultaneous "make" and "break" of the sectors, which reduces sparking, besides increasing the efficiency of the machine.

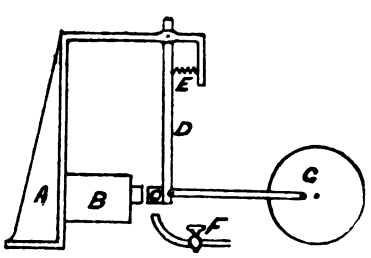


FIG. 5.

In another form of the same device a liquid—mercury, to wit—takes the place of the solid metallic sectors. The two discs are built completely of insulating material in this case, and in place of the solid metallic sectors cavities are left in their faces. The terminals of the collector end in airtight spring plungers or buffers, which serve to regulate the pressure of the mercury under the action of centrifugal force, and also to ensure a good contact between it and the terminal screws. In both forms the insulating blocks should be constructed of some durable material, such as glass or marble, whilst in the solid form the efficiency and durability may be augmented by facing the edges of the metal segments, between which the major portion of the sparking would tend to take place with some durable conducting material, such as platinum.

In the course of his electrical research, Tesla has not failed to study the subject of thermomagnetism, and as a result he constructed one or two rather ingenious forms of thermomagnetic motor, which are, however, for obvious reasons, still in an experimental stage. They are founded on the fact proved by Dr. William Gilbert at the beginning of the seventeenth century, that a magnet or lodestone when heated to redness is deprived of its magnetism. The principle underlying the device is illustrated in Fig. 5, in which A is a standard or support carrying a magnet, B, permanent or otherwise. C is an armature of the latter, forming the bob of a pendulum rod, D, supported above; E is a spiral spring which comes into play when the armature is demagnetised; F is a gas-burner or other suitable source of heat; and G is a wheel and connecting rod by which the power is converted into the ordinary form of rotary motion. Its action is as follows: The armature, C, is in the first instance attracted by the magnet against the tension of the spring, E. On heating C by means of the burner, F, it loses its magnetism and is drawn back by the spring out of the flame. On cooling, the magnetism again comes into play, and the armature returns to its original position, to be again heated, and so it goes on, the motion being of necessity somewhat slow.

There are several modifications of this motor, all working on the same main principle. In one the core of the electromagnet is made movable, and takes the place of the swinging armature, C, which is fixed. To the end of the magnet core it attached a shield, which, when the armature loses its magnetism and the core is drawn back by the spring in consequence, comes between the armature and the flame, and allows the former to cool by intercepting the

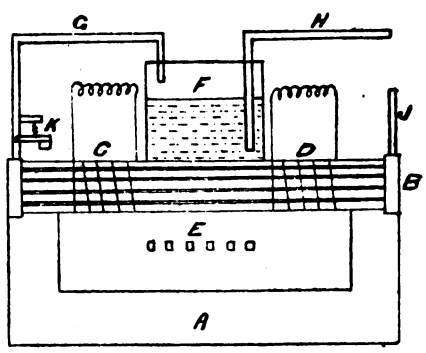


FIG. 6.

heat rays. In another form the armature rocks over the two pole-faces of a permanent horseshoe magnet spanned by a sheet-iron keeper, which latter is heated by a burner whose tap valve is controlled by the rocking armature itself.

A study of the reverse of these conditions also led Mr. Tesla to construct a pyro-magnetic generator based on the undermentioned laws: "Electricity, or electrical energy, is developed in any conducting body by subjecting such body to a varying magnetic influence. The magnetic properties of iron or other magnetic material may be partially or entirely destroyed or caused to disappear by raising it to a certain temperature, but restored and caused to reappear by again lowering its temperature to a certain degree." Tesla's apparatus for practically applying these laws is represented diagrammatically in Fig. 6. A is a permanent magnet, the poles of which are bridged across by a casing containing a number of iron tubes, B. Round this compound bridging-piece are wound the collecting coils, C and D, which serve to collect the current generated. E is a closed furnace surrounding the central portion of the bridging-piece, and surmounted by a boiler, F, the steam generated in which is conveyed to the tubes, B, in the bridging-piece by the pipe, G. H is the water-supply pipe, and J the exhaust. The admission of steam is regulated by a valve, K, under the control of the magnet, A.

From the several inventions dealt with above, it will be seen that Mr. Tesla has not confined his labours solely to the field of high frequencies.

Digitized by Google

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 118.)

Another interesting paper read was that by Prof. Dr. Wedding, who described a new form of arc lamp called the Bremer, after Hugo Bremer, of Neheim, its introducer. According to the figures obtained by Prof. Wedding as the outcome of practical experiments with the lamp, it would seem to combine simplicity of construction and regulation with high efficiency. It is not my intention at present, however, to discuss the paper at any length, though it may be mentioned that the higher efficiency claimed over that possessed by the ordinary type of arc lamp is obtained by incorporating a larger proportion of non-conducting metallic salts, such as calcium, silicium, or magnesium, with the carbon used in the lamp, thus ensuring a better diffusion of the light. The figures given by the professor showed that a continuous-current arc lamp of the Bremer type taking 12 amperes at 45 volts terminal potential consumed only 0·13 of a watt per candle-power of light obtained, while an alternating-current arc lamp of the same type taking 5½ amperes consumed about half a watt per candle with the arc exposed. Prof. Wedding thinks it possible, however, to reduce the latter figure to that obtained with the continuous-current arc. The consumption of carbon by the new lamp is about double that which takes place in the ordinary type, but, in contrast to the blue-violet light yielded by the ordinary arc, the Bremer yields a light rich in orange and yellow-green rays. The lamp has four carbon pencils, between which the arc is formed. These pencils or rods are placed in pairs at an angle to each other. In order to form the arc one of the pairs of carbons is pulled away from the other by an electromagnet. As the carbon is consumed, the length of the arc is automatically regulated by the weight of the carbons and auxiliary weights attached to the same, thus obviating the necessity for any special mechanism. It is claimed that the Bremer type of lamp may be made to yield three times the volume of light given by an ordinary arc lamp with the same consumption of energy. This is, of course, a great feature in its favour, but it remains to be seen what actual success will be obtained by the new lamp. For the present it may be regarded as still in an experimental stage. The greater consumption of carbon compared with that consumed by the ordinary type of lamp is a serious drawback to its ultimate success on the market, but this may be overcome as suggested by Prof. Wedding. At any rate, the fact must be faced that the tendency of recent improvements in connection with arc lamps has been in the direction of retarding the consumption of carbon, and the long-burning qualities obtained must, therefore, be looked upon as essential and not secondary to the success of any new lamp.

A slight digression may now be made in order to give some interesting particulars relative to the employment of electricity in the German navy, which are contained amongst the printed matter distributed to those who took part in the meeting. From this source it appears that until the year 1890 electricity was only generally employed in the German navy for lighting the interior of the ships and for searchlights. It was first towards the middle of the year 1890 that electricity was extensively employed for power purposes in the German navy, when the coast defence vessel "Aegir" was provided with a comprehensive electrical equipment. The installation included nine primary generators designed to yield a terminal potential of 120 volts. Of these machines three had an output of 48 kw. each, and were driven by steam-engines, while the remaining six each had an output of 33 kw., being driven in pairs by three steam-turbines. Since first installed this primary plant has undergone some modification, consisting now of six units in all—viz., three steam turbo-dynamos of 48 kw. capacity each for working the gun turrets, and three steam dynamos for lighting and general power purposes. The plant is not all situated in one part of the ship, but in two different compartments, one of which is in the stern of the vessel. Each of the 48-kw. dynamos is of the multipolar compound-wound type, having six poles. The shunt winding consists of copper wire 2·9mm. in diameter, and is connected in series with a regulating resistance. The series winding consists of three layers of insulated copper strip, and is excited by the whole of the current flowing through the external circuit. The armature possesses 240 coils of copper wire 3·6mm. in diameter in two layers, while the commutator has a corresponding number of segments made of hard bronze from which the current is collected by means of copper brushes. Each of the three machines may be simultaneously employed for lighting and power purposes. The three turrets are each worked by a series-wound motor, which transmits its motion to the roller base of the turret by means of worm and toothed-wheel gearing, the motor obtaining its driving current from one of the compound-wound steam turbo-generators, which latter have also been successfully employed as auxiliaries to the other steam-driven sets for lighting purposes, and experimentally for supplying energy to the steering apparatus. The five ammunition hoists on board are calculated to lift an aggregate weight of 1,323lb. in 20 seconds to a height of 29ft. Each of the shunt-wound motors which work these hoists has an output of 6 h.p. when running at 800 revolutions and consuming 50 amperes of current at 120 volts terminal pressure. The power for driving the steering gear on board the "Aegir" is provided by two shunt-wound motors connected in parallel, which run in opposite directions to each other. When both are running at their normal speed—namely, 300 revolutions per minute—the toothed gear wheels revolve without actuating the rudder shaft. If, however, the speeds of the motors be varied relatively, this shaft is then turned in the direction of the quicker-running motor. By means of worm and toothed gearing this motion is finally transmitted to the rudder. The relative variation of the speed of the motors is accomplished through the steering wheels, the conductors to which are arranged in parallel with the shunt winding of the motors. At both sides of the centre position of the steering wheel three contacts are provided, over which an insulated contact arm, firmly attached to the hand lever, slides. These two sets of three contacts each correspond to three different speeds of the rudder shaft in the one or other direction. Moreover, the apparatus is so arranged that a turn of the steering wheel towards the right corresponds to a turn of the rudder to starboard, and *vice versâ*. The rudder may be turned through its extreme limit of action in 30 seconds. Mounted near the steering wheels are the instruments which indicate the position of the helm. These are nothing more nor less than voltmeters provided with a scale corresponding to the different angles of the rudder instead of volt divisions. The variation of pressure, which causes a deflection of the pointers towards starboard or port, is effected by a graduated resistance, whose sliding contact is connected to a pulley. In order to prevent an unintentional movement of the rudder, a regulator is attached to the rudder shaft, which automatically admits a flow of current through the shunt winding of the quicker-running motor, thereby equalising the speeds of the two motors. The capstan on board the "Aegir" is likewise electrically driven, a series-wound motor of 15 h.p. when running at 500 revolutions per minute being employed for the purpose. The gear for shipping and unshipping the boats is also electrically worked. Further, the windlasses used for raising the anchors are driven by shunt-wound motors, which, with 120 volts terminal pressure, a speed of 1,000 revolutions per minute, and taking from 25½ kw. to 38 kw., are each capable of developing from 30 h.p. to 45 h.p. For starting and controlling these motors a large resistance is placed near the anchors, while a smaller one is provided in the exciting circuits. There are also on board 10 electrically-driven ventilating fans. These are nearly always running, being of neat appearance, and needing very little attention. The repairing tools on board, such as lathes, boring machines, etc., are likewise motor-driven, besides which the generating plant supplies current for the searchlights, shiplighting, and various signalling apparatus, etc.—in fact, it may be said that elec-

Digitized by Google

tricity is utilised on board the "Aegir" for almost every purpose which admits of its application.

Valuable experience has been gained from the electrical installation on board the "Aegir," and this has not been lost on the powers that be. For instance, anchor windlasses are no longer provided with electrical means of driving in the German navy, steam having proved more suited to this particular purpose, since the motors when loosening the anchors from the ground absorbed so much energy that a single primary generator was unable to furnish the requisite current, and parallel running did not seem advisable on account of the involved danger of reversing the poles of the compound-wound machines. The experience gained on the "Aegir" has also proved of service in other directions.

One consequence of the increased use found for electrical energy has been that the pressure of the primary current generated has increased. Formerly when searchlights were responsible for the bulk of the energy consumed, the generators were wound to give 65 volts terminal pressure. On the newer ships of the line in the German navy a pressure of 75 volts is generated, while upon the newer cruisers a uniform pressure of 110 volts has been adopted.

The battleships of the "Kaiser" class now building are to be provided with generating plant consisting of four shunt-wound machines of 60 kw. output each. The interior lighting of each of these ships will require from 35 kw. to 40 kw., while the five searchlights with which each is equipped will absorb another 45 kw. to 50 kw. What energy remains for disposal is to be utilised for driving ventilating fans, ammunition hoists, gun turrets, and coal hoists, etc. Besides the primary generators, the ships of the above-mentioned class are to be provided with accumulators for supplying current to certain of the ship's apparatus. The batteries will be worked in parallel with the primary generators if required, to which they act as a reserve, being of sufficient capacity to supply the signal lamps and ship's lights for a long time in case the main source of supply should fail. In part the new ships will be provided each with three batteries of accumulators, of which one will remain in parallel with the primary generators for service at a moment's notice in case of necessity, while the other two will supply at a lower pressure (35 volts) to the ship's telegraphs, etc. One of the latter batteries will be charged as the other is discharged.

I have by no means exhausted the source of information already mentioned, but the above notes should give some idea of the extent to which electricity is usefully applied in the German navy. That attention should be drawn to the matter is all the more necessary having regard to the obsolete methods of hoisting ammunition, etc., still prevailing in our own navy, upon the protection of which our very existence as a nation is admitted to depend. Individual instances of good progress in this direction may be pointed to, but, as a whole, our navy is woefully behind the times in matters of detail and consequent moment. In the course of an excellent series of articles describing the manœuvres recently completed from the vantage point of one of our more modern cruisers, Mr. H. W. Wilson asks some very pertinent questions in the *Daily Mail*. Speaking of "shell hoists," he says: "The bugle's fierce note is heard, caught up and re-echoed by other bugles in other parts of the ship. Then follows the snapping and clicking of breech-blocks opening and shutting, and all the elaborate mimicry of a furious battle. But if this were the 'real thing,' would not these two forecastle guns before us be hard put to it to keep up the supply of ammunition? The 100lb. shells, the heavy brass cartridge cases, with their 13lb. of cordite, have to be hoisted by four men a height of 42ft. from the magazine in the sweltering bowels of the ship below to the cool daylight of the upper deck. Other navies harness electricity or hydraulics to do such work; our fleet will have none of these agents, alleging their liability to breakdown. Years ago I saw in French and Italian cruisers projectiles and charges whipped up by the half-dozen by such instrumentality. Is there not risk in our fleet—even in our best and newest ships—of our fire being too slow? And in speaking thus, I am only reflecting the sentiments of certain officers on board." Further comment is needless.

(To be continued.)

LOSSES IN SMALL LIGHTING PLANTS.*

BY B. V. SWENSON AND A. W. RICHTER.

The history of the development of electric lighting shows that the splendid advancement which has been made in the economical production of electric current is due largely to careful and scientific tests of electric plants and apparatus which have been made from time to time.

The complete commercial test when properly planned and executed will demonstrate the exact conditions under which a plant is operating, showing the losses which occur in the various parts of the system. By a proper interpretation of the test all losses may be located, and means may then be devised for improving the efficiency of the plant. The report of such a test should be arranged in a simple, straightforward manner, and should contain all essential data. A brief description of the test should be given, and the results and conclusions should be plainly and logically set forth.

Large plants have been tested more frequently than smaller ones, but in a general way these tests have also been of advantage to the smaller plants, as they have shown where machinery and other apparatus were faulty or uneconomical, the result being that manufacturers have improved their product very materially.

In consequence of this, some of the apparatus, as, for example, the steam-engine, has been so perfected that but little improvement in its efficiency is possible. Again, various station appliances, both mechanical and electrical, have been devised for increasing the station output and efficiency.

When such tests have been made, they have usually brought forth excellent results. Small lighting plants, however, have suffered in this particular, the reason being largely the lack of a full appreciation of the value of such tests. Then, too, it very often happens that the management realises that improvements might be made and yet is not aware of the fact that, by means of a scientific investigation of a thoroughly practical nature, one can determine just where improvements can best be made.

In a large number of cases, small plants, as well as large ones, would be greatly benefited by a practical test, if properly conducted and interpreted. This is especially true of some of the earlier plants, containing machinery and apparatus which, although the very best at the time of installation, is now almost or entirely out of date.

Very frequently in a case of this kind a test will demonstrate that it would be a good investment to "scrap" certain apparatus and to replace with new and more modern equipment. Indeed, it many times occurs that the saving made in one or two years will more than pay the cost of making the change.

It must not be understood in this connection that the writers are condemning old apparatus in general and advocating its replacement with new equipment in all cases. Far from it, for it very frequently occurs that apparatus which has been installed for a number of years will, with certain changes, still serve economically and well. Instances have come to the attention of the writers in which entire new equipment has been advocated, but where, by a proper remodelling of the plant, probably replacing some equipment with new and rearranging the plant in general, it may be operated practically as economically as with new equipment, and with far less expenditure of capital.

In order to illustrate the importance of what has been said, the results are given of one of the tests recently made by the writers in this immediate vicinity.

The plant in question is a combined lighting and pumping station. The boiler-room contains two return tubular boilers, each of 43-h.p. capacity. The feed water was taken from the main and passed through an open exhaust heater before entering the boilers. The engine-room contains a 125-h.p. Ideal engine, directly belted to a 90-kw. 2,200-volt Westinghouse alternator. The switchboard is arranged to control two single-phase feeders, each of 45 kw. capacity. The pump-house contains two duplex Deane

* Paper read before the North-Western Electrical Association at Waupaca, Wis., June 27, 1900, and reproduced in the *Western Electrician*.

Digitized by Google

pumps, each of which (at the ordinary speed of operation) has a capacity of 400,000 gallons in 24 hours.

Time will not permit of a detailed description of such a test, neither does it come within the scope of this paper, but a few of the general results obtained may be of interest. The object of the test was to determine the efficiencies of the plant and all parts thereof under actual operating conditions, and to decide upon what changes, if any, were advisable.

The coal was weighed as it was brought into the boiler-house; the water was pumped into two weighing tanks, so arranged that one could be filled while the other was being emptied. Calorimeter tests at boilers and engine were taken every hour; all other boiler-room readings were taken at half-hour intervals. Indicator cards at the engine and all engine and switchboard readings were taken every 10 minutes. In the pump house all readings were taken at 15-minute intervals.

The station was operated under ordinary working conditions. Boiler No. 1 was started at 2.15 p.m., and at 3.15 p.m. one of the city pumps was started. Boiler No. 2 was fired up at 4.5 p.m., and the city pump was stopped at 5.31 p.m., after which there was an entire stoppage until five minutes of six, when the lighting engine and alternator were started. The arc circuit was thrown on at 7.28 p.m. and stopped at 12 midnight. The whole plant was shut down at 1.15 a.m.

All instruments used were carefully calibrated in the laboratories of the University of Wisconsin, both before and after the test. The data were taken by the writers, with the assistance of two students of the university, and entirely independent of the station employés. Some of the results of the test follow:

Steam pressure, pounds	72·2
Draught gauge, inches of water	0·375
Escaping gas, degrees Fahrenheit	407
Feed water, degrees Fahrenheit	136
Kind of coal	Indiana block
Total coal consumed, pounds	3,394
Dry coal consumed, pounds	3,275
Refuse, pounds	390
Refuse, per cent.	11·5
Flue gases—Carbon dioxide, per cent.	6·57
Oxygen, per cent.	13·43
Quality of steam, per cent.	98·5
Total weight of water used, pounds	19,242
Total water evaporated, dry steam, pounds	18,950
Evaporation per pound of fuel, actual pounds	5·79
Evaporation same from and at 212deg. F.	6·45
Evaporation same of combustible, actual, pounds	6·57
Evaporation from and at 212deg. F. per pound of combustible, pounds	7·32
Evaporation per square foot of heating surface per hour, actual, pounds	1·44
Evaporation per square foot heating surface per hour from and at 212deg. F.	1 61
Standard commercial horse-power	56·55
Builder's rating at 15 square feet of heating surface (two boilers)	80 60
Ratio of commercial to builder's rating, per cent.	70·2
Time of engine and alternator trial, 5.50 p.m. to 1.10 a.m.	
Duration of engine and alternator test, hours	7·33
Water pumped into boilers, pounds	16,254
Water drawn from separator at engine, pounds	370
Dry steam charged to engine, after deducting that used by calorimeter, separator, and auxiliary pump, pounds	15 323
Dry steam charged to plant, after deducting that used by calorimeters and auxiliary pump, pounds	15,683
Coal charged to plant, 5.50 p.m. to 1.10 a.m., pounds	2,681
Average indicated horse-power of engine	62·3
Maximum indicated horse-power of engine (8.40 p.m.)	93·2
Total watt-hours	179 350
Average electrical horse-power	33 2
Maximum electrical horse-power	56·2
Load factor (average electrical horse-power ÷ maximum electrical horse-power) per cent.	39
Water pumped into boiler per engine, indicated horse-power hour, pounds	31 2
Dry steam per engine indicated horse-power hour, pounds	33 5
Dry steam per plant indicated horse-power hour, pounds	34·3
Coal per engine indicated horse-power hour, pounds	5·37
Watt-hours per pound of coal	66·9
Friction of engine, alternator excited, and exciter, horse-power	21·2
Friction of engine, per cent. of total load	8
Average efficiency (electrical horse-power ÷ indicated horse-power), per cent.	53 2
Maximum efficiency (electrical horse power ÷ indicated horse-power), per cent.	62·8

Duty of city pump:

Per pump displacement per 1,000,000 B.T.U., foot-pounds	13,810,000
Per tank displacement per 1,000,000 B.T.U., foot-pounds	12,780,000
Per pump displacement per 1,000lb. dry steam, foot-pounds	13,940,000
Per tank displacement per 1,000lb. dry steam, foot-pounds	12,900,000

The management was under the impression that the boilers and heater were not of sufficient capacity, and that it would be necessary to purchase a larger boiler and heater, which would entail a considerable investment of capital. The test shows that the boilers are operated at an average of but 70 per cent. of their rated capacity, and during the two hours of heaviest load they operate at but 5 per cent. above rated capacity. It will be seen, therefore, that the boilers are of sufficient capacity for the present requirements of the plant. The temperature of the feed water (Fig. 1),

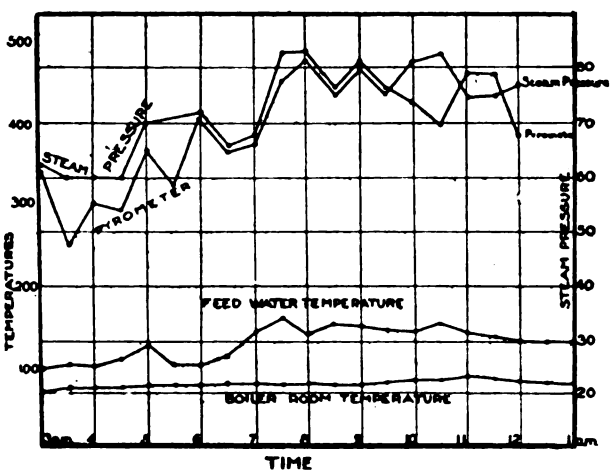


FIG. 1.—Boiler-Room Readings.

as given in the test (133deg. F.), is lower than that of the water as ordinarily pumped into the boilers. This result is due to cooling, while the water was pumped into the barrels and from there into the boilers. In order to find the actual temperature at the time when no test was being made, the temperature of the feed water was taken on the evening following the test. The data obtained showed an average temperature of 204deg. F. and a temperature of 208deg. F. at the time of maximum load (7.30 to 10 p.m.). This temperature is as high as can be obtained by the use of an exhaust heater without increasing the back pressure on the engine. A higher temperature would be conclusive proof that the back pressure is excessive, and is therefore undesirable.

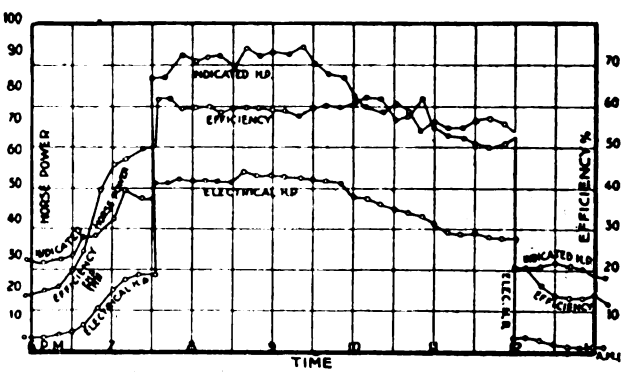


FIG 2.—Engine and Alternator Load Curves.

The indicator cards show that in all cases the pressure drops to atmospheric pressure immediately after opening the exhaust, and gradually rises until compression begins, reaching about 3 8lb. during the time of heaviest load, and 2 5lb. during the time of light load. This rise is caused principally by the piping, and cannot well be avoided when both engine and pump exhaust into the same heater. The average back pressure of the engine—namely, 1·9lb. for the period of heavy load and 1 2lb. for the period of light load—is very good. The back pressure on the pump, while it was in operation, was less than 2lb. The heater is therefore of sufficient capacity for the present needs of the plant, as shown by the test.

Digitized by Google

The evaporation (pounds of water per pound of combustible from and at 212deg. F.)—namely, 7·32lb.—is fairly good, considering the conditions and the method of handling the plant.

The flue-gas analysis shows an average of 6·57 per cent. of carbon dioxide. This result is too low, and shows that too much air is admitted to the furnace. It was found that during the time of light load and after starting boiler No. 2, a test of the flue gases showed but 2·3 per cent. of carbon dioxide, while during the time of heavy load (8.15 to 10.15 p.m.) there was about 8 per cent. of carbon dioxide. This last result is fairly good, although it can be improved upon. With very careful handling of the dampers and fire an average result of from 8 to 10 per cent. can easily be obtained.

The steam-pipe from boilers to engine was not covered. The test shows that during 7½ hours 407lb. of steam (equal to 2·54 per cent. of the total amount) was lost between boilers and engine. This loss was due in part to radiation, and partly to steam escaping with the water in the separator, due to the fact that the drain from the separator was not

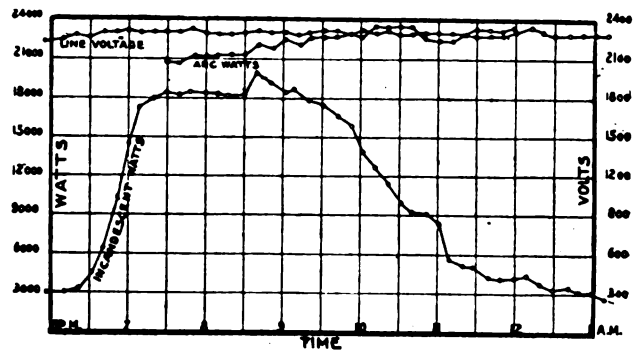


FIG. 3.—Line Load Curves.

kept entirely closed. Assuming a radiation of one British thermal unit per square foot of radiating surface per degree per hour, 1 per cent. is accounted for, leaving 1·54 per cent. to be charged to the separator.

The engine and alternator are both of very recent design, and, if they were operated at anywhere near full load, would leave little to be desired in this direction. Load and efficiency curves of engine and alternator are shown in Fig. 2. Electrical and indicated horse-power data are given as vertical distances, and time as horizontal distances. It will thus be seen that the electrical and indicated horse-power can at once be read off for any time of the day.

The average electrical horse-power is but 33·2, while the average indicated horse-power is 62·3. The maximum elec-

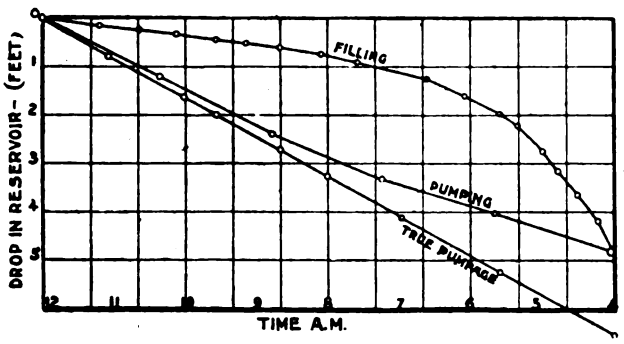


FIG. 4.—Water Curves.

trical horse-power is only 56·2, and the maximum indicated horse-power is 93·2. The minimum electrical and indicated horse-power are 3·6 and 24·8 respectively. These figures show to how great an extent the unit is underloaded. The low efficiency, which is due to this cause, averages 53·2 per cent., reaching a maximum of 62·8 per cent. at 10.10 p.m., and having a minimum value of about 14 per cent. This means that on the average 53·2 per cent. of the power generated in the engine cylinder reaches the switchboard; the remainder, 46·8 per cent., is lost in the transmission. When the lighting unit is in operation all night, this loss is increased to a considerable extent.

An investigation was made of the saving, if any, that might be made by the addition of a smaller unit, which might be operated during the period of light load and when the arc lights are not in use. It was found that with a run to 1 a.m. the investment would bear a good percentage of interest.

The horse-power and efficiency curves show the very light load on the electric station during the earlier hours of the evening and after the arcs are taken off at night, the efficiency of the unit falling as low as 13 per cent. It is evident that a smaller unit, if installed, will decrease the cost of operation to a considerable extent, besides furnishing a duplicate outfit. In case of accident to one of the units, the station will still be able to furnish light to its patrons.

A 30-kw. unit will be able to operate the incandescent circuit during the entire run, and it is therefore advisable to instal a unit of this size. The average electrical horse-power for the incandescent circuit during the entire run is 14·6 e.h.p., and the maximum is 26·8 e.h.p.

The results of the test show that the changes contemplated before the test was made are not necessary at present, but that other changes might be made which would greatly improve the economical operation of the plant.

[The paper was read by Prof. Swenson, who, at its conclusion, explained the diagrams (Fig. 3, showing the line load curves, and Fig. 4 the pumping tests) in somewhat greater detail. The graphical demonstration of heat losses in furnace, boiler, auxiliaries, engine, and dynamo, here

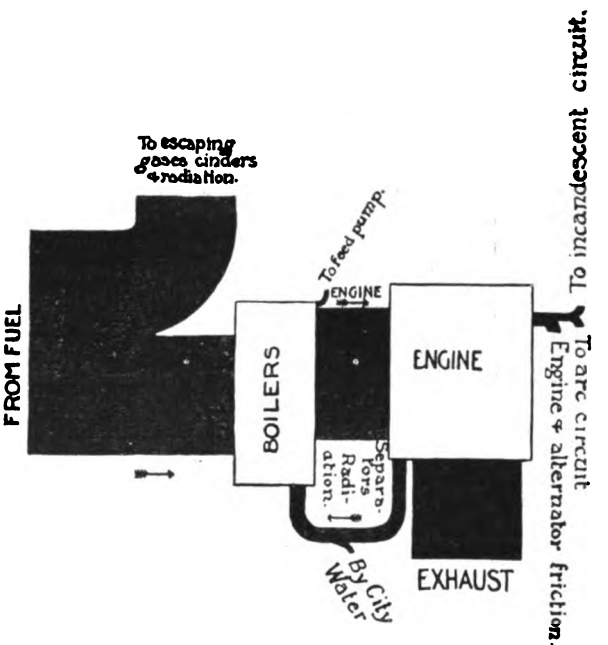


FIG. 5.—Diagram showing Losses in Heat Energy from Fuel to Switchboard.

denominated Fig. 5, was viewed with especial interest by those present.]

CONDUIT v. TROLLEY.

The following appeared in the *Daily Mail* of Wednesday, Aug. 8:

Against the Costly Conduit.

THE CASE FOR THE TROLLEY TRAM IN LONDON.

BY J. CLIFTON ROBINSON, C.E., MANAGING DIRECTOR AND ENGINEER TO THE LONDON UNITED TRAMWAYS COMPANY, LIMITED.

The adoption of the conduit system on electric tramways is a mistake which, if persisted in, will, in my opinion, entail loss on the working, and will delay, by its costliness of construction, the development of rapid transit in London. The conduit system will be found practically impossible in many of the central parts, while its cost will be at the least double that of the trolley, and it is naturally liable to more frequent interruption both from physical and climatic causes.

In proposing to adopt the conduit, the London County Council is, in fact, going contrary to the consensus of opinion

Digitized by Google

on electric tramways throughout the world. The trolley has proved itself to be the simpler and cheaper of construction, easier in maintenance, and more economical in working cost from day to day, than any other method yet known. With an extended personal experience embracing nearly the whole of Europe, North America, and Canada, and after a most careful enquiry into all known inventions and proposals, I am firmly convinced that, for many reasons, the electric trolley system is to-day the best method of tramway traction which any community can adopt.

The Conduit's Sole Advantage.

The only advantage possessed or that can be claimed for the conduit over the trolley is that it does away with the overhead wires necessary in the trolley system. These wires have been talked about and written about until to some they have become bogeys. In actual use they present no inconvenience, and their alleged unsightliness is a mere exaggeration. There is no danger with them, for if they from any cause accidentally break, the current is at once automatically cut off. Those who wish to judge of their outward appearance should satisfy themselves by inspecting the installation now being made along the streets of the western suburbs by the London United Tramways system. The conduit, as above hinted, has inherent faults which help to prove its impossibility for London. It is, besides, very costly. A well-equipped trolley line ought not to cost more than £20,000 per mile of double track, while the construction of a conduit system would at least run into double that amount for the known quantities of the work; while for the unknown factors, which must arise in many parts of central London, it is impossible to estimate the outlay further than to say that it must be gigantic. In proof of this let me briefly describe the construction of the conduit system.

How the Conduit is Built.

It requires a continuous chamber to be made below the surface of the street, going down, with its concrete foundations, to from 4ft. to 6ft., and strong enough to bear any weight, up to a traction engine, that can be brought upon it. This subway, or "conduit," must be open to the street by a continuous slot, from ¾in. to 1½in. wide, through which the plough of the car goes, to pick up current from an insulated yet open electric conductor. The construction and maintenance of such a conduit would present insuperable difficulties in London, for there, immediately below the roadway, is found a maze of pipes of every kind, including sewers, gas-pipes, water-mains, and many others. The most experienced surveyors and engineers cannot tell without excavation where many of these pipes are, for after long years all trace of them has been lost. They bend and twist, and intersect and bisect the streets in a way almost impossible to believe.

If the conduit system were adopted, the whole of these pipes within 3ft. or 4ft. of the surface of the roadway would have to be taken up, diverted, and relaid. The cost of doing this, in the oldest streets, might well run into many thousands of pounds, while in many parts it would be almost impracticable for the most experienced to estimate the cost.

What about Gas and Water Mains?

A further practical difficulty, of course, is that the County Council would not be permitted to move gas or water mains. It would first have to open up the street to find where the pipes where, and then it would have to wait the convenience of the gas or water company, which would do the work when it was most convenient to them, and then send the bill of costs (over which there would be little or no control). As an example of this, I may state that, in altering the elevation of a bridge at Hounslow, the London United Tramways found it necessary to lower some water-mains. The water company kept us waiting months before it did the work—and we could do nothing but wait.

This brings me to the next point. The placing of a trolley line involves no more disturbance of the streets than the ordinary relaying of part of a roadway. One-half of the line is done at a time, and the street otherwise remains open for traffic. But in the building of a conduit, streets must be entirely closed to vehicular traffic for probably months at a time, and to many tradesmen along the streets through which the conduit line is run this would mean dislocation of business, and to everyone much loss and inconvenience.

What are the Advantages?

The great practical question remains. After the conduit has been built, after the tremendous cost has been met, and the engineering problems have been effectually overcome, would it present any advantage over the trolley? Would it work better or cheaper? Experience goes to show that it would not work nearly so well. The conduit, with its open slot, practically acts as an open sewer. All filth, all rubbish, drift into it. It presents greater dangers for electrolysing gas and water mains than does the trolley, for with every fall of rain the current is dissipated all around. When floods of water come down the roads in the rainy weather peculiar to this climate, as in some of the hilly parts of northern London, the conduit will for the time be stopped. There is, further, an actual personal danger, for the slot would present a constant temptation to children or mischievous persons to choke it up with anything they could pass down the slot; or, ignorant of their power, to try to obtain "shocks" by reaching down to the naked electric conductor with wires or metal rods.

Conduits Abandoned Elsewhere.

The objections to the conduit are—they seem to be theoretical, but not practical. In establishing electric tramways, London is only following the lead of many other cities. Some cities began by trying the electric conduit, but only to abandon it, in nearly every case, for the overhead trolley. New York City is often quoted by advocates of the conduit as a case in their favour; but to quote New York as an example for London is absurd, for the conditions of the two cities differ so largely that there can be no comparison. When conduit lines began recently to be established in New York, there were already in existence underground tracks built for the cable lines which could be readily adapted. Conduits are, further, easy to build in New York, because there does not exist the same maze of unknown zigzag mains to deal with which are to be found in London.

When the London United Tramways Company wished to introduce electric traction on its line in West London, the London County Council used all its influence to induce us to establish the conduit on at least those sections of our system within London. But rather than listen to the voice of the charmer, we waited for two years or more till we at last secured powers to use the trolley line over all our routes.

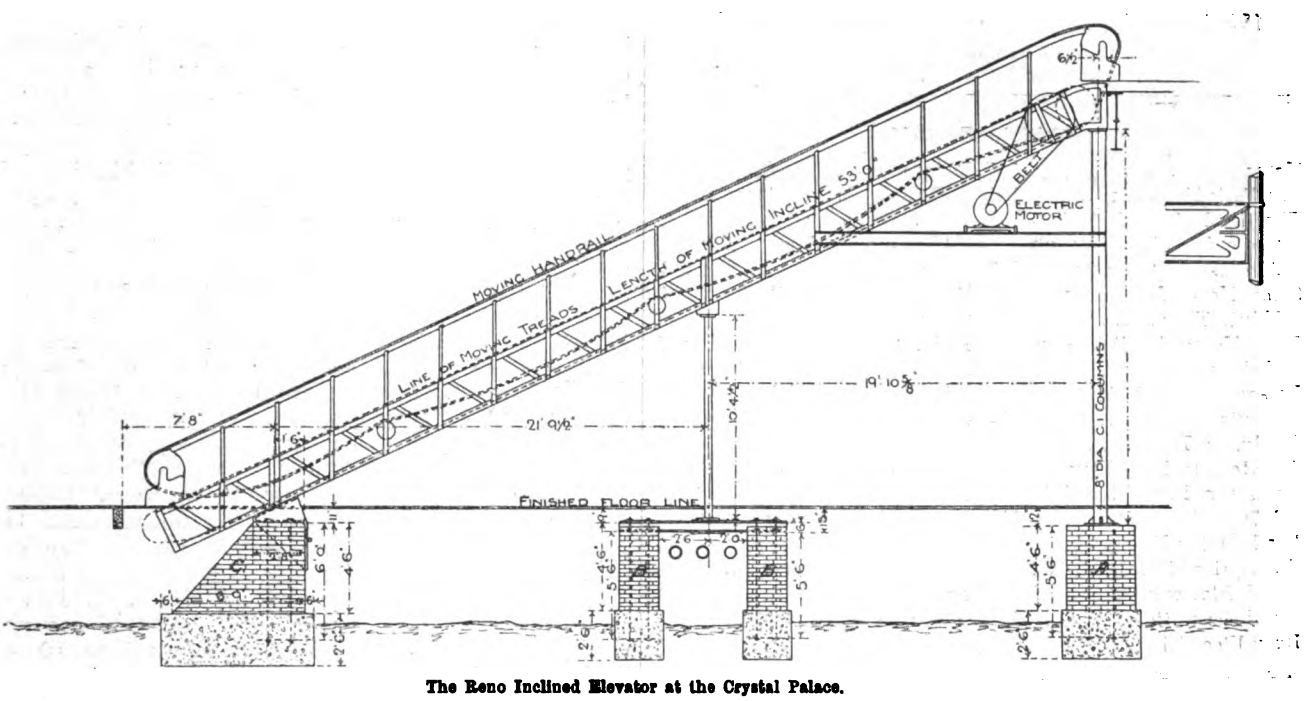
Our approaching electric inauguration, which will take place this autumn, will at once, I believe, shatter the prejudices of many who had objected to the trolley. For the trolley, wherever it has been established, has been a complete success, and has converted its most determined foes into its greatest advocates.

THE RENO INCLINED ELEVATOR.

The introduction of yet another American innovation into this country was celebrated on Friday last, when a number of Pressmen and others visited the Crystal Palace for the purpose of seeing the elevator installed there by the Reno Inclined Elevator Construction Syndicate, of 70, Finsbury-pavement, London, E.C., in operation. It is the first elevator of its kind erected in this country, though, we understand, already extensively adopted in the States, not to mention the Paris Exhibition and elsewhere. The accompanying illustrations will enable the construction of the elevator to be readily understood. When intended for single-file service, the elevator is given a width of 3½ft., for double service 5ft., and is built at an angle of 25deg., as shown. The structure consists of steel framework, bolted at the top to the steel floor beam or header, and similarly supported at the bottom. Near the middle it is supported by a steel column, the weight at that point being about 2,100lb. The moving incline consists of a series of hardwood slats or treads of a special form, attached to an endless chain, rotated by a sprocket wheel. These slats have fastened to them a series of rubber-covered longitudinal ridges, each being ¾in. wide and 1in. high. They serve as a comfortable footing for the passengers. To ensure a perfectly smooth and safe landing at the upper end of the machine, the feet of the passenger, which rest upon these rubber-covered ridges, are slid off as they arrive upon a comb shaped landing consisting of cast-iron prongs, which

Digitized by Google

fit into the grooves separating the ridges. To each end of the wooden slats is attached a small anti-friction wheel made of hemacite. These roll upon angle-iron tracks on both their upward and downward passages, and insure easy and noiseless running. The endless tread chain, besides passing over the sprocket wheel at the upper end of the machine, also passes over an idler sprocket wheel at the lower end. Attached to the shaft of the upper wheel is a reduction gearing directly connected with the electric



The Reno Inclined Elevator at the Crystal Palace.

motor. The speed of the motor, 550 revolutions per minute, is thus reduced to about 14 revolutions per minute at the driving sprocket, which gives the moving incline a speed of 90ft. per minute.

In order to steady the passenger in his ascent on the machine a moving handrail is provided. This consists of an endless steel chain of special construction, which slides in a groove in a steel bar running from one end of the machine to the other, the upper and lower ends of the chain passing around sprocket wheels enclosed in ornamental

step on to the inclined surface, when they are carried easily and comfortably—at the Crystal Palace—from the ground level to the gallery above, a height of 21ft. 7½in., the over-all length of the elevator being 51ft. In this manner the elevator is capable of dealing with 3,000 passengers per hour, its capacity being equal, it is claimed, to that of six vertical lifts. When fully loaded the elevator requires about 6·4 h.p. to drive it at its normal speed, and when empty 1·4 h.p. This power is furnished by an electric motor coupled as shown in one of the accompanying illustrations. The short drive from the motor to the main shaft was necessitated in this case by special conditions. The elevator is designed to obviate the disadvantages of the vertical type of elevator. Its greater relative capacity is sufficiently obvious, and the advantages of having an elevator constantly at work during business hours, and, moreover, available at any moment without wait or bother, give the new elevator a wide field of applicability and usefulness. It is claimed, amongst

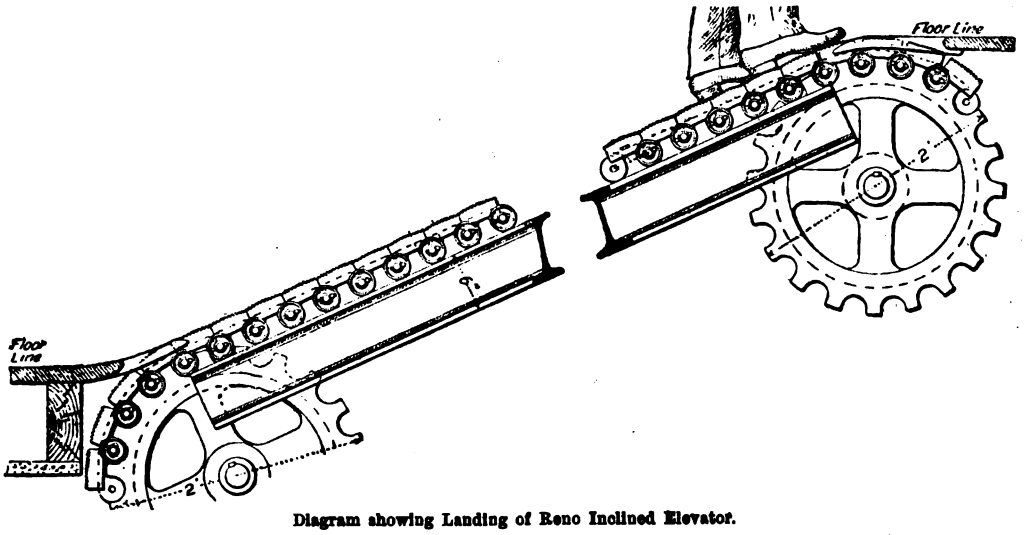


Diagram showing Landing of Reno Inclined Elevator.

iron casings. The chain, after passing around these sprocket wheels, also passes over a third sprocket wheel on the main shaft of the machine, which thus drives the handrail the same rate of speed as the moving platform. The handrail chain is covered by flexible rubber covering, which presents a comfortable surface for passengers to grasp. Needless to say, this chain handrail is another special feature of the machine. It is built up of cast-steel interchangeable links, so that it may be easily tightened up if necessary. The elevator is intended to run continuously, passengers having simply to

many other advantages, that the elevator makes the second floor or basement of store buildings almost as accessible to the public as the ground floor. Its adaptability as a freight elevator for steamships, docks, warehouses, and factories is also pointed out. Places of entertainment like the Crystal Palace, for instance, should benefit by its introduction on account of its novelty. As to actual results in this direction it may be mentioned, in conclusion, that the Reno inclined elevator at the Crystal Palace on Bank Holiday took up over 10,000 passengers at a charge of 1d. per head without hitch.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	181	Report of the National Electric Light Association Committee on the Photometric Value of Arc Lamps	201
The Paris Exhibition	186	Bristol Electricity Works	205
The Evolution of Switch Gears for High-Pressure Alternating Currents	189	Questions and Answers	205
Some Novel Inventions of Nikola Tesla	190	Light Railways	207
The Verband Deutscher Elektrotechniker	192	Manchester Electricity Works	208
Losses in Small Lighting Plants	193	Contracts for Electrical Supplies	209
Conduit *v.* Trolley	195	Traction Notes	210
The Reno Inclined Elevator	196	Lighting Notes	211
From the International in 1878 to that in 1900	198	Companies' Meetings and Reports	214
Forthcoming Events	199	Provisional Patents	216
Description of the Blackpool and Fleetwood Tramroad and Generating Station	199	Traffic Returns	216
Bury Electricity Accounts	205	Companies' Stock and Share List	216

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

FROM THE INTERNATIONAL IN 1878 TO THAT IN 1900.

Twenty-two years ago Paris was engaged, as now, with an international exhibition. Then Gramme, Jablochkoff, Planté, and one or two others made that leap in electrical practice which has since given rise to the dominant industry of the world. Till then various men had laboured and experimented, but the results of the labours and experiments had not taken the world by storm; but the time had come, and since that exhibition there has been no going back. Even with the glamour of the 1878 exhibition upon us but few believed in the possibilities of electric light as an artificial illuminant. If any reader cares to do so, let him turn up the *Journal of Science* for February, 1879, and he will find therein two or three very suggestive papers. In one, Mr. W. Mattieu Williams details his experience from 1845 onward with investigations into the applications of electricity. His conclusions are emphatically stated. He says: "During the intervening thirty years I have abstained from further meddling with the electric light, because all that I had seen then and have heard of since has convinced me that, although as a scientific achievement the electric light is a splendid success, its practical application to all purposes where cost is a matter of serious consideration is a complete and hopeless failure, and must of necessity continue to be so." What danger there is in prophesying unless you know, and how often during the past twenty years must Mr. Mattieu Williams have wished those words unsaid. Had the conclusions been different, it is possible we should not have had to wait till this year of grace to know how near Mr. Staite and his colleagues were to the solution of the problem, not only as regards the lamp, but also the dynamo. It was Gramme's work in the latter direction that made progress possible and rapid. Williams refers to Staite's attempt to obtain a lamp by means of a carbon rod in a Torricellian vacuum, and Prof. Ayrton in the same number describes his work upon such a lamp as long back as 1873, though after obtaining a vacuum he filled his globe with nitrogen. The third paper we have referred to is one by Profs. Elihu Thomson and E. J. Houston, showing that size, weight, and cost of the copper conductor required for transmitting power over a distance of 500 miles or more were not, as some writers at that time insisted, prohibitive in either of these directions. It was in April, 1879, that the late Dr. Hopkinson read his first classic paper at the Mechanical Engineers, and started the scientific process of the construction of electrical engineering apparatus. How vast the work done in all directions between the years 1878 and 1881 can be understood by referring to the reports of the electrical exhibition held in Paris in 1881.

The avidity with which electric lighting was taken up in other countries, and especially in America, where the prevailing conditions were altogether in its favour, led to legislative action in this country, and gave us the justly celebrated 1882 Bill. The

Digitized by Google

passing of this Bill led to the following remarks by Sir F. Bramwell: "The passing of this Bill must be looked upon as the beginning of the end of the carrying out of public enterprises by means of private capital." He also correctly prophesied stagnation while the inequitable conditions of the Bill remained. As we all know, these conditions had to be modified by a subsequent Act, and then came a period of activity. It is well to occasionally remember the facts of rise and progress. In our last issue we pointed out how useful American energy had been to the industry, and the moral of our present remarks may be taken to indicate that France has by her exhibitions at critical times made the world acquainted with the position of electrical matters, and by these "bold advertisements" has conduced largely, if not entirely, to epoch-making. If the Britishers have not taken kindly to Paris this year, it is not that they deprecate the value of the interchange of opinions or the examination of differences in practice, but from other and varied causes which it is needless to elaborate. The facts remain as we have stated, that the electrical industry owes much to exhibitions in Paris.

FORTHCOMING EVENTS.

SUNDAY, AUG. 12.

Institution of Electrical Engineers.—American Institute's visit. Trip up the Thames in launches.

MONDAY, AUG. 13.

Institution of Electrical Engineers.—American visit. Dinner at Prince's Restaurant, Piccadilly, at 7 p.m. Also, during the day, visits to Board of Trade Laboratories, Telegraph Department of G.P.O., Central London Railway, and Westminster Electric Lighting Station.

Institute of Junior Engineers.—Summer meeting at Newcastle-upon-Tyne. Reception at Town Hall by the Mayor. Visit Messrs. Swan and Hunter's and the Electric Supply Company's works.

TUESDAY, AUG. 14.

Institution of Electrical Engineers.—Visits to School of Military Engineering and Royal Dockyard, Chatham. Lunch at Royal Engineers' Mess Reception by Lady Fraser in the afternoon.

Institution of Junior Engineers.—Visit Messrs. Armstrong, Whitworth, and Co.'s Elswick Works, the Engineering Department of Durham College of Science, and the Newcastle and District Electric Lighting Company's works.

WEDNESDAY, AUG. 15.

Institution of Junior Engineers.—Trip on the river to inspect the Tyne Improvement Commissioners' works.

THURSDAY, AUG. 16.

Institution of Electrical Engineers.—First day of joint meeting of English and American Institutions in Paris. Subject for discussion, "The Relative Advantages of Alternate and Continuous Current for a General Supply of Electricity."

Institution of Junior Engineers.—Excursion to Sunderland to inspect the works of the River Wear Commission.

FRIDAY, AUG. 17.

Institution of Electrical Engineers.—Paris meeting, second day.

Institution of Junior Engineers.—Visit the Allhusen Works of the United Alkali Company, the preliminary works of Corporation electric tramways. Summer dinner at County Hotel.

SATURDAY, AUG. 18.

Battersea Vestry.—At 3.30 p.m., foundation-stone laying of Lombard-road central electric station.

International Congress of Electricians at Paris.—Aug. 18-25.

WEDNESDAY, AUG. 22.

Institution of Electrical Engineers.—Paris meeting; reception in the British Royal Pavilion in the Paris Exhibition, 5 to 7 p.m.

WEDNESDAY, SEPT. 5.

British Association.—Annual meeting at Bradford.

Paris.—The Association des Industriels de France contre les Accidents du Travail offer a prize of £40 for the best insulating gloves for the use of those employed in electric works. Particulars must be supplied by Dec. 31.

DESCRIPTION OF THE BLACKPOOL AND FLEETWOOD TRAMROAD AND GENERATING STATION.*

BY TOM G. LUMB, A.M.I.C.E.

The Blackpool and Fleetwood electric tramroad constitutes one of the most popular amusements we have in our midst to-day. It opens out a part of the Fylde possessing charms and beauties absolutely unknown to the great majority of the vast crowds of holiday makers. The ride on a smoothly-running electric car over the cliffs at North Shore and Bispham through the famous "Wilds of Norbreck," and thence to Rossall and Fleetwood, adds a new joy to the delights of a holiday at Blackpool. For several miles the line skirts the edge of the coast, and passengers have the advantage of a magnificent uninterrupted view of the sea on the one side and the verdant meadows and pastures on the other as far east as Bleasdale Moors. Judging by the number of passengers this season, the novelty and attractions of the ride strongly appeal to the holiday makers. Persons having business to transact in Fleetwood, or any of the intervening villages, find the cars a great convenience. Numbers of private residences are being erected along the route. The line, over 8½ miles in length, double track, was laid in a few months, and speaks well for the smartness and efficiency of the staff of the contractors, Messrs. Dick, Kerr, and Co. It is one of the best paying tramroads, if not the best, in the world. One could hardly grasp the fact that in the first 12 weeks no less than 550,000 passengers were conveyed, thus realising over £12,000, and this with only 10 open cars running.

The line commences opposite Talbot-road railway station, and passes along Dickson and Warbreck roads to the Gynn (single line with numerous passing places). From Derby-road to the Gynn there is a "double single" line—that is, the cars go up and down the road on the left-hand side, thus having a double track, but the distance between the tracks is not sufficient for cars to pass. The line then passes through the deep cutting made out of the top of the cliffs to Uncle Tom's Cabin, which was Blackpool's first place of amusement. At Uncle Tom's the ordinary form of tramway construction gives place to a light railway type of construction. Just before crossing the borough boundary of Blackpool there is the commencement of an incline with a gradient of 1 in 42, which brings the tramroad to 95ft. above the level of the sea, this being its greatest height. After leaving Uncle Tom's Cabin we come to the road leading to Bispham and the commencement of the Norbreck Estate, which is being laid out for building purposes, and upon which there are already several private residences erected. Up to Norbreck the line runs along the edge of the cliffs; then it takes a turn inland into the heart of Cleveleys, crossing the main road and running parallel with it to Rossall. Passing Rossall College the line turns to the north-east, and runs with easy curves direct to West-street, Fleetwood, passing the second accumulator station and car-shed just before reaching the town and cutting off the big corner by the hutments. The terminus, as at Blackpool, is near the station and the landing-stage for the Belfast, Douglas, and ferry steamers.

Permanent Way.—The track is of standard gauge and double throughout, except in Blackpool, where passing places are provided. The permanent way includes both tramway and light railway forms of construction. From Talbot-road terminus to the Blackpool borough boundary, and again from Poulton-street, Fleetwood, to the terminus, the line is a tramway. The intervening section—about 6½ miles in length—has, however, all the characteristics of a light railway, the line being fenced and the road being designed for comparatively high speeds. As regards the tramway construction, there are no novel points to note, except that the groove of the rails is made slightly larger to suit the thicker flange required for running on the Vignole rails. The roadway was excavated to a depth of 12in. for the full width of the tracks, and for 18in. on each side of the outside rails. A foundation of 6in. of concrete was then laid down, and on this were laid the girder rails. The rails used in Blackpool

* From the *Transactions* of the Royal Institution of Public Health.

Digitized by Google

weigh 98lb. per yard, and those in Fleetwood 83lb. They are tied to gauge by steel bars at intervals of 9ft. The sets which bring the roadway up to the rail level are of granite. On the tramway sections the electrical connections between the rail ends consists of two copper bonds of the "Daniel" type. On the tramroad the form of construction is entirely different. The route lies across fields, and as the road-bed had to be made throughout it will be readily understood that the work could not be carried out so rapidly as in the case of a tramway. In the latter, materials can be deposited all along the route, and several gangs of men can be simultaneously employed at intervals along the route. There was no roadway beside the route of the tramroad, and ballast, sleepers, rails, etc., had to be carried forward on the rails as the line was prepared, the contractors using small steam-engines for hauling material and for inspection. A large amount of excavation (123,000 cubic yards) was required, the cuttings ranging up to about 16ft. in depth. The great bulk of the material excavated was hard and tough red clay, very difficult to work; in fact, the "gullets" had to be blasted out, as in heavy railway construction. There are six barrel culverts on the line, each 6ft. in diameter, and built of three half-brick rings on a very strong concrete foundation. In building these, close poling and pumping was required (in all except one case), the material met with being "quick" clay and running sand. In some cases the work at the culverts had to be close timbered and finished in lengths of 6ft. or 8ft., the bottom being so bad. There are 10 level crossings on the line, seven of which are on public roads, and all are provided with cattle guards. The track on this section consists of Vignole rails, weighing 56lb. per yard, and laid on transverse sleepers, with centres 3ft. 6¾in. apart. Round all curves, fangbolts, and clips fix the rails in place. The rails are spiked directly to creosoted redwood sleepers (9ft. by 9in. by 4½in.), chairs not being used, and the sleepers are embedded in 12in. of ballast in the usual way. A feature of special interest, since its use is wholly new in this country, is the "plastic rail bond." This bond has been used with what appear to be very successful results in America. It is composed of two portions: a plastic or putty-like metal compound, which makes contact between the rail and the metal of the joint, and a flexible elastic cork case to hold the plastic part in position. In putting the bond in place, contact spots, about 2in. diameter, at the end of both rails and fishplates, rust and scale are cleaned off, and the centre of each of these spaces is rubbed with a special alloy, which changes any iron rust to pure metallic iron, and forms a silver-like deposit, which repels water and will not corrode. One side of the cork case, containing the plastic material and the steel spring, is then placed upon the prepared surface of the web of the rail, and a similar case is attached to the end of the next rail. The fishplate is then bolted down, and, as the bolts are tightened, the cork case is compressed to half its former thickness, and the amalgam in the case comes into full contact with the rail and fishplate, giving an electrical connection between the rails of low resistance. The bond is thus entirely concealed from view, and it is protected by the cork case from injury arising from movement between the rail and the fishplate.

Generating Station.—The generating station and principal car-shed is situated about two miles from the Blackpool terminus and a quarter of a mile from the line, with which the car-shed is connected by a spur track. All the buildings, including a lofty chimney, are constructed of brick. The whole of the installation is compactly and conveniently arranged. The boiler-room measures 68ft. by 66ft., and the engine-room 77ft. by 32ft. The car-shed is 170ft. by 67ft., and is capable of accommodating 24 cars. The Fleetwood car-shed is 116ft. by 67ft., and has accommodation for 18 cars. At the terminus close to the old barracks, known as Euston Barracks, there is a third car-shed, with waiting-rooms, stores, and office. At Bispham, Norbreck, Cleveleys, and Rossall there are waiting-rooms for the convenience of passengers, together with places for stores. Four Lancashire boilers, constructed by Galloways, Limited, of Manchester, form the steam-raising plant. Each boiler is 30ft. long by 8ft. diameter, and the steam pressure is 120lb. Water is obtained from a reservoir adjacent to the engine-room, which is filled by surface water collected from the surrounding fields and springs. It is also provided with one of Klein's patent coolers. If required, water can also be drawn from the local supply, and a storage tank has been constructed above a small outbuilding near the boiler-room. The reservoir, however, is expected to supply all requirements. After passing through the hot-well, the water is fed to the boilers through a set of Green's economisers of 288 tubes. Two direct steam-driven Worthington feed pumps are employed. All steam and exhaust pipes are placed in a basement beneath the engine-room, giving easy access to all parts. The steam-pipes are arranged to form a ring. The main pipe and the branch to each engine are fitted with a steam separator. A water-gauge indicates the amount of water collected, and by means of a valve the attendant may clear the separator of water when required. There are five open marine-type vertical compound engines of 200 h.p. each, running at a speed of 175 revolutions per minute, with cylinders 12in. and 24in. in diameter and 16in. stroke, constructed by Messrs. Mather and Platt. Direct coupled to each engine is a multipolar dynamo capable of giving a continuous output of 120 kw. at 505 volts, to which I shall again allude presently. The engines have cast-iron standards at the back, which, with the polished steel columns in front, serve to support the cylinders and guides for the piston rods. The pistons are supplied with Mather and Platt cylinder rings, packed with metallic packing. The Pickering throttle governor is used, and the engines have hand regulation for the expansion gear. Although the engines usually run condensing, valves are provided so that exhaust may be made direct to the atmosphere. Ledward ejector condensers are used, the condensing water being taken from the storage tank. After leaving the engine-room the water passes down a wooden troughing, and for some distance around the reservoir before entering it. This is used at the times the cooling tower is not needed. The water for the condenser is pumped up by centrifugal pumps driven by Mather and Platt's single-acting enclosed high-speed engines, the pumps being coupled direct upon the same bed-plate. The dynamos, which were constructed by Mather and Platt, have six poles. They have shunt-wound magnets. The yoke casting is in one piece, and the upper half of the machine can be easily removed, this giving access to the armature, which is of the slotted series drum type. The brushes are of the laminated spring type. A noticeable feature in the dynamos is the collar connecting the fields coils and encircling the armature. This arrangement effectually prevents all sparking, and its advantages more than counterbalance the slight loss in electrical efficiency which it entails. As the efficiency of the generators is 93 per cent., it will be seen that the effect of the collars is negligible. The dynamos run with great steadiness, and as the rise in temperature of no part of the machine exceeds 25deg. when working continuously on full load, they run absolutely cool. From the generators the current is conducted to the switchboard, which is fitted with the usual measuring instruments, switches, and automatic circuit breaker of the "Cutler" type, mounted on slate panels, of which there are five, two for the dynamos, two for the feeders, and one for the Board of Trade testing instruments and station switches. Three boosters have been included in the equipment of the station. They stand along the wall beside the switchboard, and occupy little space. These machines consist of a four-pole motor connected direct to a four-pole generator in the same bed-plate. The motor is connected to the switchboard 'bus bars, and the speed may be varied to suit the voltage required by means of a resistance inserted in the shunt windings. The generator side of the booster is capable of developing 130 amperes at 200 volts. By means of suitable switches any feeder may be connected to a booster, by which the pressure at the feeding point is automatically kept constant. This allows all the dynamos to be run in parallel at the same voltage, and all the feeders may be of the same size. By means of the boosters the accumulators may be charged independently of the line. The engine-room is provided with a five-ton travelling crane, which is also designed for use in the adjacent car-shed, which has

Digitized by Google

space and pits for 24 cars. The trolley wires are brought into the shed, so that the cars can be conveniently shunted. At one end of the shed is an 8-h.p. Mather and Platt "Manchester" motor, which drives a shaft for operating tools required for repairs, etc. The whole of the station buildings are lighted by incandescent lamps controlled from one central distribution board.

Distributing System.—Current is conveyed from the generating station to the line by four feeders, each consisting of $^{37}/_{14}$ copper cables, lead-covered and armoured, and laid in trenches along the trolley line. The feeders have an insulation resistance of not less than 1,000 megohms per mile. They are taken into cast-iron section boxes, which are placed at intervals of half a mile along the line, and are then connected with the trolley wire through four wedge switches placed in the section boxes. One feeder cable runs direct to the accumulator station situated near the termini at Fleetwood. At this station there are batteries of 250 cells, made by the Chloride Electrical Storage Syndicate, the battery having a capacity of 300 ampere-hours at a voltage of 500. A small switchboard, fitted with recording voltmeter, for measuring the drop in the rails, and with Aron ampere-hour meters, and watt-hour meters to register the charge and discharge of the cells, is provided at the accumulator station, so that the cells may be connected in parallel with the trolley wire, or the feeder may alone be directly connected to the line, or the cells disconnected from the line and coupled direct to the feeder for charging. Usually the batteries will be in parallel with the trolley wire, as their principal function is to steady the voltage on the line and supply sudden demands for current, thus relieving the generating plant from undue strains. Another important use of the accumulator is to provide power independently of the generating station for early morning or night cars, thus allowing the generators to be shut down over longer periods than would otherwise be the case. The batteries at Bispham and Fleetwood will provide sufficient current for 100 car miles, or six return journeys. This use of batteries for traction, which was first introduced by Messrs. Mather and Platt on the Douglas and Laxey electric tramway, is now frequently employed. Mather and Platt have since made use of batteries on the Snaefell Mountain Railway and the Stockholm and Rimbo Electric Railway, and the system has also been adopted at Leeds and Halifax. In all these installations Chloride cells have been used, with results that appear, so far at least, to be very successful.

Overhead Work—Throughout the line a double trolley wire has been erected, one over each track. The trolley wires, which are ·348in. diameter, are supported on standards, to which the wire is attached by means of brass ears insulated from the pole-arms by Etna insulators. In Blackpool side poles with single arms, fitted with ornamental scroll work, are used, except in a few instances where the width of the road necessitated span wire construction. Along the tramroad and in Fleetwood centre poles with double bracket arms are used. On the poles along the tramroad ornamental scroll work is dispensed with, and the standards are of the simplest character. The trolley wires are divided by section insulators at each section box, so that any section may be cut out if necessary.

Rolling-Stock.—The company have at present in stock 12 open cars, 12 closed cars, and three trail cars; and 12 more cars are in course of construction at the new car works at Preston. Each motorcar is 34ft. 5in. long, and is mounted on two bogie trucks with 28in. wheels. There is seating capacity for 48 passengers, and the car weighs when loaded 12 tons. On each bogie is mounted an iron-clad motor of the G.E. 1,000 type, rated to give about 35 h.p. The motor is geared to the axle through a single-reduction cut gear, enclosed in an oil bath, the ratio of reduction being about 4 to 1. The controllers are of the series-parallel type. As there are no outside seats, the trolley pole is of the ordinary swivel type. The cars are well lighted with incandescent lamps.

The undertaking was initiated by Mr. B. Sykes and Mr. T. S. Turnbull, of Manchester, by whom a syndicate was formed. Dr. Edward Hopkinson, of Messrs. Mather and Platt, and Mr. George Flett, of Messrs. Dick, Kerr, and Co., were prominent members, and obtained an Act of Parliament in 1896 incorporating the Blackpool and Fleetwood Tramroad Company. The portion of the line within the borough of Blackpool was constructed by the Corporation and leased by the tramroad company. The remaining length, from the borough boundary to the Fleetwood terminus, was constructed for the company by Messrs. Dick, Kerr, and Co., Limited, of London. Messrs. Mather and Platt, of Salford, Manchester, carried out the electrical equipment of the power station, overhead work, and the rolling-stock. The whole of the work, excepting the electrical equipment, was carried out under Messrs. Garlick and Sykes, the engineers to the company, with Tom G. Lumb as resident engineer. Mr. H. F. Parshall, of London, was the consulting engineer for the electrical equipment, and Mr. McMahon acted as electrical engineer for the company. The work was commenced about the end of July, 1897, and completed in March, 1898. From July 14 to Dec. 31, 1898, the number of car miles was 173,997. From Jan. 1 to June 30, 1899, the number of car miles was 181,568. The number of passengers carried from July 14 to Dec. 31, 1898, was 734,293; from Jan. 1 to June 30, 1899, was 620,897; and from June 30 to Sept. 9 the number carried was 798,956. The secretary and manager is Mr. John Cameron, who has made a name for himself throughout the tramway world, and the fact of the £10 shares having reached £23. 10s. per share gives one an idea of his capabilities as manager. I have to thank him and Mr. McMahon, the electrical engineer, for their courtesy in supplying me with particulars up to date.

REPORT OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION COMMITTEE ON THE PHOTOMETRIC VALUE OF ARC LAMPS.

This committee, composed of Henry L. Doherty, W. E. Goldsborough, and J. Q. Brown, have presented a progress report at the Chicago meeting of the association. Through the good offices of Purdue University, La Fayette, Ind., the committee has been able to take advantage of the excellent laboratory facilities afforded by the school of electrical engineering in that institution, of which Prof. Goldsborough is the director.

In an accompanying report, Prof. C. P. Matthews, who performed the photometric work, gives a detailed description of the methods and devices perfected by him to minimise the errors and uncertainties arising in arc light photometry. The most unique of these is the adoption of two mirrors instead of one to direct the light from the source to the photometer. These mirrors are placed on opposite sides of the arc, and, as a result, the illumination of the photometer disc is rendered fairly uniform. Thus the fluctuations, so troublesome when measurements are made in the usual way with a single mirror, are greatly reduced. The colour difference is also lessened by the use of a rotating sectored disc of very small angular aperture. This diminishes the apparent illumination of both sides of the photometric field to a point where the colour difference ceases to be troublesome. Another device for lessening the labour of the process, and also the retinal fatigue, is the recording drum. This has been already described, but in these tests it has been used with an electromagnetic recorder, which somewhat enhances its usefulness. To test the efficacy of this combination of devices in eliminating errors peculiar both to the source and to the method, readings were made by a number of observers. These measurements show a very satisfactory agreement, demonstrate that the end sought has been accomplished, and that personal and other errors are not greatly in excess of those met with in the photometry of steady and monochromatic sources.

Reference to Fig. 1 will show the disposition of the apparatus as used in these tests. The two mirrors, M M', are mounted at the extremities of iron arms, and are suitably counterbalanced as shown. The arc is fixed in the centre of rotation at *a*, and light is incident upon the photometer disc at *c*, by the two paths

Digitized by Google

shown in dotted lines, direct light from the arc being cut out by a screen not shown in the figure. This plan necessitates a fixed photometer, P, and in order that a variable illumination may be produced to balance that due to the arc, a cord and windlass are arranged, W, permitting the observer to move with facility the secondary standard, S, which is an incandescent lamp. At D is shown a long wooden cylinder, upon which is wrapped the paper to receive the records of the test. These records are made by an electromagnetic device, R, which punctures the paper whenever an electric circuit is closed at the button, B. The observer, seated before the photometer in a closely-screened enclosure, operating with one hand the windlass, and with the other the push-button, is enabled to take settings with relatively great rapidity and accuracy. At a point 200cm. to the right of the photometer disc a reserve standard is mounted on an arm which may be swung into a position in line with the bar. This reserve standard was carefully evaluated once for all in terms of the Hefner lamp. To determine the intensity of the secondary standard, S, it is only necessary to turn the reserve into position, and record a series of readings in the same way as for the arc. This operation is carried out at the end of each test, or more frequently if any change has been made in the temporary standard. Thus it will be seen that, should the lamp under test be found particularly weak at certain angles, the limit of the bar might be reached in the attempt to get a setting. In such case it is necessary to stop down the temporary standard, and to again refer it to the reserve. It may be added that the reserve is never allowed to burn more than a few minutes, and cannot possibly deteriorate under such conditions of use. With this disposition of the mirrors, the angle of incidence at the photometer disc is constant. In Fig. 1 this angle is shown at more than twice its actual value in order to reduce the length of the drawing. The real value of this angle was 5° – 54′. To make a correction for this lack of normal incidence would mean the division of the intensities, as found, by the cosine of 5° – 54′, or ·9947. Failure to do this introduces an error of about one-half of 1 per cent., which is clearly negligible in work of this character. It is, of course, necessary in testing sources with large globes or shades to use mirrors of size such that the globe or shade may be seen in its entirety when the eye is placed at the point C (Fig. 1); and it is further necessary that the distance *a b c* should be large. It is important to note that the double-mirror method, while enormously diminishing the fluctuation due to wandering of the arc, can have no effect on such fluctuations as are due to variations in length of the arc, or to variations in the current.

A preliminary test of much interest is described as follows: "When an opalescent inner globe is used, the globe itself becomes more or less luminous by diffusion. The diffusion differs with the height of the arc in the globe; that is to say, with the length of the lower carbon. To ascertain the magnitude of this effect, I have carried through three tests on the same lamp and inner globe, and also the same carbons, the lower carbons being cut successively to the lengths of 4¾in., 2¾in., and 1¼in. The results appear in Fig. 2. In every case the arc was placed at the centre of the mirror system." An inspection of these results shows that least light is obtained with the arc at the top of the globe, and most light when the arc is at the mid-point. This is explained in part by the fact that, with the arc at the top, a good part of the luminous flux is incident upon the non-reflecting surface of the gas cap. While the second and third positions yield a considerably increased flux of light with a clean globe, they must be considered as impossible conditions in practice, since by the time the arc has descended to these points the globe has received a coating. The net result, then, as the lamp burns is due to an increase in light flux due to the descending arc, and a diminution in light flux due to the formation of a coating. How this affects the quantity of light emitted—*i.e.*, the product of flux and time integrated throughout the life of the carbons—is a subject for future investigation, and involves the questions of carbons, shape of globes, etc. In the tests the initial condition, the simplest to obtain, was chosen, even though the light emitted may be less than at some subsequent period in the life of the carbons.

The first investigation taken up by Prof. Matthews was intended to settle the status of the 110-volt direct-current enclosed arc lamp as found in its commercial form to-day. Reports are made upon eight different lamps of this tyye.

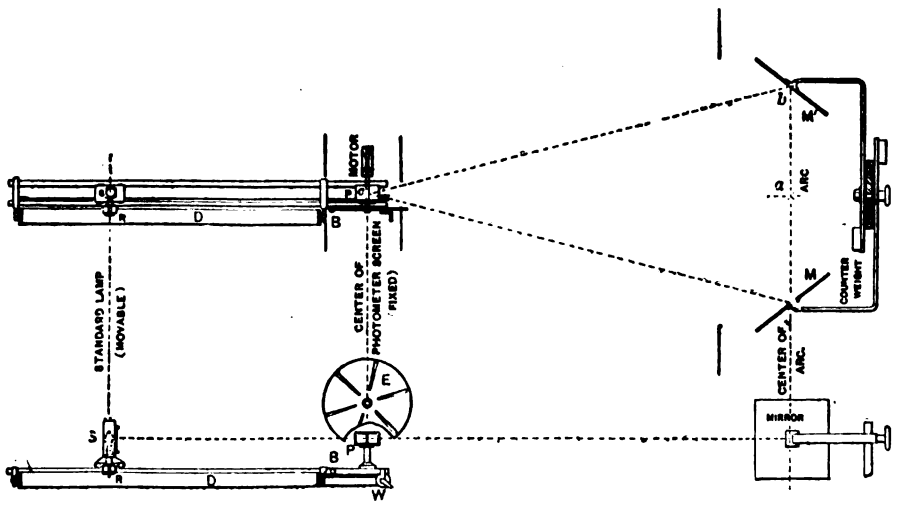


FIG. 1.

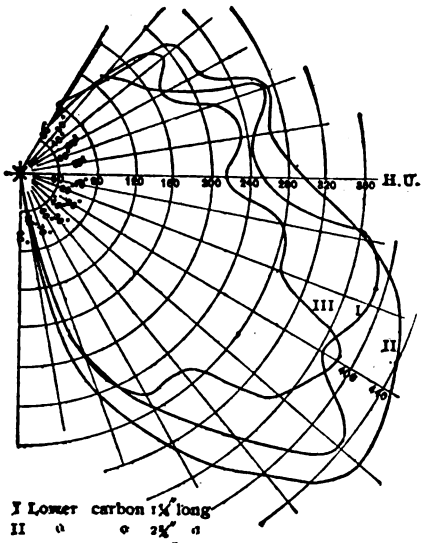
The tests were made upon the lamps as sent by the makers, but with a certain uniformity in conditions. These conditions are: (1) the same brand of carbons throughout; (2) an opalescent or milky inner and a clear outer globe, as supplied; (3) an opalescent inner and an opal ground, or milky outer globe, as supplied. Thus there are two regions where curve II. extends beyond curve I.

Fig. 3 shows the results of a representative test on one of these lamps. The regularity and relative position of these curves are indicative of the accuracy of the methods employed. The curves show very clearly the slight absorption of the clear outer and the large absorption of the opalescent outer. The clear outer globe shows some diffusion, as it tends to round out the curve. In the case of the opalescent outer globe, the diffusion is so marked that the luminous intensity is practically constant throughout a very large solid angle. In the higher angles above the horizontal the intensity is greatly increased, producing the effect, approximately, of a luminous sphere of equal intrinsic brightness. This results in the elimination of shadows, and the production of a pleasing light for interiors. The quality of light is also changed to a considerable extent through the absorption of the excess of violet rays otherwise very marked in the light of the arc. This result is attained, however, at a diminished efficiency. In this and nearly all the curves with the opalescent outer globes, a certain wavy outline is noticed. This effect is due, in large part, to the variations in the diffusive power of the globe itself. One finds difference in thickness and translucency to a considerable extent in such globes, and as the angle

Digitized by Google

of view changes these differences would tend to distort the distribution curve.

At a common terminal E.M.F. of 110 volts, seven of these lamps take an average current of 4 90 amperes, which means an average total power consumption in each lamp of 539 watts. With 80 volts at the arc, this power is divided into 147 watts waste in the resistance coils and 392 watts



I Lower carbon 1¼" long
II " " 2½" "
III " " 4½" "

FIG. 2.

in the arc. The average yield of light, expressed as mean spherical intensity, is:

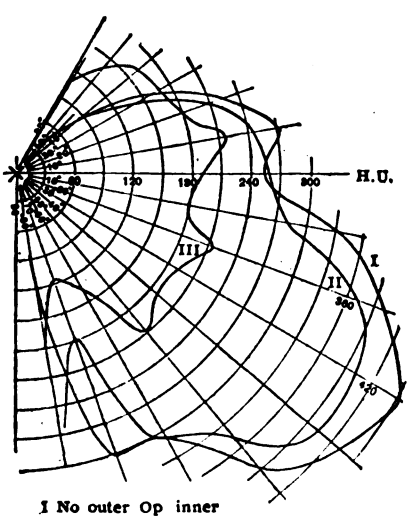
Opalescent inner, no outer*	256 H.U.
Opalescent inner, clear outer	207 H.U.
Opalescent inner, opalescent outer	177 H.U.

* The computations for no outer globe have not the same value as the others, for the reason that the number of such tests was less.

Hence the power required to produce one unit of light in this type of lamp is:

Opalescent inner, no outer	2·10 watts.
Opalescent inner, clear outer	2·66 watts.
Opalescent inner, opalescent outer	3·04 watts.

Attention was called to the fact that these figures give the value of this type of lamp as a light producer, and not



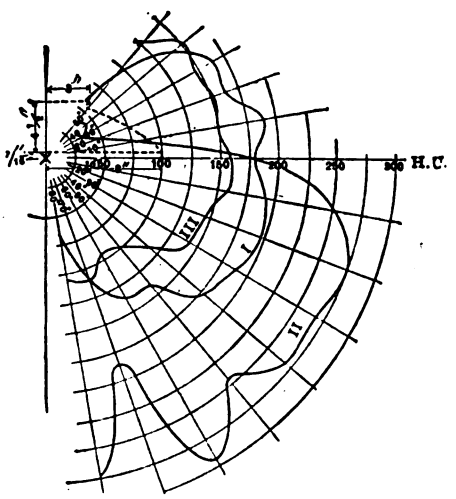
I No outer Op inner
II Clear " " "
III Op. " " "

FIG. 3.

a light distributor. The efficiency of the type as a distributor of light can best be found from a consideration of the curves of illumination—a matter which does not form a part of this investigation.

The second investigation reported deals with the general status of the 110-volt, alternating-current, enclosed arc lamp in its commercial form. Conditions similar to those described in the preceding tests obtained throughout this investigation. Seven lamps were subjected to tests. Of the results, none are more instructive than those obtained on lamp 106 (Fig. 4). The highly beneficial effect of a shade on an alternating-current lamp is here well shown. The large upward lobe of the distribution curve is intercepted and turned into useful directions. It is to be remembered that these distribution curves represent the state of affairs when the lamp is newly trimmed. As the arc burns lower, the upward flux of light is strengthened and the value of the lamp as a light source improves, because the shade then reflects a larger flux of light into useful directions. The shade in this case extends downward to a plane about ½in. above the arc, when the latter is at its highest point. The horizontal intensity with shade is slightly less than with clear outer globe, showing that the latter strengthens this intensity by diffusion more than it reduces by absorption. The increase in intensity from the horizontal to 20deg. B is very marked when the shade is employed in the position here indicated, and these are angles of most importance in street-lighting, if not in interiors. The mean hemispherical intensity is altered by the substitution of the shade for the clear outer globe in the ratio of 254 : 169, or 50 per cent. increase. It is worth noting that the curvature of this shade is admirable for the effect sought. A shade which is concave outwards will divert a portion of the luminous flux upwards, where it is largely dissipated by absorption.

As to the efficiency of this type of lamp, the following table gives a recapitulation of the power measurements on the alternating-current lamps. The mean power consump-



I Op inner Clear outer
II Op. " Shade
III Op. " Op. outer

FIG. 4.

tion of seven lamps is 417 watts. The average value of the mean spherical intensity is:

With clear outer globe	159 H.U.
With opalescent outer globe	130 H.U.

Therefore, as light producers, the average efficiency is:

With clear outer globe	2·62
With opalescent outer globe	3·20

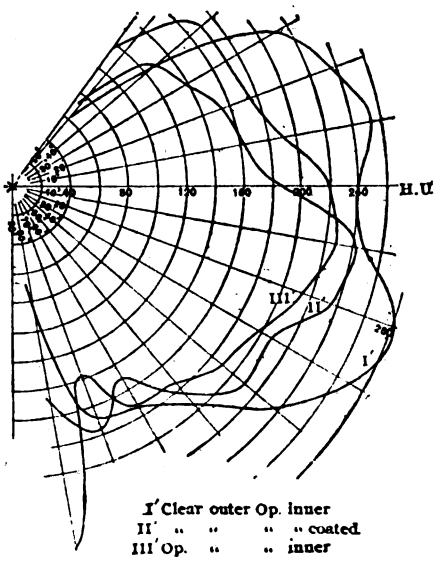
In watts per mean spherical Hefner unit. The mean power in the arc is 342 watts, and in the mechanism 74 watts.

On the Relative Merits of the Direct-Current and Alternating-Current Lamps as Light Sources.—Regarding these lamps merely as light producers, the average direct-current lamp yields, with opalescent inner and a clear outer globe, 207 H.U., whereas the average alternating-current lamp for circuits of the same pressure yields 159 H.U., which gives the former lamp an advantage as a light source, irrespective of efficiency, in the ratio of 48 : 159, or 30 per cent. It is pretty well demonstrated that the alternating arc is *per se* less efficient than the direct-current arc. Just what the proper ratio may be is a matter for physical research, and varies with several factors, such as current density, wave form, etc. Comparing the average performance of the lamps in the first series of tests with the average performance of the lamps in the second series of tests, one finds very nearly the same power consumption per light unit—viz.:

	D.C.	A.C.
Clear outer	2·66	2·62
Opalescent outer	3·04	3·20

Digitized by Google

The difference is slightly in favour of the alternating-current lamp in the first case, and somewhat more in favour of the direct-current lamp in the second. To compare the direct-current lamp with the alternating-current lamp on the basis of mean spherical intensity is not always fair. When an outer diffusing globe is used, this basis of comparison is correct enough, for the reason that the distribution of intensity is fairly constant in all directions both for the direct and alternating current types. For outdoor use,

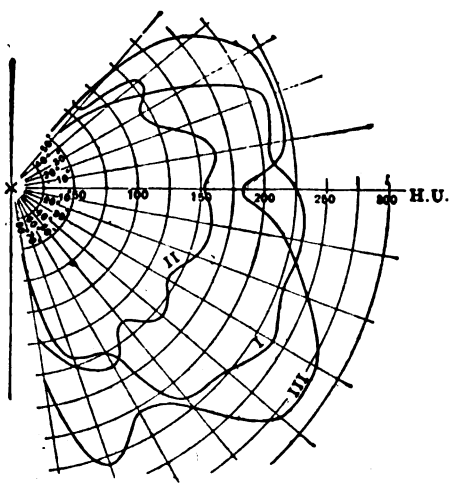


I' Clear outer Op. inner
II' " " " " coated
III' Op. " " inner

FIG. 5.

however, lamps will be provided with inner globes only, or clear outer globes, or shades, as the case may be. In any event the upward luminous flux which passes the globes or shades is practically of no utility. Hence, for outdoor use, the mean hemispherical intensity below a plane passing through the arc is a better basis for comparison.

The average direct-current lamp in this series of tests yields a mean hemispherical intensity of 273 H.U. with clear outer globe. The average alternating-current lamp yields but 190 H.U. This gives the former an advantage



I Op. inner: Clear outer
II Op. " : Op. "
III Op. " coated : Clear outer

FIG. 6.

as a useful light source represented by the ratio of 83 : 190, or 43 7 per cent. Moreover, the power required per unit intensity is in the two cases 1·97 watts and 2·19 watts per mean hemispherical H.U., so that not only does the direct-current lamps with clear outer globes give a stronger mean intensity below the arc, but it does so at a higher efficiency. But it is wasteful to use an alternating current lamp for street-lighting without a shade or reflector. The tests on lamps 102 and 106 enable one to draw certain interesting comparisons. They give mean hemispherical intensities respectively of 266 and 254 H.U., or very nearly the same as the average direct-current lamp with clear outer. This yield is obtained at a power consumption of only 418 watts, which is 1·61 watts per H.U. This emphasises the great importance of a shade on the alternating-current lamp. Finally, comparing this last result with the performance of direct-current lamp 1, with no outer globe and no shade, the mean hemispherical intensity is 362 H.U., the power consumption 558 watts, and the power per H.U. 1·54 watts. The conclusion based on this single comparison is that for street-lighting, the direct-current lamp without shade gives 39 per cent. more useful light than the alternating-current lamp with shade, and at slightly greater economy. The accompanying table gives the summarised results of the preceding investigations:

SUMMARY OF EXPERIMENTS.

No.	Current.	Watts consumed: In lamp.	In arc.	Mechanism.	Mean intensity in H.U.: Spherical: Op. outer	Clear outer	Lower hemispherical: Clear outer	Mean watts per — Spherical H.U.: Op. outer	Clear outer	Lower hemispherical H.U.: Clear outer
1	5 01	551	401	150	172	235	332	3·10	2·37	1·66
						256·	362*		2·18*	1·52*
3	5·08	559	406	152	195	216	282	2·85	2·60	1·99
4	4·76	524	381	143	127	139	208	4·12	3·76	2 52
5	4·16	458	333	125	154	174	221	2·96	2 63	2·07
7	4·76	524	381	143	203	233	317	2 63	2 20	1·65
9	4·84	532	387	145	182	226	281	2 83	2 38	1·89
10	4·99	549	399	150	202	242	309	2·74	2 24	1·77
12	4·87	536	390	146	178	195	230	3 05	2 66	2·33
	4·9	529	384	144	176	207	272	3·03	2 60	1·98
		A	B.							
101	6·40	448 63	340 ·82	108	127	141	206	352	317	2·17
102	6 79	459 ·61	375 73	84	146	203	236	3·31	226	1·94
						176†	266†		260†	1·72†
103	5 89	424 ·65	344 ·75	80	116	130	147	3·66	3 15	2·88
105	6·20	414 61	382 ·80	32	128	187	219	3 21	2·20	1·89
106	6·12	378 56	298 70	80	132	153	169	2·82	2·56	2·23
						152†	254†		2 49†	1·48†
108	6 48	457 64	383 ·80	74 5	133	175	211	3 30	2·61	2·16
110	6·18	339 49	276 72	63	140	126	143	2 41*	2·68	2 37
	6 29	417 ·60	342 76	74·5	130	169	190	3 31	2 66	2·23

* Condition of no outer globe. † Condition with shade on lamp. A. Power factor lamp. B. Power factor arc. Note.—All marked values not included in the mean.

The report concludes with a description of certain preliminary experiments to determine the amount of light absorbed by the coating of ash formed on the inner globe of the enclosed arc, and the time law of its formation. But two representative examples of these measurements are here given. Fig. 5 refers to a direct-current lamp having a large inner globe of the closed-bottom type. Curve I.' shrinks to curve II.' in 106 hours, and the absorption is 16·6 per cent. In Fig. 6, which represents the result of a coating test on an alternating-current lamp, one finds the striking result of more light with coating than without. The absorption is 12 5 per cent. It is important here to remember that, with the arc at the top, the strong upper lobe of the distribution curve of the alternating arc is very much curtailed. Now, as the arc lowers this lobe unfolds, as it were. In 70 hours' time the coating has not formed with sufficient rapidity to offset this increase in luminous flux. Hence the result shown.—*Electrical World.*

Krupp's Works, Essen.—Some idea as to the extent of the electrical installation at Krupp's Works, Essen, where upwards of 27,000 workpeople are employed, may be gathered from a few bare facts. The supply of electricity to the works for lighting and heating purposes is provided for by three generating stations and six distribution sub-stations. Radiating from these are 26 85 km. of underground feeder cables and 90 km. of overhead distributor cables, which supply energy to nearly 900 arc lamps, 6,724 incandescent lamps, and 179 electromotors. That the electric generating plant in its present capacity by no means satisfies the existing demand for light and power is betrayed, however, by the mention in last year's report of the concern of about 19,000,000 cubic feet of gas generated and consumed at the works.

Digitized by Google

BURY ELECTRICITY ACCOUNTS.

From the accounts of the Bury Corporation electric light department, just issued, it appears that the total expenditure on capital account to March 31, 1900, amounts to £40,715. An abstract of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., is given herewith:

REVENUE ACCOUNT.

Expenditure.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Coal and other fuel, including dues, carriage, and expenses of placing same on works	£489	2	4			
Oil, waste, water, and engine-room stores	73	3	1			
Wages at generating station	339	0	0			
				901	5	5
Repairs and Maintenance.						
Buildings	1	8	6			
Engines and boilers	59	3	5			
				60	11	11
Management Expenses.						
Salaries—engineer's department	280	0	0			
Salaries—collector and office staff	72	10	0			
Printing and stationery	21	14	7			
Incidentals	52	2	1			
				426	6	8
Distribution.						
Repairs and maintenance of mains	19	9	6			
Repairs and maintenance of meters	8	7	0			
Private construction	0	12	11			
				28	9	5
Public Lamps.						
Wages	37	16	1			
Carbon, etc.	24	18	5			
				62	14	6
Miscellaneous.						
Rates and taxes	179	2	2			
Bank interest	94	13	3			
				273	15	5
Amount carried down to net revenue account				1,891	19	11
				£3,645	3	3

Cr. Income.	£	s.	d.
Sale of current—Private consumption	3,033	5	0
Public lighting	473	19	10
	3 507	4	10
Rental of meters, etc.	118	8	5
Private construction	19	10	0
	£3,645	3	3

Dr. Liabilities.	£	s.	d.
Loans on mortgage	32,969	0	0
Sundry creditors	3,531	8	10
Cash owing to bank	3,240	2	9
Sinking fund	829	19	11
Debt extinguished	1,426	0	0
Balance, being income beyond expenditure	183	14	8
	£42,179	6	2

Cr. Assets.	£	s.	d.
Amount expended as per capital account	40,714	19	5
Sundry debtors for current supplied to March 31, 1900	1,428	18	0
Stock of stores	35	8	9
	£42,179	6	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			228,546
Quantity sold	Public lamps	45 505	213,395
	By contract	6 421	
	Private consumers by meter	161,469	
Quantity used on works			6,939
Total quantity accounted for			220,334
Quantity not accounted for			8,212
Number of public lamps			31
Total maximum supply demanded (kilowatts)			197

BRISTOL ELECTRICITY WORKS.

The following is the report of the Electrical Committee to the City Council on the working of the electrical department for the year ended March 25, 1900, and shows an expenditure to date on capital account of £252,588. An abstract of the revenue account, balance-sheet, and statement of electricity generated, sold, etc., together with a further reference to the report, and a curve showing the progress of the undertaking, will be given in a future issue.

The number of consumers on March 25, 1900, was 1,215, being an increase of 248 during the year. The number of lamps connected was 85,956 (of 8 c.p.) as compared with 68,536 at the corresponding period of the previous year. During the year a number of motors have been connected with the mains. The use of electricity for motive power in Bristol is in its infancy, and judging by its extensive use for similar purposes in other towns, your committee anticipate a much larger demand when its advantages are better known. The number of units sold was 1,812,511, being an increase of 449,725. An examination of the accounts will show that the financial results of the year have been satisfactory, considering that the effect of the reduction in the charges for private lighting made on Oct. 1, 1898, and for public lighting made on Jan. 1, 1899, has been felt throughout the year, whilst only a part of the previous financial year was affected. The gross receipts amounted to £31,717. 14s. 2d., and the gross expenditure to £17,962. 1s., leaving a gross profit of £13,755. 13s. 2d., from which has to be deducted: interest on loans and bankers' overdraft, £6,019. 15s. 8d., and repayment of money borrowed, £7,590, leaving a balance of £145. 17s. 6d. The following statement exhibits the financial position of the undertaking at March 25, 1900: total capital expenditure, £252,588. 7s. 2d.; mortgage debt, less paid off or set aside, £198,620; balance at credit of reserve fund, £5,000; balance at credit of depreciation account, £2,024. 17s. 7d.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

295. What is the best arrangement and the best machinery to use to run 14 direct-current arcs taking 25 amperes?—A. SMYTH.

296. In a continuous-current circuit, three-wire system, with 120 volts in the mains, which is the best way for supplying power in the daytime at 240 volts without any trouble, with the supply of light in the evening at 120 volts? It is needed that power cannot be used in the evening, nor the light in the daytime.—CIENFUEGOS, CUBA.

[This question wants a little in clearness, but we think readers will fully understand it, and, as it comes from friends across the sea, we trust the replies will enter a little into detail.—ED. *E. E.*]

ANSWERS.

289. What is the best method of determining the counter E.M.F. of electrolytic baths?

Answer to No. 289 *(awarded* 10*s.).*—The difference of pressure, E, between the electrodes of a cell through which a current, C, is passing may be written:

$$E = K + R\,C,$$

where K is a constant (the counter E.M.F. of the bath), and R is the resistance interposed by the electrolyte to the passage of the current. If we put

$$C = 0$$

in this equation, we find that

$$E = K.$$

Thus K, the counter E.M.F. of the bath, is equal to that E.M.F. which will just drive an indefinitely small current through the bath.

The value of K may be measured in a variety of ways:

1. Measure the difference of pressure, E_1, between the electrodes when an observed current, C_1, flows through the cell. Then change the current to C_2, and measure the corre-

Digitized by Google

sponding difference of pressure, E_2. An ordinary voltmeter and ammeter may be used for these measurements. Then

$$E_1 = K + R C_1;$$
$$E_2 = K + R C_2;$$
$$\therefore K = \frac{C_2 E_1 - C_1 E_2}{C_2 - C_1}.$$

2. Measure the difference of pressure between the electrodes when a very small current is passing. (The current, C, must be so small that the product, C R, is negligible. R may be calculated from the dimensions of the cell and the specific resistance of the electrolyte.) This will obviously be equal to the counter E.M.F. of the bath.

3. Connect the electrodes of the bath with a suitable battery and a voltmeter by means of a key in such a manner that on depressing the key the battery circuit is broken, and the voltmeter is connected with its + terminal to the anode and its − terminal to the cathode of the bath. Then the reading of the voltmeter *immediately* after the battery circuit is broken will give the counter E.M.F. of the bath. An electrostatic voltmeter should preferably be used for this experiment.—E. E.

Answer to No. 289 (*awarded* 10*s.*).—The practical resistance of an electrolytic cell consists of two factors: firstly, the ohmic resistance of the electrolyte, and, secondly, the counter E.M.F. generated by the chemical reactions set up by the working current. The total resistance of an electrolytic plant comprises the above factors plus the ohmic resistance of the leads from the battery or from the dynamo-electric generator, whichever may be employed. Several methods may be used to determine the ohmic resistance and also the counter E.M.F.

When the energy is supplied from batteries or from accumulators, the simplest method to determine the counter E.M.F. is to suddenly, by a suitable switch, cut off the source of energy and connect the terminals of the electrolytic cell through an electrometer of high resistance (in the reverse direction to the working current), and compare the deflection with that obtained from a Clark's or other standard cell.

When employing dynamo-electric currents it would, however, not be advisable to adopt this method, owing to the risk of damage to the engine and to the dynamo by the sudden change from full load to no load. In such a case a better method would be as follows: First, run the dynamo at its normal speed with normal output. Allow ample time for the full counter E.M.F. of the electrolytic cells to be attained. Call the E.M.F. at the terminals of the dynamo E and the current C. Next increase the speed (say 10 per cent.), again allowing ample time for the counter E.M.F. of the cells to attain its maximum.

Let a = the increased current at the higher speed;
b = the increased E.M.F. at the higher speed;

then the new readings will be $E + a$ for the E.M.F. and $C + b$ for the current.

Let R = the total resistance of the outer circuit brush to brush;
Y = the metallic resistance of the circuit, and
X = the counter E.M.F.;

then at normal speed we have

$$R = \frac{E}{C} \text{ and } Y = \frac{E - x}{C},$$

and for the increased speed

$$Y = \frac{E + a - x}{C + b}.$$

Whence
$$X = (E - a) - \left(a \frac{C - b}{b} \right)$$
$$= E - \frac{a C}{b};$$

and
$$Y = \frac{a}{b}.$$

For example, at normal speed the readings are E = 5 volts, C = 50 amperes, and at the increased speed $E + a$ = 6 volts, and $C + b$ = 70 amperes, and hence a = 1 volt and b = 20 amperes. Then

$$R = \frac{E}{C} = \frac{5}{50} = 0{\cdot}1 \text{ ohm};$$
$$X = E - \frac{a C}{b} = 5 - \frac{1 \times 50}{20} = 2{\cdot}5 \text{ volts};$$
$$Y = \frac{E + a - X}{C + b} = \frac{5 + 1 - 2{\cdot}5}{50 + 20} = 0{\cdot}05 \text{ ohm}.$$

—W. G.

Answer to No. 289 (*awarded* 7*s.* 6*d.*).—The best method of determining the back E.M.F. or amount of polarisation in electrolytic vats is to fit the vat for the time being with insoluble electrodes, also providing a third thin metal plate so that it can be interposed when required between the anode and cathode, and the nature of this plate must be such as not to sensibly affect the resistance. Now, if E, P, C, R represent E.M.F., polarisation, current, and resistance respectively, then with the two electrodes we have $E_1 = P + C R$. If the third electrode be now interposed so as to completely divide the cell, and the resistance and current is maintained unchanged, then $E_2 = 2P + C R$, or, $P = E_2 - E_1$. In putting the method into practice the main difficulty is encountered in arranging the cell so that the third electrode may be put in or taken out easily, and in such a manner that the current shall pass through it and not round it.

In an actual experiment a rectangular cell of ebonite is provided with platinum electrodes which fit into grooves in the walls of the cell, and between these a third groove receives the third plate, which is placed in such a position so as to prevent undue leakage round the electrode with moderate conductivities and current densities.

About half an hour elapses before the polarisation becomes constant. The following are some results obtained:

Copper Sulphate, 16 *per cent. at* 15*deg. C.*

Current density, in amperes per square dcm.	Polarisation, volts.
·03	1·591
·06	1 628
·12	1 668
·2	1·695
·3	1·717

Silver Nitrate, Normal, 15*deg. C.*

Current density, in amperes per square dcm.	Polarisation, volts.
·015	·888
·03	·897
·06	·903
·12	·908
·2	·926
·4	·935

—J. C. B.

Answer to No. 289 (*awarded* 7*s.* 6*d.*).—The back E.M.F. may be easily calculated, as shown by the following considerations:

Let Q = quantity of electricity passed through an electrolyte (coulombs);
V = back E.M.F. (volts);
z = electro-chemical equivalent of ion deposited (grammes per coulomb);
J = Joule's equivalent of heat
= 42×10^6 ergs;
H = the heat of combination of the ion in question with the other resolved ion.

The work done is = V . Q × 10^7 ergs;
= Q . z . H . J.
$\therefore$ V = z . H . J × 10^{-7} volts.

An example may be useful—say, what is back E.M.F. in water voltameter?

Take from the tables—

$z = 1{\cdot}0384 \times 10^{-5}$ (hydrogen);
H = 3 4 × 10^4 (H and O).

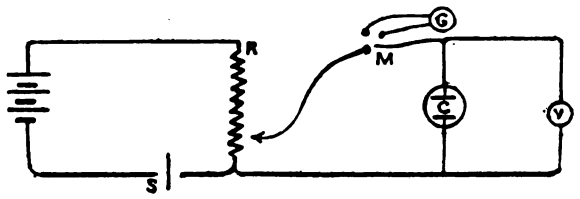
Hence V = z H J × 10^{-7};
= $1{\cdot}0384 \times 3\,4 \times 4{\cdot}2 \times 10^{-5} \times 10^4 \times 10^{-7} \times 10^7$
= 1·48284;

which is the required E.M.F. in volts.

A practical method may be given on this principle: that an applied E.M.F. exactly equal to back E.M.F. of electrolyte would not decompose it. But this would be a

Digitized by Google

laboratory experiment and not suitable for a workshop. There can be no rough-and-ready way of doing this. Fit up apparatus as shown:



C = the electrolytic cell;
V = voltmeter, Weston or Siemens;
G = galvanometer;
M = mercury-cups, and S a switch battery of preferably secondary cells;
R = rheostat.

Pass a current through the cell and decrease it by altering the E.M.F. by means of rheostat until the galvanometer indicates no current or as near to it as possible. Then read volts on voltmeter, which gives back E.M.F.

N.B.—A mean of several observations must be taken, and readings should be taken on both rise and fall of current.—A. S.

Question No. 290.—Give comparative figures as to the weights and efficiencies of two direct-current dynamos of about 200 kw. capacity, running at a speed of about 50 revolutions per minute, the first machine to be a two-pole one and the second a multipolar. Figures from actual machines would be of greatest service.

Best Answer to No. 290 (*awarded* 10*s.*).—Such an output as 200 kw. at 50 revolutions is entirely unsuited to a two-pole

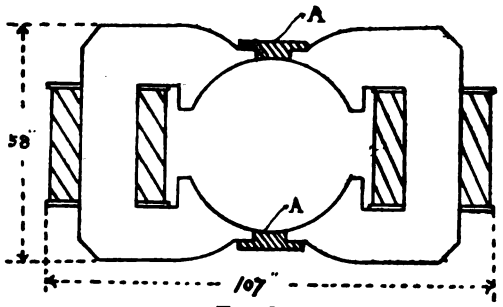


FIG. 1.

design, and it is most unlikely that anything approaching this has ever been actually made, the reason being that a multipolar machine can be made of very much less weight, as will be seen by the comparison given below. This com-

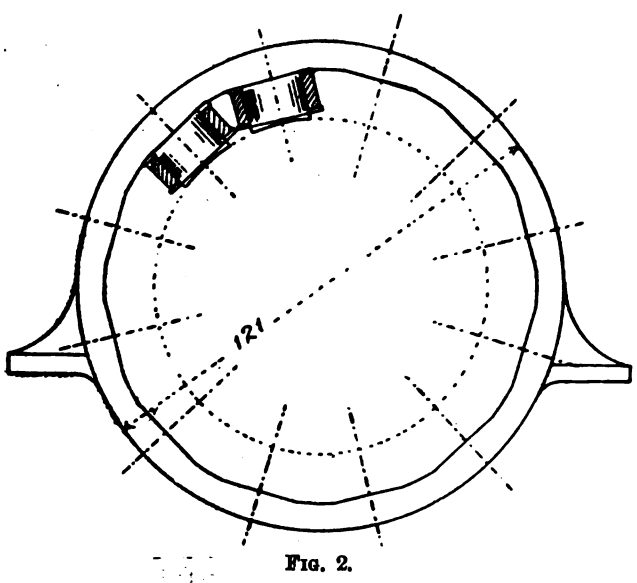


FIG. 2.

parison has been worked out on the basis of equal heating—a temperature rise of about 70deg. F. being allowed. Though the figures are not taken directly from actual machines, the multipolar is only slightly modified from existing machines to suit the output given, and the two-polar is based on machines of such outputs as 200 kw. to 300 kw. at 300 revolutions, which is the largest output for which two-polars are ever used at the present time. To give the two-polar every advantage, the Manchester type of magnet (Fig. 1) has been chosen, as this is not only considerably lighter than the equivalent single-limb magnet type, but also allows the poles to be conveniently split at the centre by a non-magnetic distance-piece (as shown at A, Fig. 1), which has the effect of practically halving the armature reaction, and thus allowing a much smaller air-gap to be used, without fear of sparking, than would otherwise be the case. Further, the two-polar is made with a smooth-cored armature, as a considerable air-gap is in any case necessary to prevent sparking, and may as well be occupied by the conductors. The multipolar is made with an ordinary slotted armature core, as is now almost the universal custom. The number of poles chosen is 12, but if this number is slightly reduced or increased, the effect on the total weight will not be great. The two figures shown are to scale.

COMPARISON.

	Two-polar. Fig. 1.	Multipolar (12 pole). Fig. 2.
Output	200 kw. at 50 revs.	200 kw. at 50 revs.
Diameter of armature core	40in.	80in.
Length of armature core	60in.	15in.
Net weight of armature copper (not including commutator)	40cwt.	15cwt.
Net weight of armature core discs	135cwt.	70cwt.
Armature hub, commutator, and spindle (approximate)	70cwt.	80cwt.
Net weight of magnet (iron or steel)	470cwt.	200cwt.
Net weight of magnet (copper)	105cwt.	35cwt.
Complete weight of machine exclusive of bearings and bedplate	850 cwt.	420 cwt.
Approximate commercial efficiency at full load	87 per cent.	89 per cent.
Approximate commercial efficiency at half load	85 per cent.	86 per cent.

Q.

LIGHT RAILWAYS.

The Light Railway Commissioners have submitted to the Board of Trade an order for the construction of a light railway in the county of Gloucester, between Wotton-under-Edge and Charfield.

The Carnarvon County Council have approved of the application of the North Wales and District Light Railway and Electric Power Syndicate, Limited, for the loan of £5,500 to enable them to construct a light railway from Pwllheli to Morfa Nevin, on condition that the promoters of the railway provide a roadway along the whole of the route of a width of not less than 19ft. 6in. from the end of the sleepers to the foot of the hedge, and also that the top of the sleepers be made level with the surface of the roadway, and that all occupation and public crossings are paved.

At the meeting of the Surrey County Council a resolution to the effect "that a committee be appointed to consider the position this Council should assume with relation to all applications to the Light Railway Commissioners and to Parliament for powers to construct light railways and tramways within the administrative county, and to report to this Council thereon," was considered and lost.

At the last meeting of the Gwyrfai District Council a joint committee of Pwllheli Town Council and the Gwyrfai Council recommended that of the two schemes for the construction of a light railway to Dinas Dinlle, the one submitted by Mr. Peterson, of London, on behalf of a syndicate, should be considered favourable by the two authorities.

The Light Railway Commissioners on Friday last held an enquiry in reference to an application for an order authorising the construction of a light railway from Bury St. Edmunds to Attleborough. The Commissioners having discussed the plans for a few minutes, the President said an order for the construction of the amended scheme, that was to say, a line from Bury to Diss, with a short branch from Stanton to Walsham-le-Willows, would be granted, subject to the approval of the Board of Trade.

An enquiry was held last week by the Light Railway Commissioners into an application by Messrs. H. H. P. Bouverie, A. Peace, and R. A. Read for an order authorising the construction of a light railway between Bridgwater, Cannington, Bolam Bridge, Fiddington, Stowey, and Stogursey. This order was granted.

Digitized by Google

The Oxford County Council have passed a resolution to apply to the Railway Commissioners authorising them to make under certain conditions a grant of £15,000 towards the construction of the Witney, Burford, and Andoversford Light Railway.

In connection with the scheme now before the Light Railway Commissioners for the construction of light railways between Blackburn, Burnley, and Whalley, the Tramways Committee of the Blackburn Corporation have approved a proposal to form a tramway from Furthergate to the borough boundary in Burnley-road. The cost is estimated at £15,000, and the connection would bring practically the whole of East Lancashire into the system.

The Light Railway Commissioners have refused the application of Mr. Henry Brinsley Sheridan, J.P., and Mr. Thomas W. Barber, M.I.C.E., for powers to construct a series of light railways for South Devon.

MANCHESTER ELECTRICITY WORKS.

The following is the report of the Electricity Committee for the year ended March 31, 1900, together with an abstract of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

The total quantity of electricity measured and accounted for during the past 12 months amounted to 6,468,405 units, being an increase of 1,254,184 units, or 24 per cent., over the previous year. The number of consumers at the close of the year was 3,240, representing an increase of 670 as compared with the preceding year. The total number of lamps connected was: incandescent (of 8 c.p.) 237,145, arc 2,139, as compared with 188,999 and 1,817 respectively. There were also in use 500 motors, representing 2,050 h.p., showing an increase on the previous year of 166 motors, equivalent to 890 h.p. The maximum load at any time during the year was 5,607,000 watts. During the past year additional mains have been laid to the extent of 83,250 yards, or 47 miles 530 yards, making the total length laid at March 31, 110 miles 45 yards.

The revenue derived from sales of current, etc. (which works out at 3·20d. per unit accounted for) amounts to		£86,297 18 4
And the working expenditure to		49,905 11 6
Showing a gross profit of		£36,392 6 10
Out of this sum, the following requirements had to be met—viz.:		
Interest on mortgage debt, etc.	£14,264 15 0	
Sinking fund	12,935 0 5	
		27,199 15 5
Showing a surplus or net profit of		£9,192 11 5
This surplus, together with the balance of £2,000 brought from last year's account and £572. 6s. 5d. interest on reserve fund investment, making a total of £11,764. 17s. 10d., has been appropriated in the following manner—viz.:		
Paid to city fund in aid of rates		£10,000 0 0
Placed to reserve fund		1,764 17 10
		£11,764 17 10

The following statement exhibits the financial position of the undertaking at March 31, 1900:

Total capital expenditure		£641,821 18 0
Mortgage debt		556,278 9 0
Amount of mortgages redeemed to date by action of sinking fund		49,232 11 0
Balance at credit of renewals suspense account		335 4 5
Ditto reserve fund		13,360 15 2

Owing to the necessity for renewing a considerable length of mains which had proved defective, the charge upon revenue account for repairs and renewals of mains this year amounts to £7,453. 10s. 6d., as against £1,495. 12s. 6d. last year. In addition to this, the sum of £12,459. 10s. 6d. has been taken from the renewals suspense account to cover similar expenditure. Your committee regret that the accident which happened to the machinery at Dickinson-street station in September last did considerable damage to a portion of the plant installed there. Two 400-h.p. engines and dynamos were completely wrecked; whilst other engines, a switchboard, a range of steam-pipes, and the building were also damaged. The amount withdrawn from the reserve fund on account of the breakdown is £7,069. 18s. 1d. The parts of the two wrecked engines and one horizontal engine have since been sold, and on the space set at liberty two new direct-driven generators, each of 1,000 h.p., will shortly be erected. These machines will be suitable for lighting and tramway work. The work in connection with the foundations and buildings at Bloom-street generating station is proceeding with all dispatch, and the several contractors for the supply of engines, generators, boilers, etc., have the plant in a forward state. Your committee are pushing forward the equipment of this station in order to meet the increasing demand for the supply of electrical energy, and to be ready to supply the current necessary for working the tramcars. At the Polygon, Ardwick, satisfactory progress is being made with the erection of buildings for workshops and cable stores, etc., and it is expected they will be ready for occupation before the end of the present year. Your committee have recently approved of plans for the equipment of a part of Stuart-street generating station, and specifications for the various works will shortly be issued. Very considerable progress has been made during the past year with the laying of electric mains in the districts of Withington, Moss Side, and Levenshulme. The supply of current has been available in portions of Moss Side since December last, and in Withington since February last. On Sept. 30 last the price of electric energy to long-hour consumers was reduced from 1½d. to 1¼d. per unit, and a similar reduction was made in the price of current supplied for motor purposes. The above represents a concession to the consumers of £2,873. 8s. 6d. in six months.

Revenue Account.

Dr.			£ s. d.
Generation of Electricity.			
Coal	£10,375 19 9		
Oil, waste, water, etc.	3,207 14 8		
Sundries	554 14 6		
Wages at generating station	4,126 15 4		
Repairs, maintenance, and renewals of buildings, machinery, etc.	4,308 5 5		
Current used on works and maintenance of lamps, etc.	529 12 0		
			23,103 1 8
Distribution of Electricity.			
Wages	2,225 15 2		
Sundries	939 14 4		
Repairs, maintenance, and renewals	8,928 5 4		
			12,093 14 10
Rents, Rates, and Taxes.			
Chief rents	478 7 11		
Rents of sub-stations and offices in town hall	531 0 5		
Rent of telephones	48 2 6		
Rates	4,813 18 10		
Income tax	692 9 7		
			6,563 19 3
Management Expenses.			
Salaries—Engineer's department	3,369 2 5		
Secretary's department	1,487 1 8		
Stationery, printing, and advertising	862 1 5		
General establishment charges	1,093 5 9		
			6,811 11 3
Law and Parliamentary Charges and Expenses.			
Law and parliamentary charges	107 3 0		
Ditto re transfer of orders from various authorities	318 17 9		
Stamp duty	343 11 11		
			769 12 8
Special Charges.			
Insurances	28 6 6		
Bank commission	74 18 3		
Contributions to thrift fund	121 16 11		
Commission on loans	182 10 6		
Repairs and maintenance of office furniture	11 0 6		
Official clothing	87 16 6		
			506 9 2
Bad debts—amount written off			57 2 8
			49,905 11 6
Balance carried to net revenue account			36,392 6 10
			£86,297 18 4

Cr.	£ s. d.
Sale of current per meter—Manchester	85,372 6 11
Withington	77 17 1
Moss Side	195 12 10
	85,645 16 10
Public lighting—Manchester	364 1 8
Rental of meters—Manchester	184 2 11
Cottage, etc., rental	103 16 11
	£86,297 18 4

General Balance-Sheet.

Dr.	Liabilities.		£ s. d.
Mortgage debt—loans as per capital account			556,278 9 0
Sundry Creditors.			
Interest accrued on mortgage debt	£2,289 9 8		
Deposits held as security for current supplied	2,413 11 10		
Interest accrued on ditto	157 7 5		
Trade accounts owing	30,759 19 7		
	35,620 8 6		
Amount owing to bankers	50,145 10 0		
City fund—street-lighting	157 16 10		
			85,923 15 4
Amount at credit of renewals suspense account			335 4 5
Amount at credit of reserve fund			13,360 15 2
Balance, being surplus—mortgages redeemed by sinking fund			49,232 11 0
			£705,130 14 11

Digitized by Google

Cr. Assets.			£	s.	d.
Amount expended as per capital account			641,821	18	0
Stocks on hand			7,855	15	11
Sundry debtors—accounts due for current supplied	£27,384	10 7			
India 3 per cent. stock (proportion of reserve fund investment)	9,837	2 9			
Other accounts due	2,945	2 1			
	40,166	15 5			
Cashier, cash in hand	25	3 1			
Treasurer, ditto	787	2 1			
			40,979	0	7
Reserve fund investment			13,360	15	2
Law and parliamentary charges—proportion carried forward			1,113	5	3
			£705,130	14	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated, in B.T. units			6,927,396
Quantity sold	Private consumers	6,312,182	6,355,872
	Public lamps	43,690	
Quantity used on works			112,533
Total quantity accounted for			6,468 405
Quantity not accounted for			458,991
Number of public lamps			26

Total maximum supply demanded, 5,607,000 watts, equivalent to 175,219 lamps of 8 c.p.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Halifax.—Tenders for incandescent lamps are required by the Corporation.

Luton.—The Electric Lighting Committee invite tenders for the supply and erection of meters.

Lincoln.—The Town Council invite tenders for wattmeters and demand meters. Tenders by Sept. 14.

Hamburg.—Two 30-ton electric cranes are required. Enquiries may be made at the Town Hall. Tenders by Sept. 10.

Warrington.—Tenders are required by the Corporation for installation of mains and fittings at town hall and market.

Barcelona.—The Public Works Department, Madrid, invite tenders for a system of electric tramways in Barcelona. Tenders by Aug. 18.

Plumstead.—The Vestry invite tenders for the supply and erection of various plant and machinery for electricity works. Tenders by Sept. 15.

Portsmouth.—The Electric Lighting Committee invite tenders for carrying out the street work required for laying cables, etc. Tenders by 15th inst.

Leeds.—The Guardians invite tenders for the installation of electric light to the Poor-Law Offices, East-parade, Leeds. Tenders by 14th inst.

Newport (Mon.).—The Guardians invite tenders for a complete installation of electric light at the new workhouse, Stow-hill, Newport. Tenders by 22nd inst.

Belfast.—The Electricity Committee invite tenders for the supply and erection of an auxiliary feed-water heater with pipe connections. Tenders by Aug. 15.

Stockport.—The Tramways Committee invite tenders for 20 double-deck tramcars, complete with electric equipment for overhead traction. Tenders by Aug. 31.

Bradford.—The Guardians invite tenders for the installation of electric lighting at their union workhouse. Tenders by Aug. 13. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for the erection of a new boiler-house (all trades except ironfounders') at the generating station, Crown Point, Leeds. Tenders by 21st inst.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of lighting cables, tramway feeders, and street lighting. Tenders by Aug. 13. Details in our advertisement columns.

Barnes.—The Urban District Council invite tenders for the supply and erection of pipework, condensers, etc., and overhead travelling crane. Tenders by Aug. 14. Details in our advertisement columns.

Cupar Fife.—Tenders are invited at once for an electric lighting installation at the Fife and Kinross District Lunatic Asylum, about 800 lights. Apply to Mr. D. Osborne, clerk to the Board, Cupar Fife.

Newcastle-on-Tyne.—The Corporation invite tenders for the laying down in Newcastle of about five miles of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. Tenders by Aug. 22.

Edinburgh.—The Lord Provost, Magistrates, and Council are prepared to receive tenders for coal-conveying machinery for Dewar-place station, contract No. 54. Tenders by 13th inst. Details in our advertisement columns.

Aberdeen.—The Corporation Tramways Committee invite tenders for the supply of steel poles, bases, and brackets for extensions of their overhead system of tramways. Tenders by 25th inst. Details in our advertisement columns.

Fulham.—The Vestry invite tenders for wiring the town hall, Walham Green, for the electric light. Tenders by 24th inst. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the following plant: lighting switchboard, traction switchboard, and balancing transformers at their new electricity works, Strawberry-road, Pendleton. Tenders by Sept. 3. Details in our advertisement columns.

Whitby.—The Council invite tenders for the following plant: two water-tube boilers, pumps, condensers, pipes, etc., two steam dynamos, balancer, and boosters, switchboard and connections, battery, travelling crane, and cables, arc lamps, etc. Tenders by Sept. 3. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the supply, delivery, and erection of the whole of the plant and apparatus necessary to completely equip for electric traction their proposed power station at Vivash-road, Fratton-grove, Portsmouth. Tenders by Sept. 4. Details in our advertisement columns.

Grimsby.—The Corporation invite tenders to specification for the supply and delivery, in connection with the electric lighting of the borough, for additional steam dynamos: Section 1, engine; Section 2, dynamo; and extension of switchboard for dynamo No. 7, and traction work. Tenders by 18th inst. Details in our advertisement columns.

St. Petersburg.—The Posts and Telegraphs Department invite tenders for the working of the telephone systems in St. Petersburg, Moscow, Warsaw, Odessa, and Riga for 18 years from Nov. 1, 1901. Tenders by Aug. 28. All necessary particulars may be examined on personal application at the Imperial Russian Financial Agency, 107, Cromwell-road, London, S.W., on Mondays, Wednesdays, and Fridays, from 2 to 4 p.m.

Aberdeen.—The Town Council invite alternative tenders for the supply of 650 tons steel girder straight-track tramway rails, weight about 100lb. per lineal yard; 150 tons steel girder curve-track rails, weight about 104lb. per lineal yard, in standard lengths of 60ft. or 45ft., as may be decided; also for 60 tons fishplates, weight about 75lb. per pair. Tenders by 24th inst. Details in our advertisement columns.

Hanley.—The Electric Lighting Committee invite tenders for the supply, delivery, and erection complete of two Lancashire boilers and fittings, including steam receiver; water-tank, girders, and pumps; fuel economiser, with engine or motor; smoke chimney, exhaust fan, with engine, etc.; feed-water heater; forced-draught fittings, firebars, or other appliances to boiler furnaces; and coal conveyor and bunkers. Tenders by 25th inst.

London, S.E.—The Directors of the South London Electric Supply Corporation, Limited, invite tenders for the supply and erection at their works at Bengeworth-road, Loughborough Junction, S.E., of a complete condensing plant for dealing with 28,000lb. of steam per hour, comprising surface condenser, steam-driven air and circulating pumps, cooling tower, and pipe connections. Tenders by 14th inst. Details in our advertisement columns.

Fenton (Staffs).—Tenders are invited for works in connection with the construction of a single line of railway (2ft. 6in. gauge) from Waterhouses to Hulme End, Staffordshire (about eight miles two furlongs), and incidental works connected therewith, for the Leek and Manifold Valley Light Railway Company. Plans, specifications, bills of quantities, and forms of tender may be inspected at the offices of the company's engineer, Mr. Joseph Forsyth, Heron's Cross, Fenton, Staffs, on and after Aug. 4, and copies of same may be obtained from him. Sealed tenders must be sent to Mr. Edward Challinor, secretary, Leek, by Sept. 1.

London, W.—The Central Electric Supply Company invite tenders for the supply, delivery, and erection of (Specification 2A) dry-back marine boilers, 11ft. 6in. diameter and 14ft. long, gangways, feed and drain pipes, etc., complete, as required for each of three blocks of boilers. Each or all of the blocks can be tendered for, each block containing six boilers. Tenders are also to be submitted for mechanical stokers, with the shafting and gearing for driving them. Alternative tenders are invited for (Specification 2B) water-tube boilers as an alternative to the dry-back marine boilers, including the mountings, feed and drain pipes, etc. Copies of the specifications, with forms of tender, drawings, and general conditions, can be obtained from the General Manager, 19, Carnaby-street, Golden-square, W., on payment of £3. 3s., to be returned on receipt of a bona fide tender. Specifications and drawings can be seen at the office of Prof. Kennedy, 17, Victoria-street, S.W. Tenders, on the prescribed form, endorsed on the outside "Electric Plant—Tender to No. — Specification," must be sent to Mr. F. J. Walker, general manager, before 10 a.m. on Aug. 20.

London, E.C.—Tenders are invited by the Pacific Cable Committee on behalf of her Majesty's Government and the Governments of Canada, New South Wales, Victoria, New Zealand, and Queensland for the manufacture and laying in the Pacific Ocean of 8,272 nautical miles of telegraph cables between Vancouver and Fanning Island, Fanning Island and Fiji, Fiji and Norfolk Island, Norfolk Island and New Zealand, Norfolk Island and Queensland. It is proposed to divide the whole undertaking under three distinct contracts, for any one or more of which contractors may tender. Each of these contracts will include a clause under which the contractor guarantees the good electrical condition and working order of the cables for 30 consecutive days after the completion of the laying. A fourth contract is also proposed for surveying and sounding the whole route before the cables are laid. Forms of contract, specification, and tender may be obtained of Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street,

Digitized by Google

E.C., at whose offices charts showing the proposed route of the cable and the positions where soundings are to be taken may be inspected. The last day for the reception of tenders is Aug. 14. They must be enclosed in sealed covers, marked "Tender for Pacific Cable," must be addressed to Messrs. Clark, Forde, and Taylor, 4, Great Winchester-street, E.C., and must be delivered by 12 noon on that day.

RESULTS OF TENDERS.

Beckenham.—The following tenders have been received for the work of fencing at the electric lighting station: Nightingale, £197. 10s. 6d.; T. W. Jones, £203. 10s.

Barton.—The Guardians have accepted the tenders of the Lancashire Dynamo Company for a switch for the new motor at £11. 15s., and for the new dynamo at £50.

Manchester.—Messrs. W. T. Glover and Co., Limited, of Trafford Park, Manchester, have secured from the Corporation a large order for their diatrine paper cables.

Hapton.—The Parish Council have accepted the tender of Simpson Bros., of Hapton, at £122, for the lighting of Hapton township with electricity from Sept. 1, 1900, to April 30, 1901.

Birkenhead.—The Corporation have accepted the tender of Messrs. Stirling and Hughes, of Bootle, for constructing and erecting a new car shed in connection with the electric tramways in Laird-street, Birkenhead.

Liverpool.—A contract has been entered into with Willans and Robinson, Limited, Rugby, for the supply and delivery of three sets of plant similar to those on order for the Lister-drive and Pumpfields stations, at £6,939 per set, less 2½ per cent.

South Shields.—The Guardians have accepted the following tenders: Falconar, Bell, and Co., for the installation of the electric light at the workhouse, £1,969; W. Christie, for the erection of a dynamo-room, extension of boiler-house, and providing a new boiler, £1,224. 19s. 6d.

Bermondsey.—The Vestry have received the following tenders for the erection of a generating station in Neckinger, Spa-road:

G. E. Todd and Co., 192, Hackney-road, N.E. (accepted)...	£12,723
A. Johnson and Co., 66, Watling-street, E.C.	13,890
Hughes and Stirling, Arundel-street, Strand	14,791

BUSINESS NOTES.

TRACTION.

Sunderland. — A Board of Trade inspection of the new electric tramways in Sunderland was announced for the 9th inst.

Torquay.—The Electric Light Committee have been instructed to report upon the desirability of an electric tram scheme for the extended borough.

Darwen.—A sub-committee consisting of the Chairman, Vice-Chairman, Alderman Cocker, Councillors Cooper and Walmsley has been appointed to deal with tramway matters.

Bath.—From the local Press we gather that the tramway scheme which is on foot has the approval of every local authority interested, and the support of the inhabitants without as well as within the borough.

Southend.—The Town Council have accepted the tender of Messrs. Smith, McMillan, and Co., London and Philadelphia, at the price of £87,500, for carrying out a system of electric tramways for the borough.

Cheshire.—The application of the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, for the consent of the Council to the laying of the proposed tramways in the Cheshire salt district has been referred to the Parliamentary Committee of the County Council.

Norwich.—After a trial of two days the electric tramways of Earlham, Dereham, Thorpe, and Magdalen roads were opened to the public on July 30. During the first day 26,000 passengers were carried, representing an income of £108. During the three first days 73,000 passengers were carried.

Halifax.—The work at the King Cross and Warley-road tramlines is now almost completed. It will be some time, however, before this section is connected with the Highroad Well route, as the roadway which branches from Warley-road into Gibbet-lane, along which the trams will travel, requires widening.

Central London Railway.—The receipts for the first week amount to £4,323. The number of passengers were as follows: Monday, 85,400; Tuesday, 91,900; Wednesday, 86,700; Thursday, 96,100; Friday, 80,700; Saturday, 102,790. On Bank Holiday the line conveyed 100,391 passengers, and on Tuesday 105,171.

Burnley.—Notice is to be served upon the Burnley and District Tramways Company, Limited, requiring them to sell to the Corporation, under the conditions provided by Section 43 of the Tramways Act, 1870, so much of their undertaking, including line, buildings, rolling stock, etc., as are within the borough of Burnley. The Council have secured the services of Major Cardew as consulting engineer.

Automobile Association.—In the Chancery Division on Wednesday Mr. T. R. Warrington, Q.C., moved, before Mr. Justice Kekewich, for the appointment of a receiver in the case of Zacharias *v.* the Automobile Association, Limited. Mr. W. C. Kenshaw, Q.C., appeared for the Company. After some discussion an order was agreed to mutually for the appointment of Mr. Taylor as receiver and manager.—*Financial Times.*

Glasgow.—At a recent meeting of the Corporation Mr. Paton stated that the Tramway Committee were already advertising for contractors for some of the tramway extensions that had been sanctioned. The receipts for the week ended July 28 were £8,511. 13s. 10d., as compared with £8,148. 9s. 9d. for the corresponding week of last year.

London County Council Tramways.—No. 17 of the new lines under consideration by the London County Council (see map p. 170, last issue), at Southwark-street, will be especially useful. As in some parts of Stamford-street the carriageway is not wide enough, it will be necessary to widen the street. This line is 1 mile 2 furlongs 7·7 chains long. The estimate of the construction of the line for electrical traction is £45,000.

St. Helens.—At a recent meeting of the St. Helens Corporation Electric Supply and Tramways Committee the starting places and routes to be taken by the full service of electric cars on the entire system were fixed upon. It was also decided that arrangements be made for through cars from Haydock or Parr to Denton's-green and North-road. The committee accepted an offer from the Gas and Lighting Committee to purchase the buildings and fittings of the disused electricity works in the Warrington Old-road for the sum of £1,800.

Dundee.—The Town Council have received their license from the Board of Trade granting the new electric tramways. Ex-Provost Brownlee, convener of the Tramways Committee, said at the last meeting of the Town Council that the electric system had been a great success, and it had worked exceedingly well. The cost of traction was very low. Horse traction had cost them 6d. per car mile, whereas by electric traction the cost had been reduced to less than 1½d. per car mile. There would also be a great saving in the wear of the causeway blocks, and four of the new cars were doing the work of six of the old ones.

Sheffield.—The Tramways Committee have decided to run the Nether Edge, Abbeydale-road, and Eccleshall-road electric cars to the cross-over at the upper side of Fitzalan-square, and thus do away with the block in High-street. They have also decided that the tramline in Church-street, from St. James's-row to the bottom of Bow-street, shall be doubled as soon as possible. The temporary electric car-shed on Queen's road is now completed, and tramlines have been laid to it. Tenders are to be invited for a permanent tramcar depôt to be erected in Queen's-road. The following is a return of the traffic for the month ended July 29: total takings, £9,938. 11s. 6½d.; number of passengers, 2,564,668.

Longton.—At the last meeting of the Improvement Committee the Town Clerk reported that he had been in communication with the Board of Trade with reference to the dispute between the Corporation and the Potteries Electric Traction Company, Limited, which had been referred to arbitration, and he had suggested that all matters in dispute should be decided at the same time, and had received a reply from the Board of Trade that they considered that it would only complicate matters to extend the reference as suggested, and that the fresh points might be referred to the arbitrator after he has decided the present reference. The Borough Surveyor reported that, in accordance with the requirements of the Council, the British Electric Traction Company, Limited, had delivered at the Corporation yard about 800 tons of surplus paving, etc., excavated in the construction of the tramways in the borough.

Wigan.—The borough engineer's report upon the tramway to Markland Mill Bridge states that the construction of the line between Market-street and Markland Mill Bridge was commenced on the 11th of last month at a point about 100 yards west of the Woodhouse Inn, where the first passing place is fixed. The road has been taken up and the site prepared for the rails for a distance of 140 yards double and 270 yards single track. The rails have been laid and completed for a length of 60 yards double and 50 yards single track, and a further length of 220 yards single track is completed with the exception of bonding; 346 square yards of paving has been laid down. The platelayers are at present practically idle in consequence of having to wait for the repunching of the joint-plates, but a supply is expected from Barrow in the course of a day or two. On the whole, satisfactory progress has been made, considering the difficulties with the sole and fish plates. The Electric Light and Tramways Committee have visited the works of Messrs. Dick, Kerr, and Co., Preston, and inspected the work in progress and cars which have been constructed and finished for various corporations.

Derby.—At the quarterly meeting of the Town Council the Tramways Committee reported that the receipts of the Corporation tramways during the four weeks ended July 21, 1900, were £1,345, an increase of £62 as compared with the corresponding period last year. A scheme had been approved by the committee which made a reduction in the number of hours worked by the tram drivers and conductors, but did not alter their pay. The Council was recommended to grant £160 for the purchase of charabancs and two covers. The committee proposed to adopt electric traction for the whole of the routes, and decided to recommend the Council to take powers for the compulsory acquisition of property, situate in Full-street, bounded on the north by the electric lighting station and Silk Mill-lane, on the south by the public baths, on the east by the mill race, and on the west by Full-street, containing an area of about 6,030 square yards, as a site upon which to erect buildings for the generation of electricity. The Council was further recommended to approve the scheme, and to sanction the insertion of clauses in the next Bill in Parliament for alteration of the existing system, for the proposed extensions, for the scheduling of land proposed to be acquired for street widening, and for generating station. After a short discussion the report was adopted.

Digitized by Google

Dudley.—The Dudley, Sedgley, and Wolverhampton tramway is now practically complete, and will shortly be in full working order. An extraordinary dispute which developed some sensational phases has occurred. In connection with the reconstruction of the local tramways the Dudley Corporation have an agreement with the British Electric Traction Company to take over at valuation in about four years' time the whole of the lines within the borough. The *Midland Counties Express* says: "One clause in the agreement provides that the lines shall be constructed and equipped to the satisfaction of the borough surveyor (Mr. J. Gammage). This agreement has been faithfully carried out with regard to the lines running to Stourbridge, Netherton, and Kingswinford, but in connection with the Sedgley line a serious hitch has occurred. On Saturday it was discovered that instead of laying the cables in earthenware conduits and setting them in pitch, the tramway company's workmen were threading the cables through pipes. Mr. Gammage protested, but the traction company's foreman continued the work in spite of all that could be said. Various official negotiations took place, but still the work proceeded. The upshot was that a gang of Corporation workmen were set to fill up the trench which at Scott's Green the tramway men had excavated. The excitement then became great and rapidly spread. As fast as the tramway men pushed forward their cutting, just as fast the Corporation employés filled it up and battened it down. High words were banded between the two sets of workmen, and threats of a somewhat sanguinary nature were freely indulged in. This continued throughout the evening and into the night. There were on both sides men well known in the town as being very handy with their fists, and a gathering crowd of spectators began to anticipate great doings. Mr. Chief Superintendent Speke, however, took the precaution of drafting to the spot a force of constables. Matters were in no way improved when the tramway company brought carts on the scene to carry away the dirt thrown from the trench, thus taking from the Corporation men the opportunity of refilling the excavation. Our representative called on Mr. Gammage on Sunday to enquire what was the matter. Mr. Gammage briefly explained the situation. Our representative enquired why the matter could not have been left to legal arbitrament, and the surveyor replied that an injunction would be applied for at the earliest possible moment. Meanwhile he had considered it necessary to take other steps."

Blackpool.—A correspondent to our contemporary which rejoices in the short title of *Gazette and News for Blackpool, Fleetwood, Lytham, St. Annes, Poulton, and the Fylde District*, makes some terse and apparently well-deserved remarks with regard to the unsatisfactory working of the trolley arm now in use on the Blackpool cars. He is naturally indignant at having had to spend nearly an hour on a car to get from the Clifton to South Shore, in consequence of the trolley pulley coming off, which had to be replaced no less than 11 times. He considers the present arrangement as quite obsolete, and suggests that Mr. Quin will, no doubt, soon adopt the latest expedient, if he has not already arranged to do so. The letter continues as follows: "There is as much difference between this and the existing primitive and antiquated arrangement as there is between a 'watch and a wheelbarrow' as a chronometer. In order to 'contact' the pulley and wire instantaneously, the fork of the trolley has 'wings' projecting outwards an inch or so, forming with the groove in the pulley a shallow channel to receive and guide the pulley on to the wire the moment it comes under it and is 'let go.' The bamboo imitating boat-hook, now used, is entirely dispensed with, and a thin light rope employed instead. But it has not to be carried up and down the car to be secured out of the way; this is now done automatically. As it is impossible for the trolley pulley to get across, or at right angles to the feed wire, and can be placed in contact the moment it is under the latter, by the car man 'letting go' the end of the rope, when, simultaneously with the contact, the rope is, as just stated, automatically drawn up under the arm, and carried along to the car, the loose end hanging loosely down the side, clear of the passengers and the passing traffic. When the trolley has to be reshipped at the terminus or elsewhere on the journey, the guard simply takes hold of the end of the rope, pulls it down, and by doing so, the simple diminutive 'traveller, as it is designated, which actuates or controls the rope, is drawn up to the end of the arm, close to the trolley, and the pulley of the latter is instantaneously engaged with the conductor wire, as already indicated. The end of the rope is then released, and the 'traveller' immediately gravitates or runs down automatically without friction to a stop-piece or projection on the arm, the end of the rope hanging down, as already stated, ready for the guard to catch hold of it and tranship the trolley again when desired. By adopting this 'wing-trolley' arrangement the traffic would not only be accelerated and the number of journeys augmented, but the profits would also be considerably increased, and the delays and annoyance to passengers reduced accordingly."

LIGHTING AND GENERAL.

Greenock.—The electric light is to be fitted into the dials of the mid-parish clock.

Bangor.—It is expected that the electric light works will be started by the end of this month.

Darlington.—The electric lighting generating station is to be insured for £3,000 for three months.

Dover.—The electric light company intend to extend their main from Castle-street to Victoria-park.

Albury.—The question of electric light will be further discussed at the next meeting of the Parish Council.

Fakenham.—The Parish Council have appointed a committee to report upon an electric lighting scheme.

University College, Liverpool.—The session 1900 1901 commences Oct. 4. Full particulars appear in another column.

Maidenhead.—An enquiry was held on Wednesday into the Council's application for a loan of £25,000 for electric lighting.

Kendal.—We note application is being made for an electric lighting provisional order, and plans, etc., are being prepared.

Stockton.—Extensions of the electric light mains, including the laying of a feeder, at a cost of £1,250, have been agreed to.

St. Albans.—The Board of Guardians have formed a committee to enquire as to the desirability of lighting the workhouse by electricity.

Pwllheli.—The Electricity Committee recently appointed by the Town Council are considering the question of lighting the town by electricity.

Daventry.—The Town Council have decided to renew their application to the Postmaster-General for a post office telephone exchange at Daventry.

Torquay.—The Local Government Board have sanctioned the borrowing of £15,000, repayable in 25 years, for the extension of the electric light works.

Paddington.—It appears that the Vestry disapprove of the step taken by the electric lighting company to enable them to change the voltage from 100 to 200.

Spalding.—The Urban District Council have decided to oppose an application about to be made to the Board of Trade for supplying electric light to Spalding.

Pemberton. — The Electric Lighting Sub-Committee have resolved that plans be lithographed, and that tenders as per plans and specifications be advertised for.

St. George (Hanover-square).—The Vestry have decided to adopt the proposal of the Westminster Electric Supply Corporation in respect to lighting the streets by electricity.

New Branch.—The British Thomson-Houston Company, Limited, have, in addition to the other branch offices, opened a branch at Newcastle-on-Tyne, in the St. Nicholas-chambers, Amen-corner.

Macclesfield.—The Electrical Power Distribution Company intend to apply for a provisional order in the ensuing session for the supply of electrical energy for public and private purposes in the borough.

Explosion.—A number of explosions occurred in the Strand on Saturday, a gas-main and two electric light circuits having become fired. It was only by cutting the connections that the fire was extinguished.

Eccles.—The Town Council are seeking expert advice with a view to the alteration or extension of the existing electric light undertaking so as to supply the probable increased demand during the ensuing winter season.

Leith.—During a recent meeting of the Town Council it was stated that during the last year £404 had been paid for electrical lighting and painting the town hall and another £1,000 towards the electric lighting undertaking.

Electric Cranes.—In order to facilitate landing and embarking mails and baggage on the cross-Channel mail packets, electric cranes are about to be placed on the landing stages at Dover. A great saving of time will thus be effected.

C. V. Lamp Syndicate, Limited.—This Company has been registered with a capital of £14,000 in £1 shares, the object being to manufacture and deal in electric lamps, and to carry on the business of electricians, electric engineers, etc.

Kingston.—The Lighting Committee of the Corporation are urging the Board of Guardians to come to a decision with regard to electrically lighting the workhouse; extensive reports having been prepared, they desire a speedy solution of the question.

A Paris-Berlin Telephone.—The Paris, Frankfort, and Berlin telephone service was opened to the public on Aug. 6. The charge for the use of the wire between Frankfort and Paris is 3s. 4d. and 4s. 10d. between Paris and Berlin for each three minutes.

Hove Electric Lighting Company. — The directors have declared an interim dividend at the rate of 7 per cent. per annum upon the share capital of the Company for the half-year ending June 30 last. The dividend will be paid, as usual, on Oct. 15 next.

Gardner Electric Drill and Hammer Company, Limited. This Company has been registered with a capital of £40,000 in £1 shares, the object being to acquire certain inventions and improvements relating to electric power, rock drills, and electric hammers.

Sevenoaks.—Councillor Marriott has resigned his position as a member of the Electric Lighting Committee, and Councillor Underwood has been elected to take his place, whilst the vacancy occasioned by the resignation of Mr. Ince has been filled by Mr. Crosbie-Hill.

Glasgow.—At Monday's meeting of the Corporation a question as to what progress was being made with the electric lighting of the streets elicited the reply that the delivery of the pillars was being pressed on with, and there was every probability that the streets would be lighted by the time of the exhibition.

Wallsend.—Callender's Cable and Construction Company have made very rapid progress with the erection of the premises required for the distribution of electrical power throughout the important Mid-Tyne township named, and it is probable that the station will be in full working order long before winter.

Digitized by Google

Colne.—A canvass is being made for prospective electric light customers. The Electrical Committee propose to adopt the system of wiring property for electric lighting purposes, if the sanction of the Local Government Board be obtained for the loan.

Burgess Hill.—The Pleasure Grounds, Lighting, and Hackney Carriage Committee have reported to the Urban District Council that at their last meeting a resolution was passed in favour of the instalment of the electric light in the district, and they proposed further considering the subject at a subsequent meeting.

Newcastle-under-Lyme.—A sub-committee has been appointed consisting of the chairman of the Electric Lighting Committee, the Mayor, Aldermen Heath, Mellard, and Briggs, and Councillor Wain to obtain the names and terms of different consulting electrical engineers for an installation of the electric light in the borough.

Salisbury.—It appears that the National Telephone Company have placed without permission a telephone cable in the Market-place. The Council have now decided to inform the company that they could not allow the cable to remain, and have asked them to submit proposals for placing the wires underground before the next meeting.

New Issue.—An issue of fresh capital is being made by the Wycombe Electric Light and Power Company—£5,000 in 1,000 shares of £5 each. The capital, which is needed to meet the expansion of the company's business, is to be issued at a premium of 5s. per share. A dividend of 2½ per cent. was paid on the company's first year of working.

Huntingdon.—The North British Electricity Supply Company intend to apply for a provisional order authorising the company to supply electrical energy for public or private purposes within the area of the borough. The Town Council have decided to consult an engineer with regard to the intended application for an electric lighting provisional order.

Elland —The provisional order for electric lighting for Elland has received the Royal assent, and the chairman of the Council, the chairman of the Electricity Committee, and Councillors Akroyd, Thornton, and Luty have been appointed a sub-committee to enquire for a suitable site for electric lighting and destructor works, and report to the committee.

St. Annes —At the last meeting of the Urban District Council it was reported that sanction had been obtained to erect the works on the new site, north of the gasworks, and that the contractors (Messrs. Moore Bros.) were prepared to carry out the work at the price named for the old site. Messrs. England, Winstanley, and England are engaged to get out the details, etc.

Appointments Vacant.—A working foreman is wanted at once at Sheffield Corporation tramways to take charge of overhead line construction and maintenance. Wages, £2. 10s. per week. Particulars of this vacancy appear in our advertisement columns.—An assistant lecturer and demonstrator is required in the department of electrical engineering at the Croydon Polytechnic.

Stockport —The report of the Gas and Electricity Committee states that the net profit on the past year's working on the electricity department was £118 for the first 16 months. The price of current will be modified by adopting the principle of differential charging, such charge to be at the rate of 5d. per unit for the first hour's daily capacity and 3d. per unit for all current used in excess.

Nantwich.—A letter from Mr. G. R. Peers, of Deansgate, Manchester, electrical engineer, pointing out that as the Council's provisional order to supply electricity to the town had now received the Royal assent this was an opportune time to proceed with the work, and suggesting that he should interview the Council, is before the General Purposes Committee of the Urban District Council.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Babcock and Wilcox, Limited, further issue of 90,000 ordinary shares of £1 each, fully paid, Nos. 440,001 to 530,000, and to allow Edmundson's Electricity Corporation, Limited, further issue of 9,400 ordinary shares of £5 each to be quoted in the official list.

Belfast.—The Council have adopted the minutes of the Electric Committee containing the following resolution: "That a record be made of the committee's appreciation of the able and courteous manner in which Mr. V. A. H. M'Cowen has discharged his duties as chief engineer, which included the designing and establishment of the present electricity works, rendered necessary by the rapid development of the undertaking under his charge."

Personal.—We are informed that Mr. S. H. Short, technical director of the English Electric Manufacturing Company, Limited, who served on both the International Congresses of Electricians at Chicago in 1893 and at Philadelphia in 1884, has been appointed by the Commissioner-General of the Paris Exposition an official delegate of the United States to the International Congress of Electricians which meets at Paris on the 18th of this month.

Barrow.—The concrete for the second boiler foundation is to be carried out now at an estimated cost of £40. A draft of terms and conditions, to be included in an agreement proposed to be entered into with the British Electric Traction Company, Limited, as to the supply of current to the tramways, has been adopted. The electrical engineer has been authorised to prepare specification and obtain quotations for the supply of electric motors for the next 12 months.

Golborne.—At the last monthly meeting of the District Council a communication and formal notice was submitted from the South Lancashire Tramways Company *re* an application proposed to be made to the Local Government Board for a provisional order to supply electricity to local authorities, and the letter asked for an interview. It was resolved that the Council give the representatives of the company an interview on Sept. 6 at five o'clock at the Council offices.

Wrexham.—At the last meeting of the Town Council a letter was read from Mr. Peers, one of the consulting engineers, asking that he might be engaged to prepare a specification for lighting the fire station with electricity, whereupon it was recommended that Mr. Peers be informed that in the opinion of the committee he and his colleague, Mr. Trentham, should submit for adoption by the Depôt Committee and the Council a general specification for the wiring of premises.

London Gazette.—A receiving order has been made out *re* H. Howe, 16, Bold-lane, Derby, on debtor's petition. The first meeting of creditors will be held on Aug. 14 at the official receiver's offices, 44, Full-street, Derby, at 12 noon, and the public examination at Court House, 20, St. Peter's-churchyard, Derby, at 11 a.m. on Sept., 11, 1900.—F. W. Henton, 24, King William-street, Strand, W.C. (G. W. Chapman, Bankruptcy-buildings, Carey-street, W.C.), and L. J. Lawrence, 5, Stafford-street, Old Bond-street, London (G. W. Chapman, Bankruptcy-buildings, Carey-street, W.C.), have been granted their release as trustees.

Publications Received.—We have received from the General Electric Company, Limited, two price-lists for insertion in their big catalogue, one dealing with multipolar motors, and the other with reversible automatic lift controllers and motor-driven starters for presses, rolling-mills, lathes, and tools of all kinds. Also a leaflet dealing with a new curling-iron heater, and other small electrical accessories. From the British Westinghouse Electric and Manufacturing Company, Limited, comes a publication entitled "Polyphase Induction Motors"; while the British Thomson-Houston Company, Limited, sends us a pamphlet describing the magnetic blow-out lightning arresters for direct current of their manufacture. These several publications we hope to accord extended notice in our next issue.

The Telephone as it is in England, A.D. 1900.—The following interesting correspondence has appeared in the *Times*. Mr. James Nelson wrote from the Junior Constitutional Club: "At 12.45 p.m. I called Newport by telephone, giving number, etc., and, after waiting half an hour, rang up asking when I might expect to be put through. I continued doing this until a quarter to three, receiving then the same answer as to every previous enquiry: 'We are asking the Post Office,' but with the addition, 'there are two calls before you!' I then said I did not believe that there could be calls before me as I had been ringing for two hours, and that I should write to the *Times*. This announcement had a surprising result, for in two minutes I was through to my friend at Newport." Mr. W. E. L. Gaine, general manager of the National Telephone Company, wrote from Oxford-court, Cannon-street, on the 8th: "With reference to the letter which appears in the *Times* of to day from Mr. James Nelson, under the above heading, in fairness to the National Telephone Company may I be permitted to say that when messages are sent through the Post Office trunk wires the responsibility for the delays which take place rests entirely with the Post Office and not with the company? Complaints of delays in connection with the trunk wires are received daily from all parts of the country, and are due to the inadequacy in the number of trunk wires to carry the constantly increasing traffic. Unfortunately, the company mostly gets the blame, although it has nothing whatever to do with the matter."

W. T. Henley's Telegraph Works Co.—An extraordinary general meeting of this Company was held at Cannon-street Hotel, E.C., yesterday, when the following resolutions were passed as special resolutions: "(1) That the ordinary share capital of the Company be increased from £150,000 to £200,000 by the creation of 10,000 additional ordinary shares of £5 each, such shares to rank in all respects *pari passu* with the existing ordinary shares, except that dividend shall only be calculated and paid in respect of the amount from time to time paid up thereon; (2) that the Board be and are hereby authorised to offer the said 10,000 new ordinary shares to the holders of the existing ordinary shares, *pro rata*, according to the number of such shares held by them respectively, at such dates, at such price, and on such terms as the Board shall determine, and that the Board be and are hereby authorised to dispose of any of such new ordinary shares which shall not be applied for in accordance with such offer, at such dates, at such price, and on such terms as they shall think most beneficial to the Company; (3) that the preference share capital of the Company be increased from £150,000 to £200,000 by the creation of 10,000 additional preference shares of £5 each, such shares to rank in all respects *pari passu* with the existing preference shares, except that dividend shall only be calculated and paid in respect of the amount from time to time paid up thereon; (4) that the Board be and are hereby authorised to offer the said £10,000 new preference shares to the holders of the existing preference shares, *pro rata*, according to the number of such shares held by them respectively, at such dates, at such price, and on such terms as the Board shall determine, and that the Board be and are hereby authorised to dispose of any of such new preference shares which shall not be applied for in accordance with such offer, at such dates, at such price, and on such terms as they shall think most beneficial to the Company, but it is hereby expressly provided that the Board shall not at any time issue preference shares to an amount exceeding the amount of ordinary shares for the time being issued." Extraordinary general meetings of the preference and ordinary shareholders were afterwards held, when the foregoing resolutions were confirmed.

Digitized by Google

Sutton Coldfield.—A movement is on foot for electrically lighting the borough. The Council are enquiring for sanction to borrow £36,000 for this purpose, together with £600 for street improvements; £26,000 is required for the building of an electric light station, and £10,000 for extensions, if required, to Boldmere, Wylde Green, and Four Oaks. Plans have been submitted giving full details. A large number of applications for electric light are expected, as the gas lighting is bad.

Stafford.—An additional cable is to be laid down on the west side of Gaolgate-street and Market-square from Gaol-square to St. Mary's Churchyard by the Callender Cable and Construction Company, Limited, at 15s. per yard, the total cost being about £300. The committee have decided to increase the salary of the second assistant at the electricity works from £120 to £140, his work having very considerably increased during the 18 months he has been in the service of the Corporation.

St. Pancras.—At the last meeting of the Guardians a report was adopted recommending that the question of providing the main buildings of the workhouse with electric light be postponed; but that the necessary steps be taken for installing the Cook's-terrace Infirmary with electric light, the current to be provided by the electricity department of the Vestry, and the fittings to be obtained and fixed according to a plan and specification already prepared by Mr. Sidney W. Baynes, the chief electrical engineer of the Vestry.

Hampstead.—The Vestry have come to the conclusion that for roads containing many trees arc lamps are not a complete success, but they are now trying the experiment of fitting new electric burners on to some of their present gas standards in the Belsize district. The new lamps are in clusters of three incandescent lights, some of 16-c.p. and others of 32-c.p. So far the result has been most satisfactory; the current is taken from the private supply cables, and the lamps are easily switched on and off by the lamplighters on their rounds.

Bradford.—We gather from the local Press that Messrs. R. W. Blackwell and Co., Limited, of London, who carried out the electrical equipment of the Bradford Corporation tramways to Great Horton and Eccleshill, have addressed a complaint to the Bradford Corporation. They allege that in connection with the extensions now in hand (for which their tender was £13,540), the successful contractors, Messrs. McCartney, Elroy, and Co. (whose tender was £12,064), have been allowed detailed deviations from the specifications, which amount to a saving of £851.

Winchester.—At a recent meeting of the City Council Sanitary Committee, Messrs. Lankester and Son submitted full particulars of their estimate for lighting the pumping station by electricity. The capital of the wiring plant and instruments is estimated at £269. Interest and depreciation, coal, oil, and repairs would amount to £32 per annum. The committee recommended that the tender be accepted, and the work forthwith carried out by Messrs. Lankester, and that application be made to the Local Government Board for sanction to borrow £275, repayable in 20 years.

Salford.—At a recent meeting of the Town Council, Councillor Foden asked if the Lighting Committee had decided upon the method of lighting by means of the new tramway poles, and whether there would be any improvement in the "twinkle, twinkle, little star" light they had in Cross-lane? Councillor Hulton said that the Electric Light Committee were ready to proceed as soon as they could get the current, and as soon as the Tramways Committee had finished their work. It was intended to put an arc lamp on every alternate pole, and the other poles would also be lighted.

Grantham.—The Town Council have adopted the following report with regard to the proposed municipal telephone scheme: "That the powers granted under the telephone license from the Postmaster-General to the borough of Grantham be put in force subject to the Council's consideration of General Webber's detailed reports and estimates, which he is hereby requested to submit; and that these reports and estimates be referred to a committee consisting of Councillors Parker, Coultas, Linnell, and Rowle, with a direction to report to the Council as soon as possible with detailed and definite recommendations."

Shipley.—Colonel Coke has held an enquiry into the application of the District Council for sanction to borrow £22,000 for the purpose of furthering the Council's electric lighting scheme. It was stated that there had been application by various tradesmen and business firms in the town for 2 500 incandescent and 49 arc lamps. One and a half miles of tramway in the Shipley district, owned by the District Council, would be worked by electricity at the expiration of the Bradford Tramway Company's lease in 1903, and Shipley would then supply the current for their own district. Mr. R. C. Quin, the consulting engineer to the Council, estimated that the annual income for the works would be £3,088, and the expenditure, including £1,553 for interest and sinking fund, would be £2,044.

Hull.—The City Council have adopted a report of the Electric Lighting Committee with regard to Messrs. Earle's contract for the two dynamos, stating that Mr. Payne, of Messrs. Payne, Galloway, and Payne, solicitors for the Vulcan Boiler Insurance Company, sureties for Messrs. Earle, suggested that the Corporation should agree to Messrs. Thomas Parker, Limited, supplying the dynamos, but without a spare armature, the Corporation paying for such dynamos the sum of £3,725 (the same amount as would be payable under Earle's contract), and his clients (the sureties) would pay the difference between that sum and the price charged by Messrs. Thomas Parker, Limited, which would amount to between £400 and £500. The committee recommended the Council to sanction this course.

Whitechapel.—The Board of Works have decided to borrow £30,500 on account of £105,170 for the purpose of carrying out a portion of the electric light installation. Another sum of £20,000 is to be borrowed in respect to the same work. Mr. J. Hartis, J.P., the chairman of the Whitechapel District Board of Works, last week opened the new dust destructor, and laid the foundation stone of the new electricity supply station. When completed, these works will have cost the large sum of £105,000. The present installation, which includes over 40 miles of cables, was laid down within 11 months from the time the specifications were drawn up and tenders accepted for the work. The Board is now generating the current for 60 arc street lamps, and making arrangements for 35 more, and is supplying 8,054 8-c.p. lamps to private consumers, while applications for 958 additional lamps have been received. Already over £1,000 has been paid by consumers.

Gloucester.—The accountant of the City Council has laid before the Electrical Supply Committee a statement of accounts, which showed that the amount of the loan already authorised was £43,450, of which £10,000 had been borrowed at 2¾ per cent. The total expenditure amounted to £30 772. 8s. 9d., including £6,141. 1s. on buildings, £7,198. 2s. 9d. machinery, £1,000 accumulators at stations, £12,279. 2s. 7d. mains and laying, £1,072. 13s. 8d. meters, £800. 15s. 6d. electrical instruments, etc., £1,495. 12s. 9d. engineer's commission, etc., £496. 7s. 11d. general expenses, and £285. 12s. 7d. cost of the provisional order. The descriptive pamphlet of the work is estimated to cost £38. The committee have instructed the town clerk to record upon the minutes the fact that the electricity works were formally opened by the Mayor on July 19 in the presence of the members of the Corporation and a large number of citizens, when general satisfaction was expressed with the installation and the public lighting. It has been resolved that the engineer and surveyor be instructed to prepare and submit for consideration at the next meeting a scheme for extending the arc lighting in the principal streets of the city.

Tunbridge Wells.—In view of doing away with the nuisance now caused by the smoke emitted from the shaft at the electric lighting works and the noise and vibration caused by the working of the electrical plant, the Council have decided (1) to at once proceed to erect an additional chimney at an estimated cost of £3,500, and to obtain tenders for the execution of the work, which is to be carried out under the superintendence of Mr. Maxwell, A.M.I.C.E., the borough surveyor; (2) to provide a new flue and economiser (estimated to cost £1 000), which are rendered necessary by the erection of the new chimney; (3) to call upon Messrs. Ferranti to forthwith put the large engine recently supplied by them into good working order according to their contract; (4) to authorise the committee to consult Sir William Preece, if necessary, from time to time during the progress and upon the completion of the works and to obtain a further report or reports from him; (5) to instruct the town clerk to apply to the Local Government Board for sanction to the borrowing of £5,000 to provide for the estimated cost of the works as follows: chimney, £3 500; economisers and flues, £1,000; contingencies, £500—total, £5,000.

Beckenham.—At a recent meeting of the Electric Lighting Committee the Surveyor reported that he had examined the tenders for free wiring sent in at the last meeting of the Council, and after consultation with the electrical engineer and the clerk he brought up a model tender giving average (and identical for each system of wiring) prices agreed to by each of the three lowest tenderers for each kind of wiring specified, and recommended such model tender for acceptance. This proposal, which has been confirmed by the Council, means that all work will be carried out on the same specification and paid for at the same price, and ratepayers will have the choice of three firms in ordering their work. An arrangement with the British Insulated Wire Company for the supply of plain lamps and fittings has also been approved. The Public Works Loan Commissioners have informed the Council that they are unable, for want of funds, to entertain their application for a loan for wiring. The surveyor recently was authorised to invite tenders for fencing the electric lighting station and depot, and has submitted the following tenders received for fencing the electric light works: Mr. Jones, £203. 7s.; Mr. Nightingale, £197. 10s. 6d.

Electric Power Scheme.—A correspondent writes to the *Glasgow Herald*: "Sir William Preece, the eminent electrical engineer, and Messrs. Strain and Robertson, civil engineers, Glasgow, have during the past week been visiting various industrial centres in the West of Scotland in connection with a project for establishing on or near the coalfields great central stations for generating electrical energy on a large and economical scale. The objects of the scheme are to make these central stations of such a size, and to establish them in such situations, as to enable the energy to be generated at the lowest possible cost, and distributed without serious loss to the whole of the district to be supplied. The scheme, which has been under consideration for a considerable time, and has been carefully matured, is a comprehensive one, and includes large districts in the counties of Lanarkshire, Ayrshire, Renfrewshire, Stirlingshire, and Dumbartonshire. The promoters of the scheme propose to supply the electrical energy in bulk for power, traction, and lighting purposes to corporations and county councils, and other large consumers. The agents for the promoters are Messrs. Wright, Johnston, Mackenzie, and Roxburgh, solicitors, Glasgow."

Aldershot.—The Power and Traction Company have asked the Council that their decision might be left over till their offer had been received, as the scheme is a comprehensive one. Edmundson's Electricity Corporation made what was called a sporting

Digitized by Google

offer. They suggested that the Council should arrange the necessary loan for carrying out the works. The company would undertake to carry out the works under the supervision of the Council and at prices to be arranged. Further, the company would undertake to manage the works for seven years, taking all profit or loss that might be made, and guaranteeing to the Council the payment of the amount of the interest and sinking fund which would be due upon their loan. The Council would have the option of taking over the works at the end of the seven years by paying the company a premium of 15 per cent. upon the capital expended, or, if they preferred to do so, to allow the company to continue the management for another seven years, the premium to be paid at the end of that time being 10 per cent. By this method the Council would avoid all risk, and would be free to take over the works at a period when there would be no question as to their satisfactory financial position. No final decision has, however, been arrived at.

Portsmouth.—Mr. Price (the electric light superintendent) has submitted to his committee a report showing the extension of the electric lighting in the borough, and forecasting the demand that would have to be met during the Christmas season of 1901. The *Hampshire Telegraph* says that Mr. Price estimated that the probable demand would be for 53 per cent. of the lamps on at once, making a total of 1,437 kw., or allowing 150 kw. for the arc lamps, a maximum demand for the winter of 1,587. The existing plant gives a total output of 2 086 kw., of which one quarter must be allowed for contingencies, so that the existing plant would be able to meet the demand for the coming winter. Assuming, however, that the same number of lamp connections would be made in 1901, the maximum demand at Christmas, 1901, would be 1,853 kw., allowing for no increase in the arc load, and it was, therefore, said Mr. Price, necessary to increase the plant capacity by 500 kw., which, allowing for spare current, would give 1,939 kw. to meet a demand of 1,853 kw. The committee had received from Messrs. Parsons and Co., of Newcastle, who built the present turbine engine, which has not proved a success, an offer to allow the committee the amount paid for it if they will give an order for Christmas twelvemonth for a 500-kw. machine of the latest pattern. The machine is practically of the same character as the turbines of H.M.S. "Viper," and four of them were seen in operation at the Metropolitan Electric Light Supply works on Tuesday by the Mayor (Mr. H. R. Pink), and the chairman (Alderman G. Ellis), and other members of the committee. The engine is said to be an economical one. It would require no foundations, and would occupy about one-fourth of the space in the engine-house required by the present style of engine. The price would be £5,360. The committee decided to recommend the Council to authorise them to accept this offer and order one of the new turbines for Christmas, 1901.

Rotherham.—This town is in the unique position of developing its gasworks contemporaneously with the inauguration of an electric light station, the latter being also required for traction, in which enterprise the Council intends being up to date. Some two years ago the Corporation obtained an electric lighting provisional order, and shortly afterwards called in Prof. Kennedy to advise. They adopted his report in January, 1899, and appointed him as engineer for the work. Part of the "Phœnix Land" was purchased at a cost of £2,664, and there was expended upon it £305 in roadmaking. Contracts were entered into for boilers, engines, dynamos, batteries, switchboards, cables, etc., amounting in all to £15,138. 1s. 8d., and in March last the Corporation applied for and have since received the sanction of the Local Government Board to borrow £27,969 for the purpose of electric lighting. The electric lighting scheme provides for both private and public (arc) lighting under the three-wire continuous-current system. There will be about 35 public lamps. Provision is also being made for the generating of power for the electrical tramway system at the same station. The buildings of which the foundation stone was laid comprise engine and dynamo house, boiler-house, battery-room, engineers' offices and stores, and workmen's room, together with coal bunkers, chimney stack, and economiser, and the necessary smoke flues, water lodge, etc. Every provision is being made for further extensions. The chimney stack will be 160ft. high, with square panelled base diminishing to an octagon shaft, the top portion will be panelled and finished with a 10ft. deep buff terra-cotta moulded cap, the internal dimension of the stack being 8ft. 9in. The water lodge is of puddle and concrete, and will have a capacity of 220,000 gallons. The site will be enclosed by a boundary wall, and the portion front of the building finished with palisading. On the 1st inst. the Mayor (Councillor G. Gummer, J.P.), laid the foundation stone of the works.

Colchester.—In view of the military premises being lighted electrically by the Town Council, the Electric Light Works Committee at the last meeting of the former presented a report upon the negotiations embodying a letter in which they offered to light the new barracks at 4½d. per unit for the first 50,000 units taken in any year, and 4d. per unit for any quantity over that amount. The committee recommended that the current to be supplied to the new premises should be at a pressure of 210 volts, the recommendation being made on several grounds, the most important being that if the supply be at the higher pressure the cost of the cable will be reduced by 75 per cent. The main which was laid for supplying the hospital would not be sufficient for conveying the electricity required for the new premises, and it would therefore be requisite to lay an additional cable, which the War Department had agreed shall be laid in the most direct possible route across the Abbey Field, and which would be connected to the existing cable so as to form what is called a "ring," or continuous cable. The additional lamps which would probably be lighted are expected to equal 1,200 8-c.p. lamps, and the revenue in any one year, if 50,000 units be consumed, will amount to £937. 10s. The committee, being fully satisfied that the additional revenue which will be derived in respect of the supply to the new premises justifies their proposals, recommend the Council: (1) to enter into an agreement for supplying electricity for lighting throughout (*a*) the military hospital; (*b*) the whole of the Goojerat Barracks, with the double canteen and married quarters; and (*c*) the officers' mess and recreation rooms in the Sobraon Barracks at the following specified charges: for the first 50 000 Board of Trade units taken in any year, 4½d. per unit; for any quantity taken in any year over 50,000 Board of Trade units, 4d. per unit. The agreement to be for a fixed period of seven years. (2) To empower the committee to obtain and lay a new main over the Abbey Field in the position approved by the War Department, the estimated cost of the main being £1,500; the cost of the main to be included in the next application for a loan. (3) To empower the committee to have executed at the military hospital, as required by the War Department, certain works, renewals, repairs, etc., for adapting the installation thereat to receive electricity at a pressure of 210 volts. After a slight discussion the report was adopted.

Parliament.—During the past week, in the House of Lords, the following Bills were read a third time: Plymouth, Stonehouse, and Devonport Tramways, North Metropolitan Electric Power Supply, Southport and Lytham Tramroad, Huddersfield Corporation Tramways, London County Tramways (No. 1), London County Council (Improvement), London County Council (General Powers), and London United Tramways. In the House of Commons the following Bills were read a third time: Manchester Corporation Tramways and Bexhill and Rotherfield Railway. The following Bills have received the Royal assent: London (Clerkenwell and Holborn) Provisional Order, London (Poplar) Provisional Order, Kingscourt, Keady, and Armagh Railway, Manchester Corporation Tramways, London (St. Marylebone) Provisional Order, Walsall Corporation, Liverpool Overhead Railway, St. David's Railway (Abandonment), Costa Rica Railway Company, Limited, Blackpool, St. Annes, and Lytham Tramways, Buenos Ayres and Rosario Railway, Ipswich Corporation Tramways, Salford Corporation, Withington Urban District Council, Sheffield Corporation, Clontarf Urban District Council, Baker-street and Waterloo Railway, Bradford Corporation, Charing Cross and Strand Electricity Supply, City of London (Various Powers), Croydon Tramways and Improvements, Durham (County of) Electric Power Supply, Exeter Corporation, Farnworth Urban District Council, Halifax Corporation, Lancashire Electric Power, Lancaster Corporation, Liverpool Corporation, London County Tramways (No. 2), Newcastle-upon-Tyne Electric Supply, Oldham Corporation, South Lancashire Tramways, West Bromwich Corporation, West Ham Corporation, Margate Corporation, Sunderland Corporation Bournemouth Corporation, Bexhill and Rotherfield Railway, Workington Railways and Docks, London County Council (Improvements), London County Council (General Powers), London United Tramways, Rochdale Corporation, Dublin Corporation, Plymouth, Stonehouse, and Devonport Tramways, North Metropolitan Electric Power Supply, Southport and Lytham Tramroad, Huddersfield Corporation Tramways, London County Tramways (No. 1), Devonport Corporation, Hastings Corporation, Scarborough Corporation, Newry, Keady, and Tynan Light Railway, Christchurch and Bournemouth Tramways, Metropolitan District Railway, Coventry Corporation, Taunton Corporation, South Wales Electrical Power Distribution, Tottenham Urban District Council, Southport Corporation, and Morley Corporation, and the Tramways (Ireland) Amendment Acts. Mr. Seale Hayne's Select Committee of the House of Commons has passed the preamble of the Bill confirming the provisional order granted by the Board of Trade to the Corporation of Batley, authorising the construction of tramways within the borough of Batley to be worked by electricity on the overhead trolley system, and the borrowing of £51,000 for the purposes of the order. The Earl of Camperdown's Select Committee of the House of Lords has passed the preamble of the Bill to confirm, *inter alia*, the provisional orders granted to the vestries of Mile End Old Town, Limehouse, and St. George's-in-the-East enabling them to supply electricity in these districts.

COMPANIES' MEETINGS AND REPORTS.

CENTRAL LONDON RAILWAY.

The tenth ordinary general meeting of this Company was held on Wednesday at the Holborn Restaurant, Sir Henry Oakley presiding.

The **Chairman** congratulated the stockholders on the successful completion of the railway, which was opened on July 30. Up to the present there was every indication that their most sanguine estimates of the utility and popularity of the line with the public would be realised. The Company had spent during the half year a sum of £185,000, which was much less than they had spent in corresponding periods in other years, which was owing to the fact that the works in connection with the stations and the electric plant did not absorb so much money as was expected. As regarded capital expenditure, without committing themselves to a final statement, but having carefully gone into the estimates of the work to be done and paid for, the Board had every reason to believe that the whole undertaking would be completed for the

Digitized by Google

original capital, and unless the business was so extended as to render further large capital expenditure necessary the Board would not require any authority from the shareholders at present to raise new capital. They had commenced to work the line with a five minutes' service, and had established a general fare of 2d. for any distance. He was glad to say that from the time of opening the line had been a great success. The first train that was run was crowded, and they had remained so ever since, the mid-day trains being also very well filled. The total number of passengers carried on the first day that the line was opened was 85,400, on Bank Holiday the number was 100,391, while on the day previous to the meeting the number had grown to 105,171. There was, therefore, absolutely no reason to doubt that the public were pleased with the service.

Lord Rathmore seconded the adoption of the report.

A **Shareholder** said that he regarded the 2d. fare as too small. He thought many people would prefer to a pay a little more and get a seat than to pay 2d. and not get one. He also proposed the division of the fare into smaller ones.

The **Chairman**, in reply, said the Board had not adopted the 2d. fare without the closest investigation of all matters. They had sent twice to America to examine into the working of the average fare system, and decided on that as the most workable on their railway. The 2d. fare had been decided on after considering the average fare of the City and South London Railway, the Liverpool Overhead, the Metropolitan and the District Railways, and the London Road Car Company. The Board were at present quite satisfied with the position of affairs.

The report was adopted.

METROPOLITAN DISTRICT RAILWAY.

On the 2nd inst., under the presidency of Mr. J. S. Forbes, the half-yearly meeting of the joint Company was held at the Westminster Palace Hotel.

The **Chairman** said that the receipts showed a small increase, but in the working expenses there had been a rather considerable increase, so that the profit was diminished, with the consequence that there was a slight diminution in the dividend.

In reply to a question, the following was elicited from Mr. Forbes: It had been proposed to deal with the question of the use of electricity as a separate matter, but he might at once state that the result of the experiment conducted under the direction of Sir John Wolfe Barry and Sir W. H. Preece had been favourable. In view of the heavy expenditure which the introduction of electricity might involve, they had thought it best to consult the best authorities, and working a mile by electric traction they had established the fact that electrical traction could pull a heavier load than the ordinary locomotive, and also that it could pull it quicker. What the directors proposed to do immediately was to extend that mile to Putney, or some other outlying portion of the system, where they could work it themselves without having to consult anyone else. Both the Metropolitan and District Companies were anxious to bring about the great object in view in connection with this question, and that was to make the Inner Circle an electrically-worked railway. They hoped in a short time to receive tenders from people capable of carrying out the work, three objects in view being economy, purity of the atmosphere, and capacity for carrying more weight.

A dividend was declared at the rate of 3⅛ per cent. per annum on the preference stock.

NATIONAL ELECTRIC SUPPLY.

An extraordinary general meeting was held at the Company's offices, Preston, on Monday.

Mr. John Booth presided, and the following resolution was carried: "That the capital of the Company be increased to £184,943 15s. by the creation of 20,000 new shares of £5 each, to be numbered 9,051 to 29,050 inclusive, such shares to be *pari passu* with the preference shares numbered 1 to 9,050, issued or to be issued under or by virtue of the special resolution of the Company passed on Sept. 21, and confirmed on Oct. 7, 1898, and to be preferential (as to the amount paid up thereon) to the ordinary shares both as to payment of dividend and capital, and that such shares or any of them may be issued at any time, or from time to time, at the discretion of the directors, and either at par or at a premium, and that such shares shall not confer any right of voting at a general meeting of the Company."

BRITISH ELECTRIC TRANSFORMER MANUFACTURING.

The second ordinary general meeting was held on Friday last at Faraday House, Charing Cross-road, Mr. R. Stewart Bain presiding.

The **Chairman**, who expressed himself satisfied with the last year's transactions, said the turnover had been £24,043, as compared with £12,614 for 1898-99, which was their first working year. The manufacturing charges had been £13,448, which was equal to about 56 per cent. of the turnover, against 81 per cent. in the preceding year, while the general charges in both years had been, approximately, 10 per cent. of the turnover. After deducting all charges a profit remained of £6,184. The directors had succeeded in obtaining letters patent in Germany for the transformers, which were also covered by letters patent in France, Belgium, Italy, Austria, Switzerland, the United States, New South Wales, South Australia, Western Australia, Queensland, and Tasmania. Their transformers were being exhibited at the Paris Exhibition, which entitled the Company to add an additional six months to the time within which they must work the patent in France. The vendors' shares did not rank for dividend until the subscribed shares had received 10 per cent. for one complete year. As it was now proposed to recommend that a dividend of 10 per cent. should be paid, the 20,000 vendors' shares would rank *pari passu* with the subscribed shares as from the 1st ult. Negotiations were in progress for the purchase of freehold land on which to erect new works, and the Board expected to be able to pay for it and erect and equip the works without increasing the capital.

The report, the payment of a dividend at the rate of 10 per cent. per annum on the subscribed capital, together with a bonus at the rate of 2½ per cent. for the year, and the transfer of £2,500 to reserve fund, were carried.

PAISLEY TRAMWAYS.

The thirtieth ordinary general meeting of the shareholders of the Paisley Tramways Company was held last week at the registered office of the Company.

Mr. J. G. Stewart, who presided, said, compared with last year, the revenue had decreased by £203. 16s. 8½d., while the expenditure had increased by £67. 14s. 1½d. They had been called on by the authorities of Paisley to expend a considerable sum on repairing the lines. That had been done and the accounts were paid, and he was bound to say the lines were in a more satisfactory condition now than they had been in for a long time. When the time came for transference that would tell in their favour, and they would get the money back—at least, he hoped so. In 1902 the Paisley Corporation would no doubt take advantage of the powers conferred on them and take over the system. If they did not, then the Company must work away and do their best for another period.

Mr. J. F. Baird seconded the adoption of the report, which was passed.

CHILI TELEPHONE.

The report of the directors of this Company for the year ended March 31, 1900, states that the aggregate number of subscribers at all centres at the end of the year was 4,613, as compared with 4,486 at the beginning, or a gain of 127 for the year. The gross revenue in Chili from all sources was: in 1899-1900, 651,436dol.; in 1898-1899, 599,994dol.—an increase of 51,442dol. The expenditure in Chili was: in 1899-1900, 364,549dol.; in 1898-1899, 375,230dol.—a decrease of 10,681dol. The net income in Chili from all sources was: in 1899-1900, 286,887dol.; in 1898-1899, 224,764dol.—an increase of 62,123dol. The average rate of exchange for the year was 15·17d., as compared with 14·27d. in the previous year, giving an increase for the year of 0·90d. Converted into sterling at these rates, the figures are: in 1899-1900, £18,130; in 1898-1899, £13,366—an increase of £4,764. The liquid assets and liabilities in Chili on March 31, 1900, were valued at 16½d., the current rate of exchange on that day, as compared with 14½d., at which they were valued on the corresponding date of the previous year. The increase in the value of the liquid assets over liabilities in Chili, due to this rise in exchange, amounts to £1,755, which has been carried to reserve. The balance to the credit of the revenue account, including £448 brought from the previous year, is £12,847, of which £3,044 has been carried to reserve for depreciation and renewals. The directors recommend the payment of a dividend of 4s. per share, free of income tax, being at the rate of 4 per cent. per annum, absorbing £8,800, and leaving a balance of £1,003 to be carried forward. During the year the capital outlay in sterling was £1,798, and the total mileage was: on March 31, 1900, 8,298 miles 990 yards; on March 31, 1899, 8,065 miles 513 yards—an increase of 233 miles 477 yards. In accordance with the articles of association, Mr. George Keith retires from the Board of directors, and, being eligible, offers himself for re-election. The auditor, Mr. Thomas A. Welton, also retires, and offers himself for re-election.

YORK TRAMWAYS.

The report to be submitted to the shareholders at the half-yearly ordinary general meeting at York on Sept. 6 states that the gross receipts for the half-year ended June 30 amounted to £2,148. 18s. 5d., and the working and general expenses to £1,621. 0s. 7d., showing a balance of £527. 7s. 10d., which it is proposed to appropriate as follows: interest on 5 per cent. debenture stock (less income tax), £145; dividend at the rate of 6 per cent. per annum (free of income tax) on share capital, £266. 5s.; balance carried to reserve fund for renewals and contingencies (bringing the fund up to £1,227. 5s. 7d.), £116. 2s. 10d. The number of passengers carried during the half-year has been 847,969. The York City Council has applied to the Board of Trade for power to acquire by purchase so much of the tramways within the city as are authorised by the York Tramway Order, 1879, together with the necessary equipment for working. The directors recommend that the dividend be paid on Sept. 7.

SMITHFIELD MARKETS ELECTRIC.

A circular has been issued by the directors stating that the business of the Company is progressing satisfactorily. Since the commencement of the year the lamps connected have steadily increased, while within the past few weeks 30 new installations

Digitized by Google

have been obtained in the Central Markets. The number of units sold for the half-year amounted to 367,306, against 174,827 for the corresponding six months in 1899. The directors feel justified in hoping that the result of the current year's working will show a substantial improvement upon the previous year, notwithstanding the high price of coal and the probability of still further advances.

PROVISIONAL PATENTS, 1900.

JULY 30.

13636. Combined electric alarm switch and air-brake coupling. William Edward Cocks, 11, Queen's-road, Peckham, London.

13639. An improved electric motor. Arthur George Bloxam, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société Ch. Mildé Fils et Cie., France.)

13643. Improvements in wireless telegraphy. Charles Maréchal, Jules Michel, and Eugène Dervin, 78, Fleet-street, London. (Complete specification.)

13652. Improvements in and in the construction of electrodes. Robert Jacob Gülcher, 322, High Holborn, London.

13656. Improvements in and relating to the electrodes of accumulators and the manufacture thereof. Reginald William James, 1, Queen Victoria-street, London. (Jean Jacques Heilmann, France.)

13661. Improvements in tramcars, railway cars, or locomotives, and the like driven by electric or other motors. William Robert Renshaw, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on August 25.

1899.

16055. Electric switches. Jones.

16824. Apparatus for electro-chemical and electro-thermic melting operations, especially for the production of calcium carbide. Grauer.

19856. Magnetic separators. Clark. (Courtney.)

24514. Electricity meters. Boult. (Saldana.)

1900.

2702. Electromagnetic brake dynamometer. Rieter.

5257. Apparatus for winding or producing coils, bobbins, helices, or the like for electrical and other purposes. Heys. (Scott Varley and Anderson.)

8671. Construction of electric switch Schulz.

8880. Means for recording the number and duration of telephonic conversations. Eichwede.

9836. Conduits of electric railways. Larkin.

9879. Electric incandescent lamps. Krayn.

10181. Means for electrically generating steam. Griffing.

10357. Electrical apparatus for surgical and other purposes. Hynes and Randall.

10579. Electrically-controlled apparatus for shifting and locking railway points and signals. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

12016. Electrically-propelled motor road vehicles. Ryan.

12111. Electrical jacquards and dobbies. Szczepanik and Kleinberg.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Aug. 4	781	727	+ 54	6,933	6,113
Birmingham Tramways Co.	,, 4	4,571	4,544	+ 27	133,437	126,083 *c*
Blackburn Corp'rat'n	July 28	456	488	+ 31	11,478	13,084
Blackpool Corporatn.	Aug. 2	1,134	921	+ 213	12,712	9,791
Blackpool-Fleetwood	,, 4	1,290	1,359	- 69	5,883	5,873
Bradford City Trams	July 29	592	418	+ 174	8,543	6,743
Bristol Tramways Co.	Aug. 3	3,451	3,660	- 209	—	—
City & South London	,, 5	1,541	933	+ 608	7,446	4,654
Cork E. T. and L. Co.	,, 2	525	519	+ 6	12,140	10,918 *c*
Dover Tramways ...	,, 4	275	272	+ 3	5,839	5,485
Dublin U.T., elec. cars	,, 3	3,923	1,265	+2,658	—	—
Dublin S.D. Electric	,, 3	1,045	1,155	- 110	—	—
Halifax Corporation	,, 5	872	667	+ 205	13,945	10,561
Hull Corporat'n E.S.	July 28	1,360	520	+ 840	20,502*a*	2,208*d*
Liverpool Corporat'n	,, 28*b*	9,054	7,651	+1,403	223,780	196,624
Liverpool Overhead	Aug. 5	1,635	1,654	- 19	8,499*c*	7,993
Sheffield Corporation	,, 5	2,471	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *d* Since July 5.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-¾
British Insulated Wire, Ord., 1-40,000	5	—	11½-12½ xd
—— 6 per cent. Cum. Pref., 1-27,500	5	..	5½ 6½
—— 5 per cent. Mortgage Debentures	100	—	96½-100½
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-¾
—— 6 per cent. Cum. Pref., 1-50,000	1	—	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2⅛ 2⅜
—— 4½ per cent. Debenture Stock	100	..	108-113
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	13-14
—— 5 per cent. Pref.	5	—	5½-5¾
Crompton and Co.	3	—	3¾ 4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	2-2½
—— 5 per cent. Debentures	5	—	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	—	91-93
—— 5 per cent. Second Deb. Stk., Prov. Crts. 70 p.ct. pd.	—	..	68 72
Electric Construction	2	—	1¾ 2⅛ xd
—— 7 per cent. Cumulative Pref.	2	—	2¾ 3⅛ xd
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5½-5¾
—— 4½ per cent. Debentures	100	—	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-23
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	85-90 xd
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-5¾
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6-6½
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	6½-7½
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	—	11½-12½ xd
—— 5 per cent. Debenture Stock	100	—	123-128
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	10-10½
London Electric, Ordinary	3	..	1-1½
—— 6 per cent. Pref.	5	—	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-100
Metropolitan, Ordinary	10	—	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1¼-1⅜
—— £5 Shares	5	—	7¼-7⅝
—— £4½ Shares, New	4½	—	6¼-6⅝
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	76-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	95-96 xd
South London, Ordinary	3	..	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15 xd
—— 7 per cent. Pref.	5	..	8-9 xd
Westminster, Ordinary	5	—	12 13
—— 80,001-109,437	2½	..	9-9½
Electric Railways.—			
Central London, Ordinary	10	—	10½-10¾
—— Pref. Half-Shares	5	..	5 5½
—— ,, ,, deferred	5	..	5-5½
City and South London, Consolidated Ordinary	100	—	56-59
—— Ordinary	10	—	6-7
—— 4 per cent. Debenture Stock	100	—	120-125
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	13½-13¾
Waterloo and City, Ordinary	100	—	90 95
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	17-18
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary	10	..	14-15
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	123-126
—— ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	4¼-5
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	103-106
Isle of Man Electric Power, 1-95,000	1	..	1/16-⅛
—— 6 per cent. Preference, 100,001-170,000	1	—	1/16-⅛
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. Pref.	5	—	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— 5 per cent. Cum. Pref.	10	..	10¾-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
Telephones.—			
National Telephone, Ordinary	5	—	4¾-5 xd
—— 6 per cent. Cum. First Pref.	10	—	13-14 xd
—— 6 per cent. Cum. Second Pref.	10	—	13-14 xd
—— 5 per cent. Non. Cum. Third Pref.	5	—	4¾-5¼ xd
—— 3½ per cent. Deb. Stock, Red.	100	—	97-100
Oriental Telephone and Electric Company	1	—	¾-1

Digitized by Google

NOTES.

The New German Cable.—According to Reuter, the shore end of the new German Transatlantic cable was laid on the 11th inst. from Coney Island. The cable-ship "Anglia" will continue laying the cable as far as the Azores.

Parisian Tramways.—We learn that a concession has been granted to the Compagnie des Tramways Mecaniques to construct five new lines from the suburbs of Paris into the town. The tramways are to be operated by three-phase current at high tension. The general application of electric traction on the Paris tramways should greatly develop the traffic, and is expected to greatly reduce the cost of running.

A New Application.—The uses to which electrical energy is put are multiplying rapidly as the economy and convenience of its transmission become better established. As in many other places where great works, etc., are in course of construction, electricity seems to be playing an important part in connection with the National Harbour at Dover. We note that electrically-driven concrete mixers are now employed for making the 40-ton foundation blocks used in the deep-sea work.

Storage Batteries.—At the meeting of the North-Western Electrical Association, Mr. Ferguson read a paper on "Storage Batteries for Small Stations." Among other things, he stated that a storage battery operated under favourable conditions would show upon test an energy efficiency of 75 per cent. and an ampere-hour efficiency of 90 per cent. The yearly energy efficiency of a storage battery operated under ordinary central-station conditions would, in all probability, not exceed 65 per cent.

Electric Brakes.—A State Railroad Commission in America has been reporting upon the comparative value of brakes, and it had under trial 25 varieties. Their conclusion upon the whole matter is that the electric brake stood first in the tests, the friction brake next, a hand-power brake third, and air brakes fourth. They suggest that, except in special cases where the liability to accident is very remote, the ordinary hand brakes now generally used should be replaced by a better system.

Budapest.—A short length of railway track has been put down and equipped for electric traction near Budapest by Messrs. Ganz and Co. The line is to serve for experimental purposes in connection with the introduction of electric traction for main-line work into Northern Italy which has been entrusted to the above firm, as previously noted in these columns. The current for working the line is transmitted at a pressure of 20,000 volts in the primary leads, and subsequently transformed down to 3,000 volts in the secondary.

Voltage.—The constantly-recurring question of voltage is not likely to receive a definite answer within a short period of time. A good many engineers hold the view that a very much higher voltage should be permissible everywhere, and argue that if this was so, the chapter of accidents would probably be short. There is much to be said from this point of view, in that everyone would then strive at all hazards to keep from all possible contact, and jerry-made apparatus would soon become a thing of the past, in that it would be unsafe.

Vienna-London Telegraphic Facilities.—Though the Vienna Chamber of Commerce have petitioned for better telegraphic facilities between that town and London, the authorities concerned seem to consider the existing facilities quite sufficient. The difficulties experienced lately in transmitting messages between the two capitals are not denied, but, at the same time, an alternative route is pointed out which would appear to have been left out of consideration—namely, that *vid* Zurich and Paris—to which will be soon added the Cologne-Emden connection.

Coherers.—In a paper read before the Physical Society of Frankfort-on-the-Maine, Herr Schafer described a "coherer" designed for use in connection with wireless telegraphy. The coherer is made by pasting strips of tinfoil on a glass plate. If the glass be silvered, it will answer the purpose equally well provided the silvering be divided into strips by a knife. A current of electricity across the metallic strips gave an electric resistance of 50, but when the electric waves impinged on them the resistance was increased a hundredfold. The coherer works in a vacuum.

The Wannsee Railway.—The adaptability of electricity for main-line working is receiving a practical test in Germany. The latest example of the application of electricity for this purpose is to be found in the Wannsee Railway between Berlin and Zehlendorf, which has been equipped for electric traction by Messrs. Siemens and Halske, the new service of trains having been recently inaugurated. For the present there will be only six electrically-propelled trains on the system, the service of steam-driven trains formerly employed being retained. A mixed system of working must, therefore, be in operation, particulars of which are promised by the *Elektrotechnische Zeitschrift* for an early date.

Electricity and the Textile Industry.—The great advantages attending the separate driving of looms are becoming more and more recognised in Austria, where many large mills have already been equipped with electrical generating and motor plant. One of the latest installations of the kind is that which Messrs. Herm. Schuk and Co. have put down in their new silk-weaving mills at Rovereto, South Tyrol, where a polyphase plant has been installed for driving, at present, 400 looms. The separate driving of velvet-weaving looms by means of electric motors is also stated to have been found completely satisfactory after severe practical tests, notwithstanding the difficulties presented.

Polyphase Work.—The well-known firm, Messrs. Lahmeyer and Co., of Frankfort-on-the-Maine, have just completed an interesting polyphase transmission scheme in Sinaia, the summer seat of the King of Roumania. The prime power for driving the generators is furnished by the water of the River Prahova. One of the principal objects of the installation is to provide the industrial quarters of the Prahova Valley with cheap energy, which will be transmitted distances up to 45 km. from the generating source. A large demand for current has arisen in the extensive petroleum fields in the neighbourhood. The primary polyphase current is transmitted to the various centres of distribution at a tension of 11,000 volts.

A Useful Directory.—We have received a copy of the "Universal Directory of Railway Officials" for 1900 from the Directory Publishing Company, Limited, 8, Catherine-street, Strand, W.C. The volume, which is now in its sixth year of publication, has been carefully revised and brought up to date. Practically all the tramways worked by mechanical means in the United Kingdom are now included, which feature should render the directory of considerable use to the electrical industry. Some difficulty, we understand, has been found in obtaining accurate information relative to the railways of the Transvaal and the Orange River Colony owing to the war in South Africa, but that detracts but little from the general usefulness of the directory.

Digitized by Google

Utilising the Waves.—An ingenious substitute for the old bell and gas buoys that mark the dangerous parts of our coasts is reported to have been subjected to severe tests by the Trinity House authorities with satisfactory results. The new type of buoy is said to be similar in appearance to the old, but, instead of relying upon oil or gas for its illuminating power, is equipped internally with a small electrical generating plant, which is driven by a piston actuated by the movement of the waves, being automatic in action, however slight this motion. The electricity generated supplies a powerful flashing or fixed light, as required, or works an apparatus for sounding blasts on a syren. This seems all very nice, but we should like to examine the apparatus ourselves before venturing to express an opinion upon its practical value.

Italian Railways and Electric Traction.—The commission deputed by the Italian Government to study the problem of the application of electricity to the railways, has reported that it is unable to give a decision on the subject until after a trial of four systems. These are: first, electric traction with accumulator vehicles with the Planté type of plates; secondly, vehicles with the Pescetto type of accumulator; thirdly, with overhead wires and high-tension three-phase current; and, lastly, the third-rail system with continuous current. The first system has already been tried on the Milan-to-Monza line, the second will next be tried on the line from Bologna to San Felice, the third will be experimented with on the Lecco-to-Colino line, and the fourth on the Milan-to-Port Ceresio. In this way the commission hopes to obtain a fair idea of the relative merits of each system, and to give a just decision as to the best.

The Rontgen Society.—From the third annual report of the Röntgen Society it appears there has been a very satisfactory increase to the membership of the society during the year. An addition of 62 new ordinary members, many of them residing in distant parts of the British Islands, and not a few in the Colonies, is sufficient evidence of appreciation of the society's work, and more especially of the value of its published *Transactions* in the *Archives*, as the report points out. The council has recently arranged that the *Archives* shall in future be issued bi-monthly during the session of the society in January, March, May, and July, so that members shall be in possession of papers read at the meetings without unnecessary delay. It may also be mentioned that Dr. J. B. Macintyre, of Glasgow, one of the earliest and most prominent of practical X-ray workers, has been nominated as the next president of the society.

Automatic Fire-Alarms. — We learn from the *Practical Engineer* that the latest invention in fire-alarms comes from New Zealand, and is known as May's automatic fire annunciator. It is an adaptation of the sagging wire principle, and the action of the apparatus is very simple, it allowing also for a separate detector to be placed in any room which it is desired to protect. Contact is made by means of a wire which, if heated, rings an electric bell, and at the same time operates an indicator which shows in which room the fire has occurred. A telegraph transmitter at the same time warns the nearest fire station. No doubt the machine would be very valuable in case of a serious fire, but it appears to us that a very slight provocation, such as the burning of a curtain or other hanging in a room, might summon the fire brigade on an utterly useless errand. There would, we think, probably be more trouble from this cause than there would be saving effected.

Franco-German Telephones.—We note that communication has now been established between Berlin and Paris by means of a telephone. The telephone line goes from Paris to Frankfort, which is, of course, connected in this way with Berlin, giving a through service, extending over some 600 miles, between Paris and Berlin. Although the distance between the two towns is so very great a voice speaking in Paris is said to be heard distinctly at Berlin. The connection seems to point to a much more amicable feeling growing between the two countries interested, and if anything is done by means of this intercommunication to forward this feeling, a great deal of good will have resulted. On the question of the price to be paid for conversations on this line, it seems rather difficult to see why the cost of telephony from London to Paris should be over one-third as much as between Berlin and Paris, as the cost of the cross-Channel cable could hardly account for it.

Train-Lighting.—In a paper on "Train-Lighting," by Mr. A. Lipschutz, is the following paragraph, which should be of some interest: "In order to arrive at the true cost of a candle-power per hour for any train light, it becomes necessary first to allow for the proper depreciation of the capital invested in stationary plants and train equipment; then to consider the expense for operating same, and, finally, to provide for renewals and repairs. As all lamps in electric train-lighting have to be renewed several times in one year, and renewals of burners in gas lighting are also necessary, these expenses must appear in a comparative statement of cost. In fact, no item should arbitrarily be considered too insignificant to enter into the estimate of cost, as it might often materially change the final figure. To light a modern train electrically requires, roughly speaking, about 30 h.p., and yet a company manufacturing apparatus for train-lighting states in its circular that the cost for power is so small as to deserve no consideration."

Trolley Lubricator.—Since the Helios Company, of Cologne, opened the traction department of their huge establishment a few years back they have shown themselves very much alive to the requirements of this branch of the electrical industry. One of the latest improvements introduced by them is an ingenious device for lubricating the trolley wire of an overhead system of conductors. It is sufficiently obvious that an effective lubrication of this sort would greatly lessen the wear both of the wire and of the bow or roller collector employed, hence the device in question may find extensive adoption. But that, of course, depends upon the efficiency of the new apparatus, since many unsuccessful attempts have already been made to attain the same end. The latest attempt certainly gives great promise of success, for we understand the apparatus evolved after careful experiment enables a thin and uniform coating of the lubricant to be spread along the wire. It is of light construction, being of aluminium, and may be carried by the collector arm or independently.

Rail Joints.—The *Scientific American* calls attention to the large share which the present imperfect form of rail joint contributes to the general din of street and railway travel. In this country, where street railways are not so extensively adopted as in America, we have less occasion to look upon the disadvantages of an imperfect rail joint from the same point of view, but the necessity for improvement on other scores is not lost sight of. We agree with our contemporary in the contention that theoretically the perfect remedy is to be found in abolishing joints altogether, and welding the rail ends. Several methods of doing this have already been practically tested, with more or less successful results. The latest system of rail welding, to which we referred at some length in our issue of the 27th ult., emanates from Germany, and accomplishes the end in question by the process of obtaining high temperatures

Digitized by Google

with the aid of aluminium, discovered by Dr. Goldschmidt, of Essen. This system, a description of which was given, has been adopted in several German towns with reported good results.

The Sounder Preferred.—In an editorial, our contemporary the *Electrical World* of New York dilates upon the relative merits of the sounder and telephone for central-station purposes. In many central stations, telephones are employed not only between the various offices of the staff, but also between the main station and substations, or between different departments of the main station itself. It seems that in a few instances these telephones have been replaced by sounders in the States, whereby the station operators signal to each other through the medium of the Morse code. The inherent disadvantages of the telephone in its application to central-station work are stated to be entirely absent in the sounder, which takes a positive delight in outsounding the loudest engines, to use the words of our contemporary, and its gleeful click can be heard by the operator with ease if his ear is close to the instrument. Having regard to the latter fact, and to the many other defects of the telephone avoided, preference is given to the sounder, notwithstanding that a trained ear is required to decipher its messages.

The Battle of the Systems.—Our contemporary the *Electrical World and Engineer* of New York, is most gratified to note that the joint session of the American Institute and the British Institute of Electrical Engineers is to be turned to such practical account as the promised discussion on "The Relative Advantages of Alternate and Continuous Currents for a General Supply of Electricity, especially with regard to other interests," suggests. It anticipates a very interesting discussion, although as regards the "other interests" involved the conclusions arrived at will have less significance in the States than outside, for in their easy way of doing things, our cousins over the water leave other undertakings to hustle for themselves without any altruistic efforts on the part of the electric light and power companies, as they themselves admit. Incidentally, our contemporary expresses a desire to hear the net average efficiencies of the two systems of distribution ruthlessly set forth—a wish hardly likely to be realised, though others join in giving it expression.

Accumulator Boats.—The *Elektrotechnischer Anzeiger* thinks one outcome of the progressive improvement of accumulators will be that electrically-propelled boats designed to accommodate from 100 to 150 passengers will prove dangerous competitors of steam-driven boats. The insignificant attendance required, involving no stoking, absence of smoke, and the possibility of attaining very high speeds, are all points in favour of their extensive introduction. At the same time, it must be remembered that the wear and tear of accumulators employed for boat propulsion is much less than in the case of road traction, since the concussions so detrimental to the life of the plates is almost entirely absent. It is also to be anticipated, considers our contemporary, that one will depart in the future from the principle of providing services of large steamers at long intervals—because small steam-engines work less economically—in favour of running small boats at short intervals. Within certain restricted limits we agree this may be true—namely, for river service and comparatively short runs—for there is a limit to the capacity of the accumulators which can be carried by a small boat.

Chicago and Electrolysis.—Some of our people in this country who are troubled with the nightmare called electrolytic action will probably hold up for an example the action of Chicago, where last month an ordinance was passed by the City Council to take effect immediately and must be complied with within one year. This ordinance reads: "Every person, firm, or corporation operating, holding, or controlling any surface or elevated railroad or any street railway within the city of Chicago, upon which cars are now or hereafter operated by electricity as a motive power, with a grounded return circuit for conveying the electricity, shall instal and maintain a metallic return circuit of such cross-section and conductivity for conveying the electricity so used as a motive power, that the maximum difference of potential will not at any time exceed one volt between any part of such metallic return circuit and any water-pipe, gas-pipe, or other metals not installed for the purpose of forming a part of such metallic return circuit, and that there will not be a variation in difference of potential exceeding half a volt between any two measurements made at the same time at points along and upon said metallic return circuit within a distance of 300ft. or less from each other. Such metallic return circuit shall be installed and maintained in accordance with the provisions of the general ordinances of the city of Chicago now or hereafter in force."

An Electric Mining Pump.—We notice in the *Electrical World* an illustrated description of an electrical miner's sinking pump which has been placed on the market by the Jeanesville, Pa., Ironworks Company. The design comprises three single-acting plungers worked from a common crankshaft with crank pins placed 120deg. apart, and these plungers produce a continuous stream to the column pipe and reduce the jarring of the same. The water-cylinders are cast in one piece, and connected to the guides by hollow castings which form a vacuum chamber one side and air-chamber on the other. Each plunger is fitted with bronze adjustable shoes, and each connecting rod fitted with bronze adjustable bearings at each end. The crankshaft is driven by two gears fitted over the discs which form the outside cheeks of the two end cranks, thus relieving the shaft of a great part of the strain that would be brought upon it if driven by a single gear at one end. It also economises space, in that no extra room whatever is required for these gears, and, what is equally important, it places them inside the main bearings. The crankshaft gearings are completely enclosed in a cast-iron frame. The motor is placed upon the top of the pump frame, and connects the crankshaft by gearing designed to give the desired speed to the pump. The pump frame is made to receive any make of motor which is adapted to this kind of work, and it may be either direct or alternating current.

Water Power in Canada.—As we have from time to time noted, some very important schemes for the utilisation of waste water power are now in course of progress in Canada. The most recent of these is, perhaps, the Hamilton and Lake Erie power canal, the construction of which was commenced at Silverdale, Car., a few weeks ago. This canal will be 6½ miles long, and will be fed by the Welland River. The Welland, it must be explained, discharges into the Niagara, the waters of which latter river are more or less driven up the channel of the Welland, owing to their great force and to the deflection at the junction. The power canal will discharge into the Jordan River, which has two or three important falls in the neighbourhood, its level at the point where the canal will discharge lying considerably lower than the head of the canal, the total fall of the latter which can be utilised for power being about 250ft. The initial instalment of plant will represent 25,000 h.p, to be increased to 50,000 h.p. or 60,000 h.p., as required. Plans of the canal show that it is to be 150ft. wide at the top, 60ft. wide at the bottom, 12ft. deep, with a current velocity of 3½ miles an hour. The Canadian

Digitized by Google

Steel Company, whose works are being erected at Welland, have contracted to take 15,000 e.h.p. of the total generated, so that the success of the undertaking is practically a foregone conclusion. It is further reported that the Ontario Power Company, of Niagara Falls, is now ready to go ahead, having obtained all the necessary legislative rights to utilise 300,000 h.p. An initial installation of 30,000 h.p. is proposed. The plans include a power canal on the Niagara River, discharging just above the Horseshoe Fall.

Tramcar versus Express Train.—It is useless to mention that this race occurred in America—in fact, between Kansas City and Leavenworth. The race was between an express passenger train of the Missouri Pacific Railway and a car of the Kansas City and Leavenworth Electric Railway. In the Missouri Valley, between Pomeroy and for two miles past Wolcott City, the lines of the two companies are parallel, on a level, and well constructed, thus ensuring good conditions for a race. On the evening in question a trolley car, having on board several city men returning from business, found itself next to the express train which leaves Kansas City at 5 p.m. The fireman of the engine ordered his stoker to pile on the coal, and he let her go at full speed; seeing this, the wattman, winking to the conductor, turned the handle of the controller, and the car went away like lightning. The passengers on both the car and train took, as they naturally would, the greatest interest in the race, waving hats and handkerchiefs. The express train held a lead of a few yards during half of the first mile, but the car caught up and kept level for about a mile. Towards the end the wattman turned on still more current, and left the train behind. The fireman of the latter had never before exercised himself so much; the train had attained its maximum speed, and when the tunnel was reached, which naturally brought the race to an end, the car had obtained a lead of 30 yards. As Mr. Herbert Wolcott, manager of the Kansas City and Leavenworth Electric Railway, was on board the car at the time of the race, it may be inferred that the race was not altogether unpremeditated. This gentleman states that the car was running at a speed of 55 miles an hour, which speed could still have been increased, whilst obviously the train had attained its maximum speed on the level.

The British Association.—The British Association will meet in Bradford in the beginning of September. The meeting of 1873, which was held at the same place, was presided over by Prof. A. W. Williamson, the distinguished chemist, whose presidential address consisted mainly of a review of the progress of chemistry up to that date. The second Bradford meeting will be presided over by Prof. Sir William Turner, the professor of anatomy at Edinburgh University. His address will consist of a general review of the progress of biology, with special reference to the structure and function of cells. Sir Alexander Binnie will preside over Section G (Mechanical Science), and his address will treat of the steps by which we have arrived at our modern conception of nature, when reviewed from a scientific standpoint. The address will be illustrated by a chronological chart, extending from 1550 to the present time, and including, collated with the births and deaths of the many distinguished men to whom we are indebted, the principal historical, scientific, and other data which mark the various periods, as well as the dates of discoveries and of publications bearing upon the subject. Monday, as usual, will be given up to the electrical engineers. The reading of the final report of the Small Screw Gauge Committee heads the list for that day. Mr. A. Mallock will then deliver a paper on "Resistance and Acceleration of Trains—Measurement of the Tractive Force," in which he will deal with the recent experiments made by him on electric and other railways to determine the acceleration, the tractive force, and the running resistance to which trains are subjected. This will be followed by a paper on the proposed "Liverpool and Manchester Electric High-Speed Railway," by Sir William Preece. Mr. Gibbings is down for "The Design and Location of Electric Generating Stations" on a large scale for supplying electric power and lighting to large districts, and Mr. Barker for "A Maximum Demand Meter," the joint invention of himself and Prof. Ewing. Tuesday will begin with a paper by Mr. J. G. W. Aldridge, entitled "The Automobile for Electric Street Traction." Prof. Goodman will describe his new invention, entitled "A New Form of Corimeter for Measuring the Wetness of Steam." Prof. Arnold, of Sheffield, will, under the title of "The Internal Architecture of Steel," set forth his theories on the ultimate molecular structure of steel and the micrographic analysis of steel in physical researches. The Friday evening discourse will be delivered by Prof. Gotch, the subject being "Animal Electricity," while that on Monday evening will be by Prof. W. Stroud, whose subject will be "Range Finders." Prof. Silvanus P. Thompson will give the lecture to the operative classes on Saturday, and will take as his subject "Electricity in the Industries."

German Statistics.—Our contemporary, the *Elektro technische Zeitschrift*, published its annual statistics relative to central-station work in Germany some weeks ago. These statistics have become a noteworthy feature of the paper in question, and from year to year provide some very interesting comparisons. The returns are corrected up to March of the current year, and should therefore represent fairly accurately the present position of central-station work in Germany. It appears there are now running upwards of 652 public supply stations in the country, representing an aggregate output of more than 230,000 kw. To these must be added 122 stations in course of construction, not to mention the numerous private installations and stations supplying energy exclusively for traction purposes, before a true conception of the advanced state of electricity supply in Germany is obtained. The existing public supply stations distribute energy for lighting and power purposes to over 900 towns and villages. Individual stations situated in agricultural districts supply energy to as many as 30 different places, frequently distributing over areas having radii of from 10 km. to 15 km. With regard to the systems of supply in vogue, we find that the continuous-current stations represent 80·4 per cent. of the total. Purely alternating or rotary current installations account for another 12·7 per cent., thus showing a very slight increase compared with the previous year, whereas the works giving a mixed supply or transforming a portion of the current generated into continuous current have increased considerably. Although the percentage of continuous-current stations is so high, the aggregate output of the continuous-current generators installed amounts to only 47·4 per cent., and the total output of these stations to 53·8 per cent. of the grand total. The difference between the generator and the total outputs is explained by the increasing employment of accumulators, which are installed at 93·1 per cent. of the continuous-current stations, and equal 37·9 per cent. of the machine output. Of the total output of all the public supply stations in Germany—namely, 230,000 kw.—continuous current accounts for 124,000 kw., this being generated in 524 stations, while 58,000 kw. represents the alternating and rotary currents generated in 83 stations, the remaining 48,000 kw. falling to mixed systems of supply in 45 stations. Of the total supply stations, six have capacities

Digitized by Google

exceeding 5,000 kw.; 46, capacities from 1,000 kw. to 5,000 kw.; 31, from 500 kw. to 1,000 kw.; 249, from 100 kw. to 500 kw.; and 320, or 46·9 per cent., less than 100 kw. The number of lamps, or their equivalent, connected to the mains has increased all round compared with the previous year, an equivalent of 251,961 kw. being actually connected, of which total 95,731 kw., or 38 per cent., is represented by motors. Since the year 1898 the number of central supply stations and lamps connected have doubled, while the output of the motors connected has trebled. In conclusion, it may be added that 25 per cent. only of the stations are municipally owned.

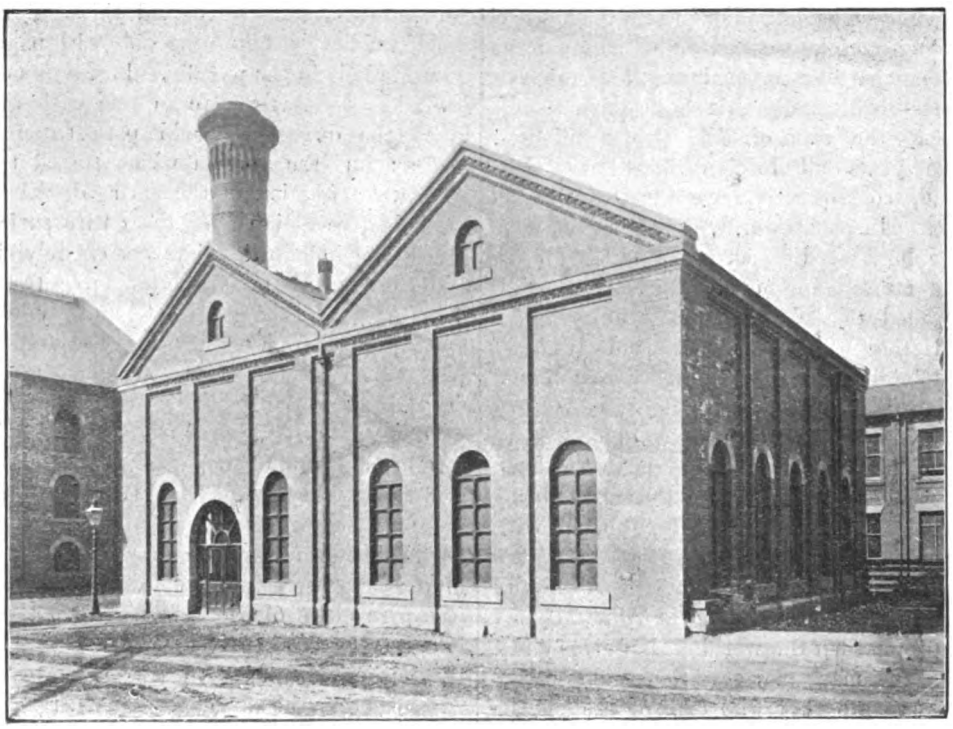
Our Latest Cruisers.—In the course of a long article dealing critically with the naval manœuvres recently concluded, the special correspondent of the *Daily Chronicle* writes as follows: "From the man to the ship. The constructive defects of our older warships have been discussed in the past *ad lib.*, and I see no object in wasting ink upon them here. About our latest craft, the cruisers of the 'Diadem' class, there are, however, a few things to be said. Good ships and all as they are, they are not triumphs of naval architecture. Space is undoubtedly wasted in them; minor constructive errors abound. For instance, they are 10 years behind the times in the matter of ammunition hoists. These are cumbersome manual ones, able to serve the 6in. quick-firers—theoretically able to fire five to ten shots a minute—at the rate of only two a minute! For the last five years all foreign ships have had electric hoists, and, consequently, are able to fire at least twice as fast. In other words, four guns in, say, a Japanese cruiser built at Elswick are worth eight in the latest thing in cruisers in our fleet. From time to time it has been argued that electric hoists are unreliable. This is rubbish. If they break down there is always hand gear to fall back upon, but there is no more reason why they should fail than that the ship's searchlights or ordinary lamps should fail. Now, time after time naval officers have asked for electric hoists. They have asked in vain. Even to-day the matter has got no further than that one is being experimented with somewhere. Speaking bluntly, this sort of thing is criminal. Officers afloat know a great deal better what is wanted than the people at the Admiralty who decide these things. The Lords of the Admiralty are far less powerful people than the world at large imagines. The real rulers in too many matters are certain obscure civilian clerks. These are they who control the pigeon-holes, and into a pigeon-hole whence it will never emerge goes everything that they can put there. It saves labour. From such internal evidence as is procurable, there is not good reason to suppose that Lords of the Admiralty are wilfully and criminally negligent. If all this time they have wilfully ignored the requests for electric hoists they would be that, and more. Where, then, have these requests gone to? Who is the man who has saved himself labour by suppressing them? It can be laid at his door if a proper search is made for him. What is more, it ought to be laid, and an example made—the crueller the example the better—for nothing short of drastic measures will stop this shameful system whereby the navy suffers so that a few lazy clerks may continue lazy. I do not know whether any of these folk will read these lines—if so, no doubt they will feel I am laying it on far too thickly. Am I? Could they only go unknown into any wardroom in the navy they would soon hold me a very milk-and-water accuser. For this is the sort of thing they would hear: 'If I had my way I'd take the —— brute, trice him up, and give him six dozen well laid on.' 'If 'twasn't for the absurd sentiment there is nowadays they'd hang 'em. I'll lay 10 to 1 that if we go to war there'll be a fleet lost, because some clerk pigeon-holes a report for fear he'll get an extra 10 minutes' work.' All this and more than this he would hear."

Sparking Experiments.—In the *Scientific American* we notice another article by Prof. J. Trowbridge on "The Electrical Plant used at the Jefferson Laboratory at Harvard University." In this article he describes some experiments he has conducted with the large battery installed in the laboratory. In connection with this battery plant, glass condensers serve the function of Leyden jars. There are 12 trays, carrying 25 glass plates each, there being thus 300 plates in all. The condensers are made ⅛in. thick, and they have a coated surface of tinfoil 16in. by 20in.; the capacity of the entire condenser in multiple is about 1·8 microfarads. When the condensers are charged to 20,000 volts and discharged in series a spark 6½ft. in air is produced. The professor experimented to find out if lightning could pass through a small orifice, and in this way noted the effect of very powerful discharges. A plate of glass 5ft. square and ¼in. thick was placed between the spark terminals, the plate being of this size to prevent the sparks from passing around the edges of it. The plate had a small hole bored through it at its centre, and this orifice could be made much smaller by filling the hole with paraffin and making a needle hole in the paraffin. It was found that when the discharge terminals were in line with the hole and 5ft. apart the discharge would pass through the minutest orifice; but the portion which passed through the hole was only a fraction of the entire discharge, for there was an inductive action over the entire surface of the glass. When the hole in the plate was entirely closed by paraffin and the spark terminals placed opposite each other, about 4ft. apart, with the glass plate midway between them, the spark jumped from one terminal to the surface of the glass, while no spark was seen on the opposite side of the glass. On close inspection, however, a faint brush discharge could be detected on the sparkless terminal. When the spark terminals were not opposite, the spark also sought the orifice, but the discharge usually jumped to the nearest point of the glass and then pursued a devious way to the hole. The professor then experimented with the discharge of the condensers in multiple. In the experiment a fine iron wire about 6in. long was stretched around the spark gap, serving as a shunt to the latter. It was found that the wire was deflagrated at the instant that the spark passed across the air gap. This led Prof. Trowbridge to think that a small spark could occur under certain conditions inside a metallic cage, and in the case of very powerful lightning discharges a wire cage would not be a perfect protection for a powder magazine. He also used the strong current from the entire battery to excite discharges in hydrogen, for the spectroscopic study of the gas. From this he found that aqueous vapour became manifest in all glass vessels which were filled with apparently pure dry nitrogen or hydrogen. The powerful discharges drove off the aqueous vapour from the glass, notwithstanding the glass had been subjected to a long process of heating to expel the vapour during the exhaustion of the tubes. The most interesting result, however, was the production of the X-rays for the first time by a steady current. An X-ray tube was connected to the terminals of the battery and a water resistance of about a million ohms inserted in the circuit. The tube was then heated by an external source of heat. In an instant the tube lit up with a most brilliant exhibition of X-rays, and photographs taken by means of them showed unmistakable evidences of the tendons and muscles, and he hoped that when the right conditions were reached he could obtain satisfactory photographs of these objects.

Digitized by Google

LEIGH CORPORATION ELECTRICITY WORKS.

Before describing these works, a few notes regarding their history may be given. Notice was served on the Leigh Local Board by the Cheshire House-to-House Electricity Company, Limited, in the year 1889 of the company's intention to apply for an electric lighting provisional order. It was agreed by the Board to oppose such application; but nothing came of the notice, nor was anything further done in the matter until May, 1894, when a committee was appointed by the Town Council to visit other towns where electricity works were in operation, and to report fully on the whole question of electricity supply. The report of this sub-committee was favourably accepted by the Council, who afterwards passed a resolution that application be made for a provisional order, which received final grant in June of 1895. Nothing was further done until the year of 1897, when the Council asked Mr. John Foster, the present engineer and manager of the Corporation's gas, water, and electricity undertakings, to prepare and report on a suitable scheme to enable them to carry out the order. The scheme was laid before the Council in May, 1898, and received their approval. At the same time it was decided to apply to the Local Government Board for sanction to borrow the sum of £10,500, which sanction was duly received on the 22nd of the following October. Previous to receiving the sanction for the loan specifications had been prepared, tenders were received, and contracts for the whole of the work were placed, subject to the sanction for the loan being given by the Local Government Board. Work was commenced on the buildings, etc., in March of 1899, and the current turned on for the first time early in January of the current year. At the present time 3,000 lamps (equivalent 8 c.p.) are connected, besides two motors of 55 b.h.p. aggregate capacity, whilst there are quite another 1,000 8-c.p. lamps practically ready to be connected to the mains. Application is being made to the Local Government Board for sanction to borrow a further sum of £5,000 for a large extension of mains, etc.



Leigh Electricity Works—Exterior.

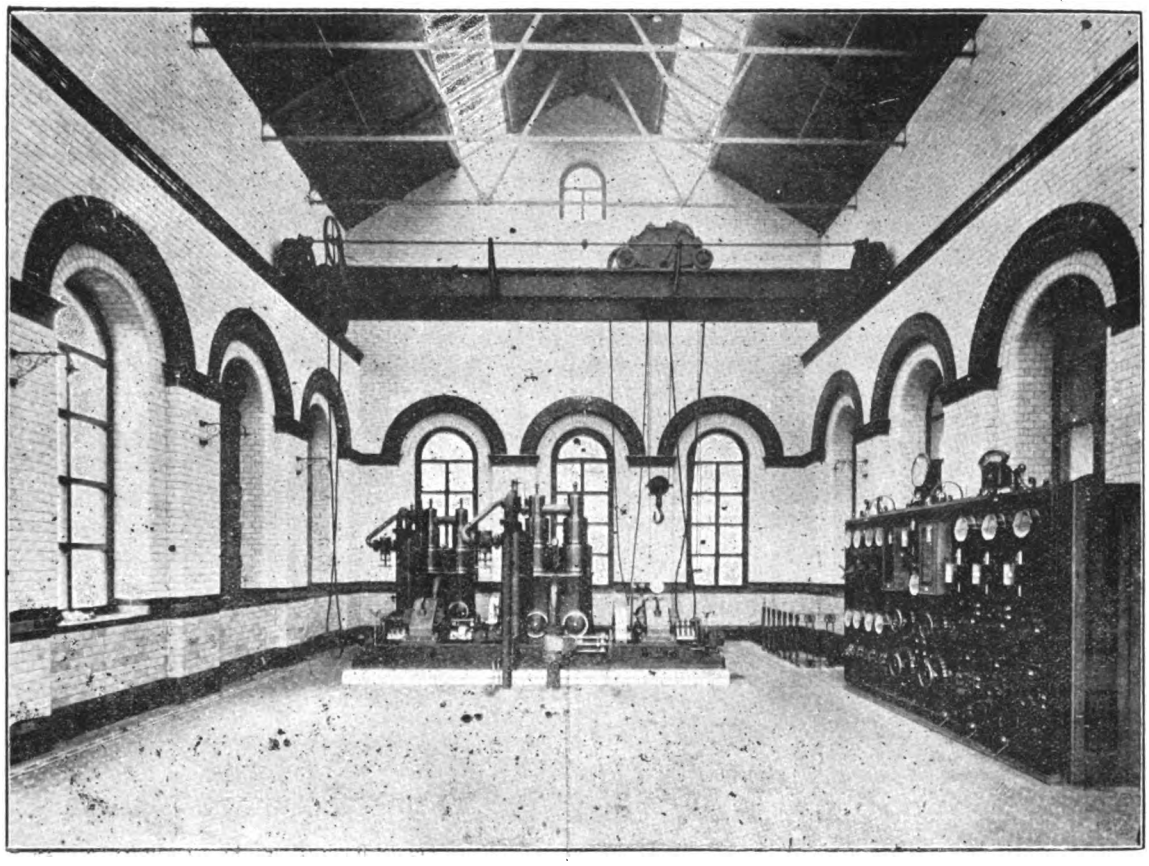
As at present arranged, the generating station buildings comprise only the engine and accumulator rooms, each 50ft. long by 32ft. wide, steam being obtained from the boilers of the gas department, which are arranged to utilise the waste heat given off the gas-retort furnaces. Space is left on one side of the engine-room to erect a boiler-house when required. The steam generating plant belonging to the gas department consists of two Lancashire boilers, 30ft. long by 8ft. 6in. diameter, fitted with Deighton's patent corrugated flues, and designed to work at a pressure of 130lb. per square inch. They were made by Messrs. Clayton, Son, and Co., Limited, the whole of the mountings being of Hopkinson's make. Musgrave's superheaters are fixed immediately behind, each superheater consisting of 38 1¼in. tubes, with the usual safety valves, thermometer pockets, etc. There are also two sets of Green's economisers erected, one set to each boiler, consisting of 96 pipes complete, with scrapers and gearing. The water for the boilers is obtained from a borehole, and before passing into the boilers is pumped into a tank, and then passed through a water-softening apparatus, made by Messrs. Mather and Platt, Limited. The steam-main consists of one single main, 8in. diameter, with subsidiary mains, 4in. diameter, of lap-welded steel (wrought) with wrought-iron flanges welded on. A Brooke's steam-dryer is provided, and Geipel steam-traps. The steam joints are made with gunmetal rings and mastic cement, the exhaust pipes being of cast iron 10in. and 6in. in diameter.

The generating plant at present comprises two direct-coupled sets, one set consisting of a Willans and Robinson's two-crank compound engine coupled to a Mather and Platt four-pole shunt-wound dynamo rated at 200 amperes, 460 volts, while the second set consists of a Willans and Robinson's two-crank compound engine with a Mather and Platt four-pole shunt-wound dynamo coupled at each end of the crankshaft, each dynamo being capable of giving 135 amperes at 300 volts. This set is used at present for charging the battery and for balancing the three-wire system. At present the engines are running non-condensing, but can with a slight alteration be run condensing when required. There is provided in the engine-room an eight-ton overhead travelling crane, made by Messrs. James Carrick and Sons, Limited, of Edinburgh, the crane being worked by ropes from the ground level.

The switchboard, which was supplied by Messrs. Dorman and Smith, of Manchester, is arranged for a three-wire system of distribution at a working pressure between the outers of 440 volts, and consists of three dynamo panels, four feeder panels, and a middle wire panel. Each machine panel is provided with one minimum automatic cut-out, one field-breaking switch interlocked with a single-pole knife switch, shunt regulating switch, ammeter, and voltmeter. There is also a Ferranti ampere-hour meter in circuit with each machine. Each feeder panel is provided with an ammeter, duplex switch, and fuses, also Thomson-Houston recording wattmeters. On the middle wire panel are mounted the battery charge and discharge switches, battery emergency switches and fuses, reversible ampere-hour

Digitized by Google

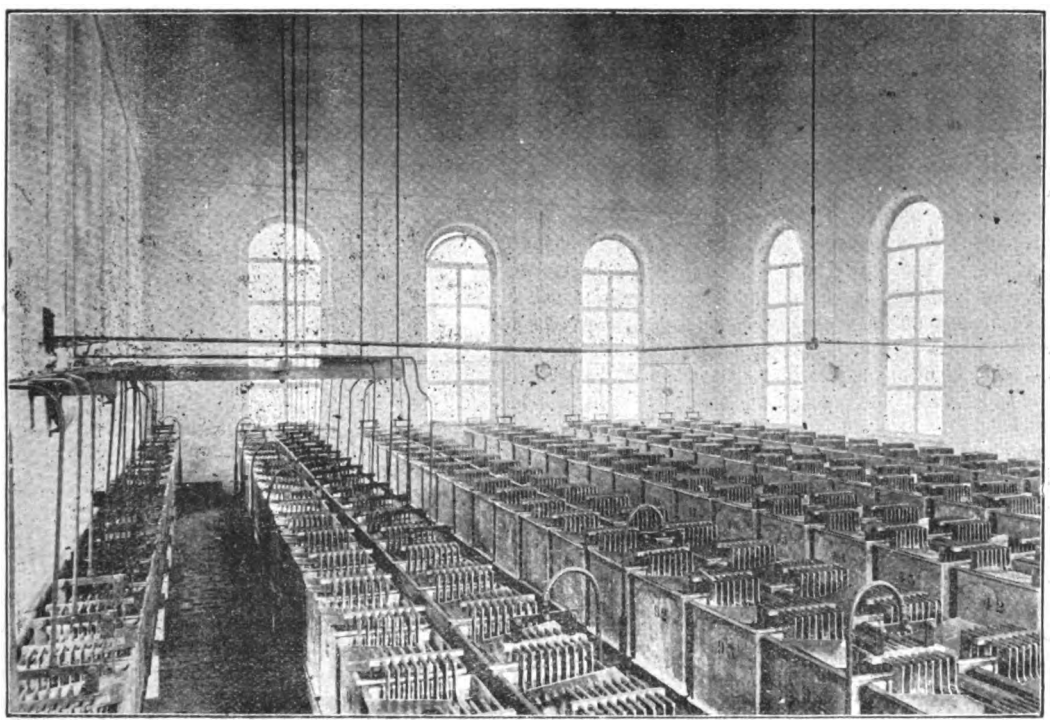
meters, polarised ammeter, battery voltmeter, and two Weston feeder voltmeters. The whole of the ammeters and voltmeters, with the exception of the feeder voltmeters, are of Lord Kelvin's multicellular type.



Leigh Electricity Works—Dynamo-Room.

The accumulators are of the Chloride C R type in lead boxes, the battery containing 240 cells, having a sum capacity of 1,000 ampere-hours, and being capable of discharging at the rate of 300 amperes for one hour without injury. The battery is fixed on one tier, with ample space to get at each cell, the regulating cells being connected to the switchboard with bare copper rods run on special insulators, and painted throughout with anti-sulphuric enamel.

The mains were supplied and laid down by the British Insulated Wire Company, Limited, and are of their three-core, paper-insulated, lead-covered type. The feeders are drawn into stoneware casing, the whole of the distributing mains being laid in stoneware troughs filled up with compound. The service cables are of the two-core type, lead covered and steel armoured, and are laid direct into the ground. At present there are two triple-concentric feeders of ·25, ·15, ·25 square inch cross-section, with subsidiary feeders of ·15, ·075, ·15 square inch cross-section. The triple-concentric distributing mains are of ·1, ·05, ·1, and ·05, ·025, ·05 diameter, laid complete with the usual disconnecting boxes, etc.



Leigh Electricity Works—Battery-Room.

The Wright demand indicator system of charging has

Digitized by Google

been adopted, the price per unit for lighting being 7d. for the first hour and 2½d. afterwards, while 3d. per unit for the first hour and 1½d. per unit afterwards is charged for power. The Corporation have decided to hire out motors, indicators, and meters, the latter, of the Chamberlain and Hookham type, being also fixed free.

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

(Continued from page 190.)

BRUSH.

The Brush Electrical Engineering Company were among the pioneers of alternating-current working, and they consequently had the problem of switching apparatus to deal with. The early workers of any system have to bear the brunt of considerable experimenting, which proves a very expensive item, though a practical result is generally the outcome of such labour. This was the case with the Brush Company, who equipped many stations with switching appliances as well as other apparatus. The high-tension switch shown in Fig. 1 is the now well-known "trigger" switch. It consists of two brass fittings mounted at either

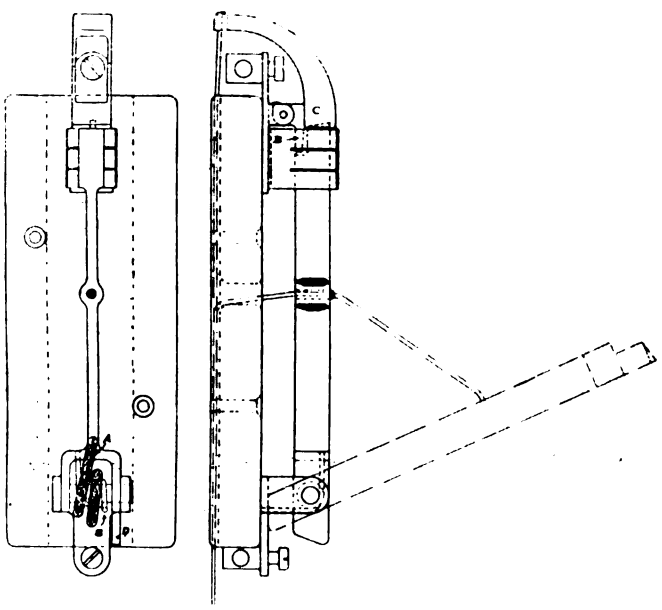


FIG. 1.—Brush Trigger Switch.

end of a porcelain base. The lower one forms a bearing, to which is pivoted the lever used to couple the two fittings together, and thus complete the circuit. This lever is operated by a catgut cord fastened near its centre and passing through a hole in the base down the back to the bottom of the switch. On pulling this cord, the lever is drawn into the contact at the top, and the spring, S, at the pivoted end is put in tension. A catch, C, held in one position by a spring, closes over a small projection at the end of the arm, and this serves to hold the switch in the "on" position. The catch above mentioned has another cord attached to it to enable the switch to be opened, which result is effected by giving the cord a smart jerk, when the lever is thrown out of the contact jaw by the projection on the catch seen at B. The tension already existing in the spring, S, carries the lever quickly away from the upper contact. An extension of the lever shown at D answers the purpose of a damper to the blow caused by the opening of the switch. Terminals are provided on each fitting for the necessary cable connections. The moving lever is supplied with current by the flexible connection seen at A, which ensures a good contact being made between the bearing and the moving part.

Fig. 2 represents a switch constructed on the same principle as the foregoing, but intended to deal with larger currents, consequently the parts are more heavily made. The blow of the arm when suddenly released is taken by the flat spring, S, and the small knob seen at the end of the catgut cord is intended to provide a good grip when opening or closing the switch. A knob for each cord is

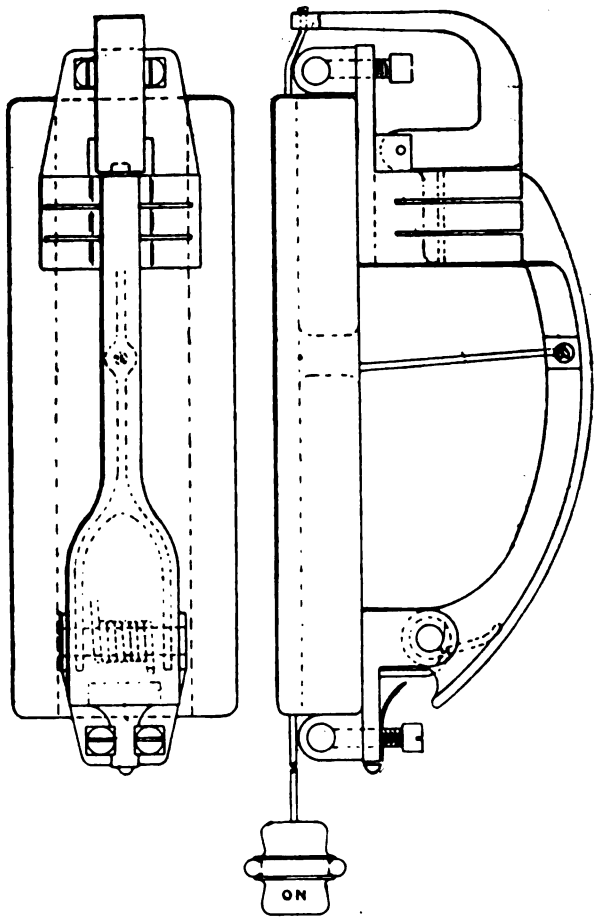


FIG. 2.—Brush Trigger Switch for Heavy Currents.

attached, marked "On" and "Off" respectively. A recess at the back of the base, shown by the dotted lines, forms a

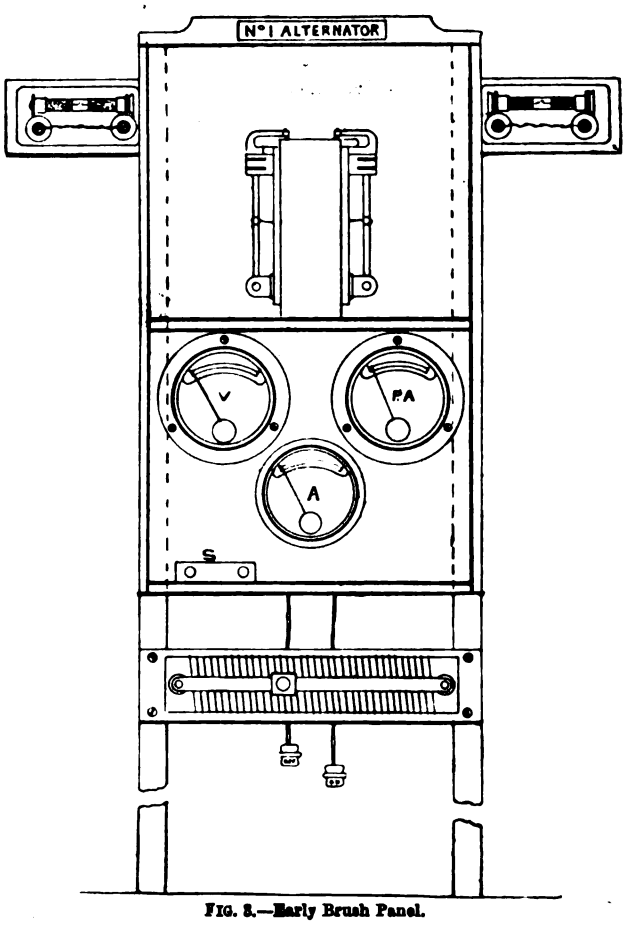


FIG. 3.—Early Brush Panel.

channel, allowing free play for both cords, without grooving the panel on which the switch is mounted. This type

Digitized by Google

of switch was introduced in 1884. The necessity for some reliable means of automatically opening the circuit in case of mishaps on the mains, brought about the introduction of a high-tension fuse. The type first constructed by the Brush Company for small currents was the Mordey sand fuse. This consists of a glass tube provided at each end with a brass cap, to which the fuse wire is soldered after being drawn into the tube. Previous to the cementing on of the caps the tube is partially filled with sand, a space of about ½in. being left open in the middle, paper wads keeping the sand in its place. The caps are provided with projections, which fit into recesses in spring clips, these latter firmly holding the fuse in position and placing it in circuit. As a dynamo main fuse it is used as a shunt to a wire of larger section, but should this melt, the sand fuse will disperse the arc (Fig. 3). An alternator panel equipped with these fuses and trigger switches is shown by Fig. 5. The body of the panel is strongly constructed of teak, and divided into two compartments. The upper one, lined with asbestos, carries the switches, and the lower one is fitted with the instruments. This last section has a glass door fitted to it. The fuses are mounted at the top of the board, on brackets fixed to the sides of the upper section. The switches are operated by the catgut cords (spoken of above), which pass through the upper and lower partitions, and terminate in porcelain knobs. Below the high-pressure panel is screwed the shunt rheostat for the regulation of the voltage of the machine. This is shown in detail in Fig. 4. It is made up of a number of turns of wire on a slate slab, which is mounted on a polished teak base. Spanning these wires is a copper bridge mounted on teak pillars, and a slider is made to move up and down this bridge. Fastened to the slider is a spring carrying a

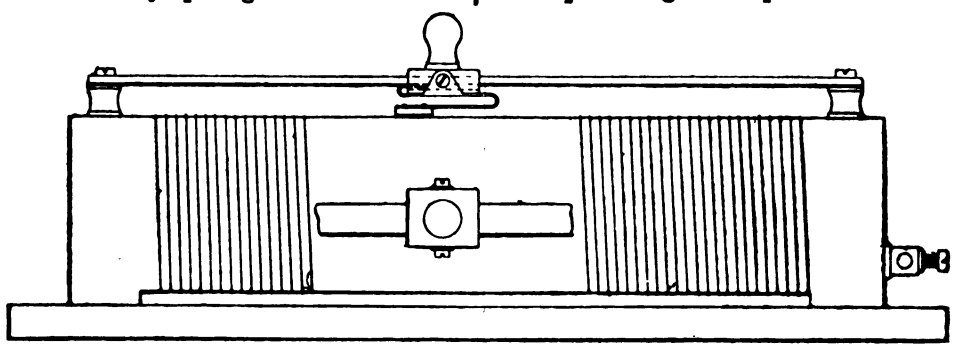
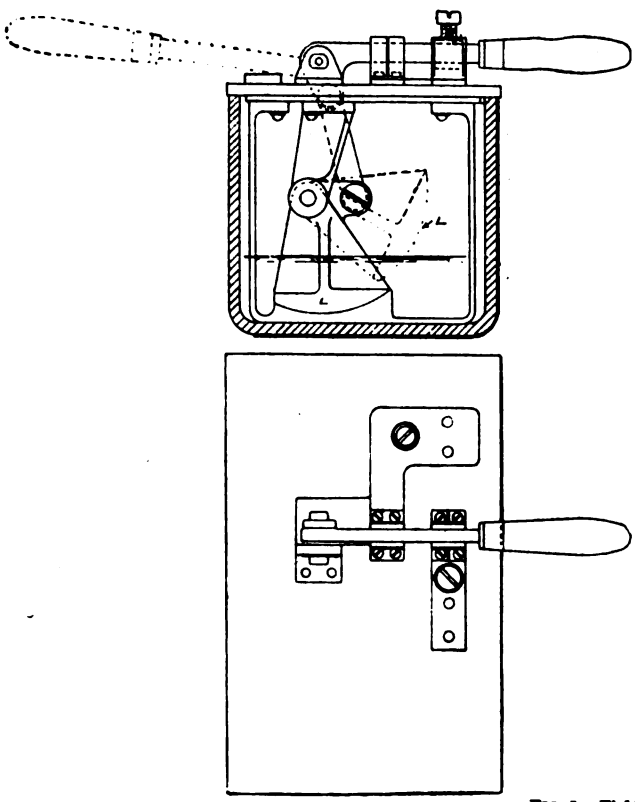


FIG. 4.—Brush Rheostat.



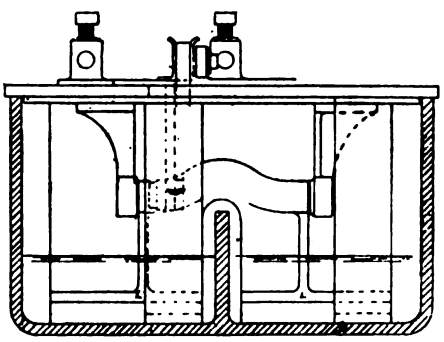


FIG. 5.—Field-Breaking Switch.

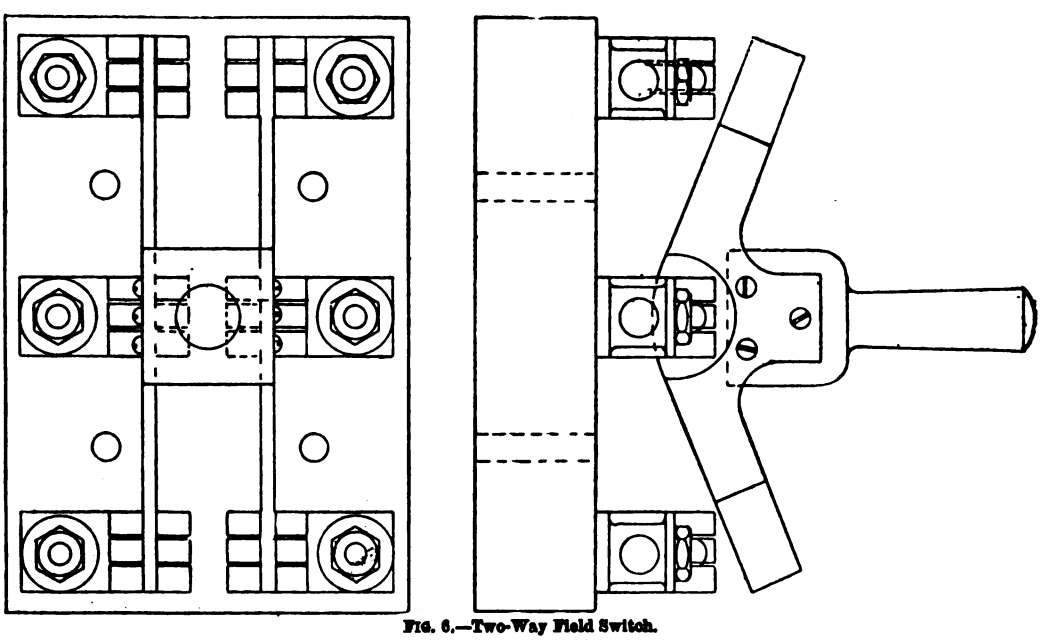


FIG. 6.—Two-Way Field Switch.

Digitized by Google

copper contact-piece, and this spring is arranged to pass under the slider in such a manner that the latter is always kept well in contact with bridge. A fine adjustment could be obtained with a resistance of this class, and the space occupied was small. Its arrangement under the panel in Fig. 3 will illustrate this. In the same figure, V is the machine voltmeter, taken off one coil or placed in circuit with the secondary of a small transformer; P A, primary

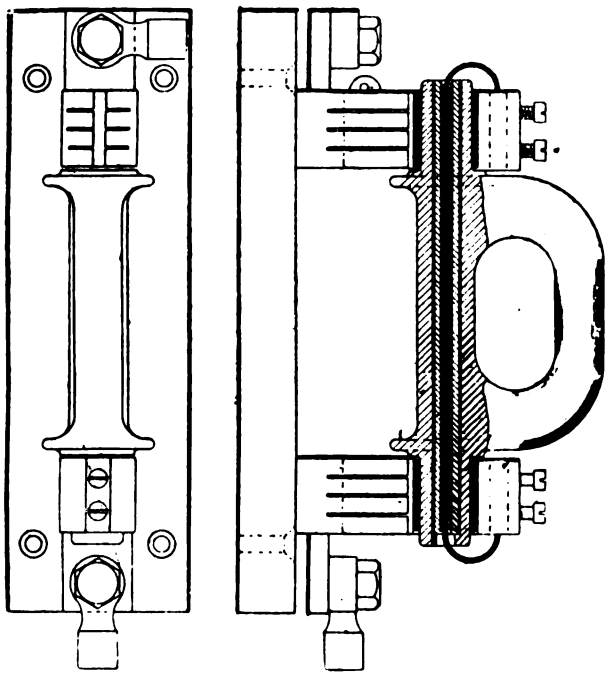
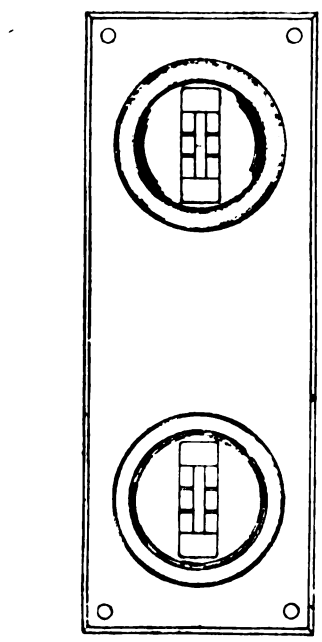


FIG. 7.—Bates Fuse—Open Type.

ammeter; A, exciter ammeter; and S, the plug contacts for the synchroniser. One plug switch for this latter was provided for the whole board, so that two might not be inserted at once.

In conjunction with the panel above described a liquid switch for opening the exciter circuit was provided, an ordinary switch being found unsuitable on account of the arc produced by the breaking of an inductive circuit.



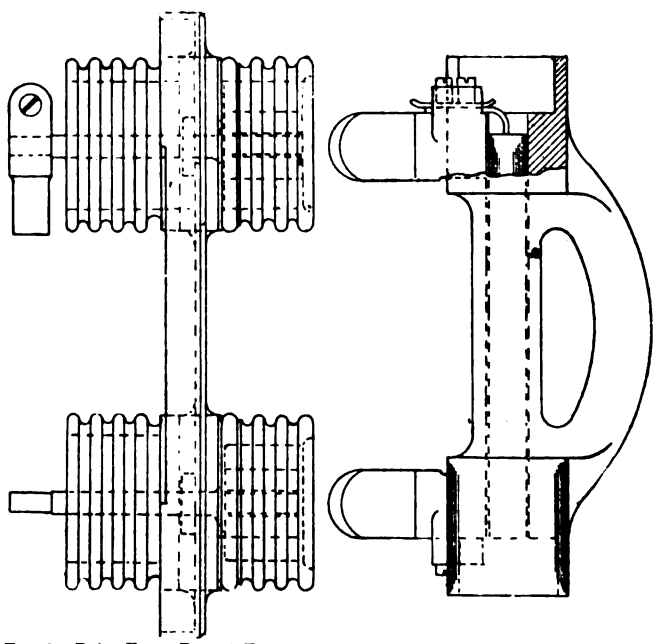


FIG. 8.—Bates Fuse—Recent Type.

Fig. 5 illustrates this switch, which consists of a wooden base fitted with the means of opening the circuit and a stoneware pot containing the liquid. Screwed to the base are two contacts, which are joined together by a brass arm when the switch is on. This lever is pivoted at one end and fitted with a handle at the other, and it is made to carry a link, which lifts two lead castings, shown at L. These latter are so shaped that they make a good contact with other lead castings connected electrically to the contacts on the base. When the field circuit has to be broken, the lever is put over to the dotted position, when current flows from one terminal to the other by way of the fixed lead castings, the liquid, and the moving leads. The stoneware pot is divided by a partition into two cells, so that two breaks are made in the circuit, there being two moving lead plates, which are joined together, and two

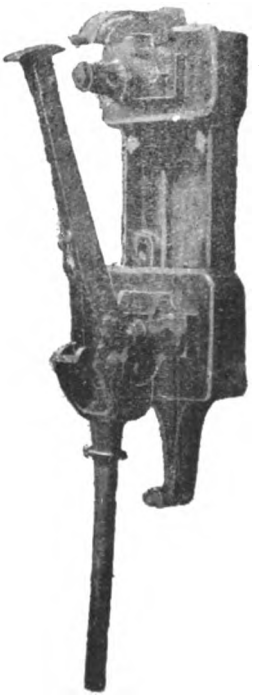


FIG. 9.—Brush Switch for Heavy Currents.

fixed plates, each coupled to the terminals of the switch. A two-way switch, as shown by Fig. 6, was used in connection with independent exciters and exciters on the alternator shaft, so that should the latter fail, the switch when put over would couple the former to the field. Such a switch is, of course, unsuitable for breaking an arc.

The sand fuse above described was only suitable for small currents, so a fuse similar to that shown in Fig. 7 was brought out. This is the now widely used Bates fuse, which consists of a porcelain base carrying two contacts, and a porcelain handle having two blades cemented at each end and joined by the fuse, which passes through a fireclay pipe pushed into a channel in the handle. The upper blade has a projection on it through which a small pin is passed, to act as a hinge in closing the circuit with the fuse. Fig. 8 illustrates the most recent type, in which all parts are carefully covered in. The contact jaws are

Digitized by Google

covered by porcelain insulators having a narrow slot, and the screws for fixing the fuse wire are well recessed in the handle. To reduce the possibilities of breakage, the base is constructed of cast iron of small section, and the insulators for the jaws are cemented into it. This gives a sound mechanical structure to the fuse while considerably reducing its weight. In cases where larger machines had to be dealt with, the panel arrangement in Fig. 3 was modified in the following manner: In place of the trigger

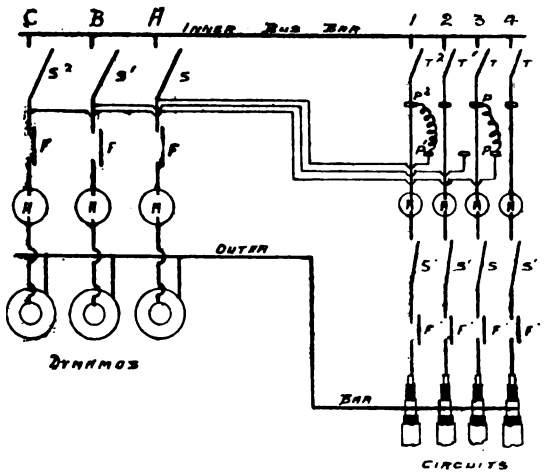


FIG. 10.

switches, two Bates fuses were fixed to the upper panel, and separated from one another by a marble slab. The switches were not used, but a type similar to that shown in the adjoining photo (Fig. 9) was fixed on the wall close to the panel and coupled to the machine. The switch is shown open, but it could be closed by raising the handle slightly above the horizontal, when a catch was released, to allow the arm to pass under the laminated contact. Fastened along the back of the arm was a strong flat spring, held at

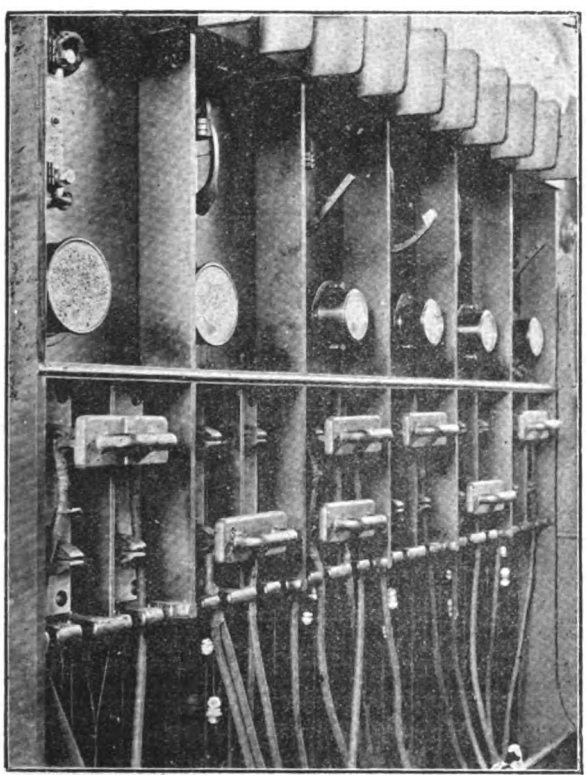


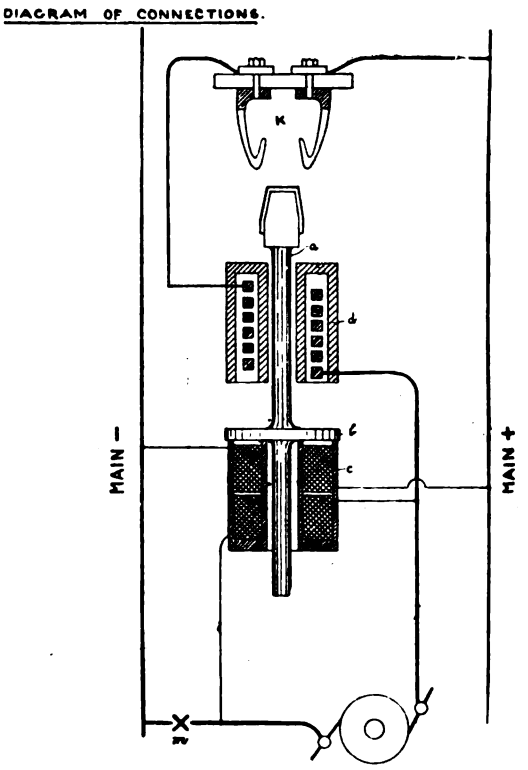
FIG. 11.—Circuit Plugboard for Separate Running of Alternators (by permission of Mr. A. B. Mountain, Borough Electrical Engineer, Huddersfield).

one end only by two bolts, the other end being left free and in such a position that a smart blow could be given to it by the handle, when the switch would fly quickly from the contact. The break was very long, and to prevent the operator receiving a blow on the head, a bar was provided against which the arm struck. It was impossible for the arm to fly back into the contact, nor could it be pushed in by any other means than the handle.

The panels equipped as above described were placed opposite the alternator to which they were connected, and were themselves coupled together by rubber cables run in wood casings. In some cases where these panels were used the alternators were run on separate circuits, but synchronised for a few minutes while the transference was being effected. Fig. 10 is a diagram showing how this

FIG. 12.—Raworth's Patent Automatic Switching Gear for use with Continuous-Current Dynamos or Exciters.

change could be made without interruption of the supply. A, B, C are machine panels fitted with switch, S, fuse, F, and ammeter, A. 1, 2, 3, etc., are circuits to be supplied, also fitted with switches, fuses, and ammeters. P, P^1, P^2 are plug contacts, which could be coupled together by a plug and jack cord. When one machine, A, say, is feeding all circuits, the switches, T, T_1, etc., will be closed, and no



F 13.

plugs, P, will be inserted but should B machine need to help with the load, it will be paralleled by closing S^1, plugs P^1 P^2 with cords will be inserted, and T^2 opened. When machine ammeter on B reads current on No. 1 circuit, switch S^1 is opened, which operation will separate B machine from A machine. The adjoining photograph (Fig. 11) shows a board connected up on this plan. The trigger switches, seen at the top, are represented in the diagram by T, T_1, etc., while the plugs and cords corre-

Digitized by Google

spond with P_1, P_2, etc. The arrangement shown was originally double-pole, but was subsequently made single-pole on the earthing of the outer.

The isolated panel arrangement reached its highest stage in the Raworth switch pillars. These were ornamental castings, which contained the necessary switches and instruments, and the apparatus was so compact in form that it could be placed on the floor of the engine-room opposite each machine. The photograph (Fig. 12) illustrates a pillar for use with continuous-current dynamos or exciters, Fig. 13 showing a diagram of its connections. The switch closes automatically when the dynamo has attained its normal voltage, but should this voltage fall below a certain point the circuit is opened. The main switch is carried on a vertical rod, *a*, on which is an iron armature, *b*, moving between two electromagnets, *c* and *d*. The lower one, *c*, is magnetised by a shunt from the mains and demagnetised by a shunt from the dynamo terminals, while the upper one, *d*, is magnetised by the main current from the machine.

FIG. 14.—Raworth's Patent Interlocked Switching Gear for use with Alternators working in Parallel.

When the dynamo is at rest, the lower magnet binds the armature down and locks the switch out of action, but when the dynamo is giving its full voltage, the magnet is demagnetised and the switch is closed by means of a weighted lever, and kept closed by the magnet, *d*. Upon steam being turned off the dynamo, the switch is opened by the falling of the armature by gravity. The weighted lever above mentioned has, on starting the engine, to be put in gear with the switch by means of a small catch or pawl, which automatically releases when the switch closes. A pillar for use with alternators is shown in the photograph (Fig 14). The arrangement, which is very neat, comprises two main switches, one field switch, one synchroniser switch, one synchroniser, one voltmeter, and two lamps for synchronising, one main voltmeter, one main ammeter, and one field ammeter.

The main switches are fixed at the top of the pillar, and are of the water break type. Below these are the synchronising lamps and voltmeter, and immediately beneath are three instruments—main voltmeter in the centre, main ammeter on the right, and field ammeter on the left. The handles seen under the instruments are for operating the switches, and they are marked 1, 2, 3 respectively, representing the order in which they should be closed. In the centre is the main switch, on its right is the synchroniser switch, and on its left the field switch. These handles are so constructed that they interlock with one another to effect the following objects: The main switch cannot be closed until the field switch is closed and the field fully excited, also not until the synchroniser switch is closed. The field switch cannot be opened when the main switches are closed, these latter being in their turn locked by shutting off the synchroniser switch. The advantages of such an interlocking system become most evident when alternators are run in parallel.

In connection with machine switch pillars above described, a feeder pillar constructed on very similar lines is used. This is shown by the photograph (Fig. 15). It takes the form of a cast-iron pillar carrying main switches, fuses,

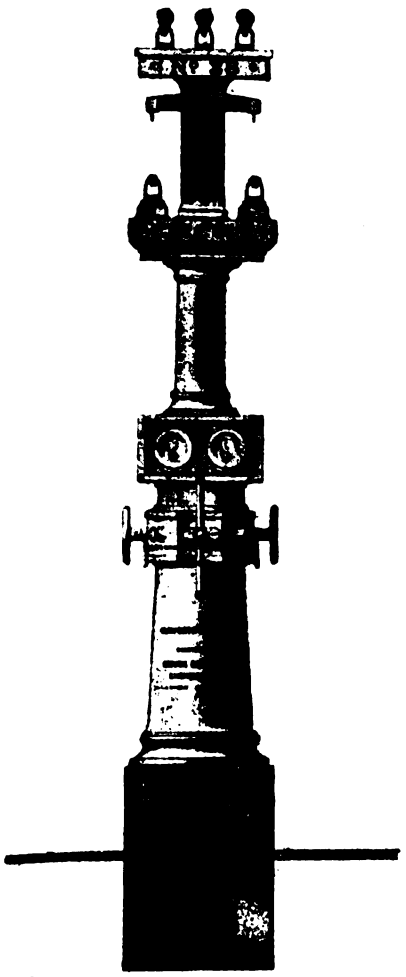


FIG. 5.—Raworth's Patent Interlocked Switching Gear for Main Feeders, Continuous or Alternating Current.

ammeter, voltmeter, and regulating gear. In the base of the pillar where the leads enter there is a switch for disconnecting the upper portion of the pillar, but at the same time establishing the circuit. This enables instruments, etc., to be examined or repaired without cutting off the feeder. At the top of the pillar are fixed three fuses, any one of which can be put in circuit by turning the right-hand lever, which, however, cannot be moved unless the main switch is open. Below the fuses are arranged double-pole switches operated by the central handle, which is locked by a trigger. This trigger must be released before the switch can be opened or closed. To the left of the centre handle is the short-circuiting switch. The hand-wheels seen on each side of the pillar are for purposes of regulation. Raworth's patent universal contact, as shown by Figs. 16 (1, 2, 3, 4, 5), is used with all switches and fuses above destribed. The contact-piece is a casting divided into a number of laminations which present many contact surfaces, and remain parallel or at the same angle to each other under varying degrees of pressure. For taper

Digitized by Google

connections the contact surfaces are arranged at such an angle that the bar or plug will stick between the jaws, but may be removed by the exertion of a very slight force. With these contact-pieces the surface presented is fully

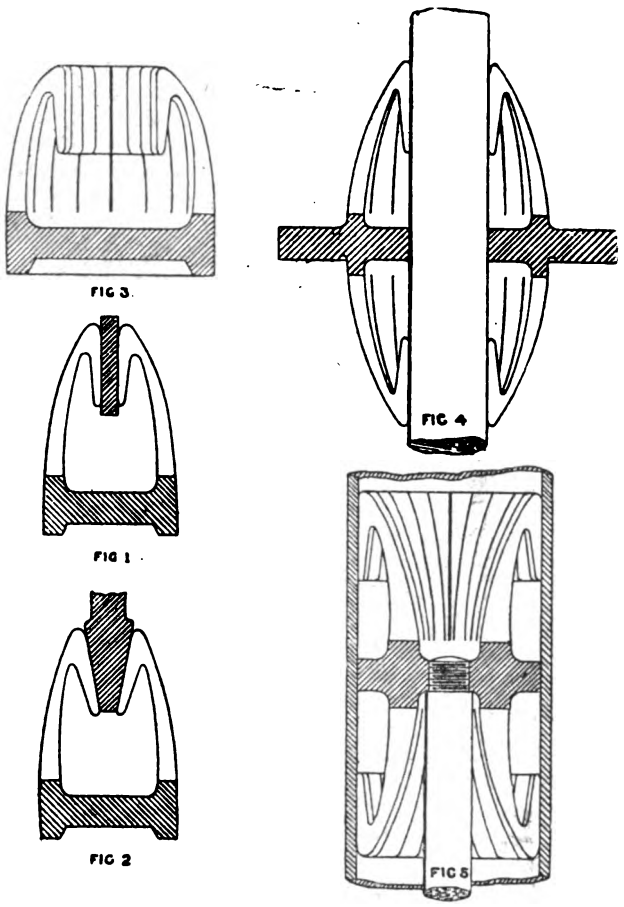


FIG 16.—Raworth's Patent Universal Electrical Contact.

four times the sectional area of the metal, and they are standardised for currents up to 1,000 amperes.

(To be continued.)

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 193.)

In my last article I referred briefly to the Bremer arc described in an interesting contribution to the proceedings of the Verband by Prof. Dr. Wedding. The subject is of sufficient interest to merit further notice, and I shall therefore venture to give more room to Prof. Wedding's conclusions, which are reproduced with diagrams in the *Elektrotechnische Zeitschrift*. After enumerating the several disadvantages attending the use of the ordinary type of arc lamp, Prof. Wedding proceeds somewhat as follows: "Repeated attempts have been made to remedy the inherent defects of the arc lamp by impregnating in various ways the carbons employed. These experiments have, indeed, tended to greater steadiness and a more uniform colour of the arc, but have never given decisive results. However, by incorporating with the carbon 20 to 50 per cent. of non-conducting metallic salts, such as calcium, silicium, or magnesium compounds, Herr H. Bremer, of Neheim, has discovered a means whereby a far higher efficiency may be obtained. The first investigations conducted by me in connection with carbons of such composition were with two continuous-current arc lamps consuming respectively 12 and 60 amperes, and an alternating-current arc taking 6·5 amperes. I used carbons of special composition only on the positive sides of the continuous-current lamps. These carbons contained an admixture of calcium. Table I. gives the light intensities corresponding to different angles of the arc with the horizontal plane obtained with the smaller lamp, while Fig. 1 gives a graphic representation of the same. Fig. 1 renders it apparent that the intensity of the light obtained at angles from 45deg. to 90deg. remained practically constant, and then decreased towards the horizontal by as much as 1,000 c.p. The mean current strength of 12·3 amperes underwent a maximum variation of 0·3 ampere during these measurements, and the terminal potential of 44·4 volts a maximum of 2·5 volts. The mean consumption of energy amounted to 546 watts, the maximum intensity of light to 6,400 candles, and the hemispherical intensity of light to 4,320 candles. The specific consumption of the lamp was consequently $\frac{546}{4,320} = 0{\cdot}120$ watt.

TABLE I.—Continuous-Current Arc Lamp without Globe.
12·3 amperes × 44·4 volts = 545 volts.

Angle relative to horizontal plane—Deg.	Intensity of light.
0	991
6·7	1,470
16·8	3,202
26	4,060
32	6,080
36·8	5,220
42	6,070
45·4	6,520
51·1	6,250
55	5,410
59·2	7,420
65	6,070
90	6,180

TABLE II.—Continuous-Current Arc Lamp fitted with Globe.
12·2 amperes × 44·6 volts = 543 watts.

Angle relative to horizontal plane—Deg.	Intensity of light.
−48	497
−32	713
−15·2	1,246
−12	1,160
− 8·5	1,040
0	1,441
10·5	1,791
21·2	2,133
30	2,782
35·2	3,440
43·4	3,774
51·4	4,000
57·6	3,480
65	3,126
76	3,440
90	3,838

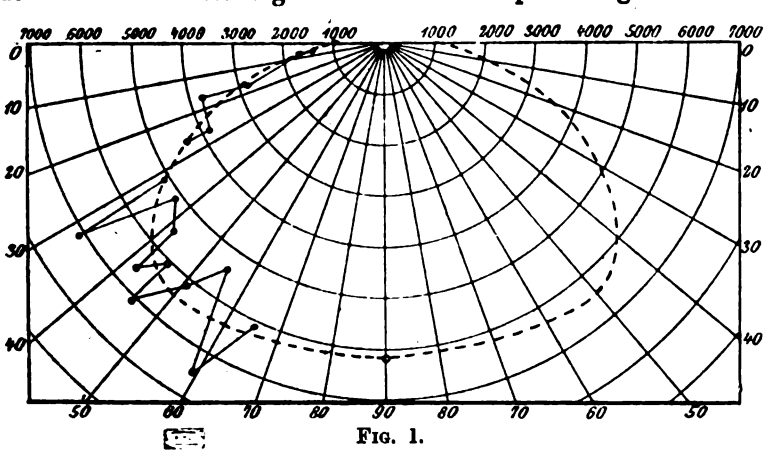


FIG. 1.

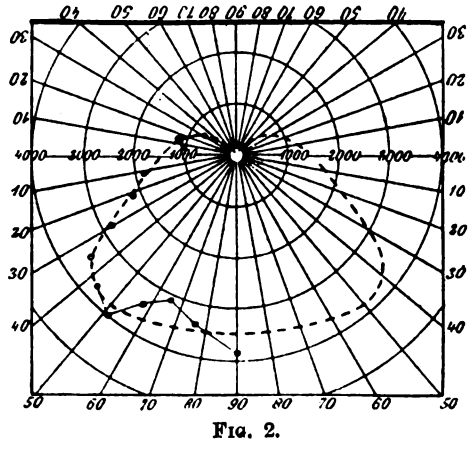


FIG. 2.

Digitized by Google

Table II. gives the measurements for the same lamp fitted with a globe and consuming 12·2 amperes at 44·6 volts terminal potential—that is to say, 543 watts. It is apparent from the graphic representation (Fig. 2) that the lamps still yielded 1,440 candles when in a horizontal position, while up to an angle of 48deg. above the horizontal there remained 500 c.p. As a consequence of this, the whole globe appears to the eye as a fairly uniform illuminated disc. It does not show the deep shadow formation upon the upper and lower diameters of the globe, as do the lamps hitherto in vogue. The impression on the eye is therefore far better. The hemispherical intensity of light relative to the lower diameter of the globe amounted to 2,772 candles, whence it follows that the specific consumption of the lamp was 0·196 watt.

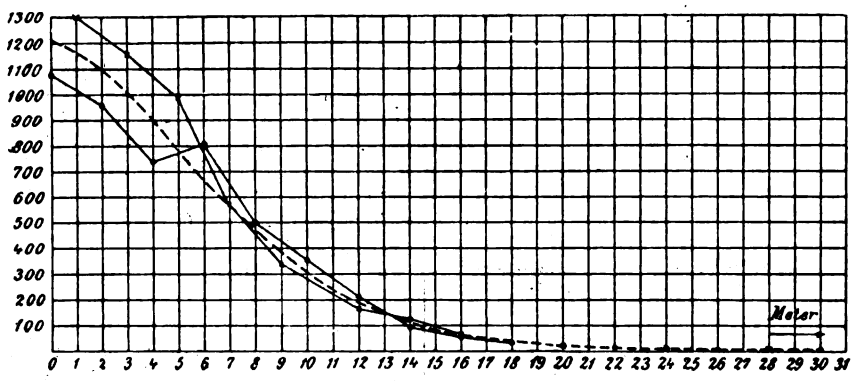


Fig. 3.

The hemispherical intensity of light of the lower diameter amounted to 2,772 candles, whence it follows that the specific consumption per candle-power was 0·196 watt. The second lamp was similar to the one now mounted on the Eiffel Tower, at a height of 95m. above the ground level. It contained four arcs, which were connected in two

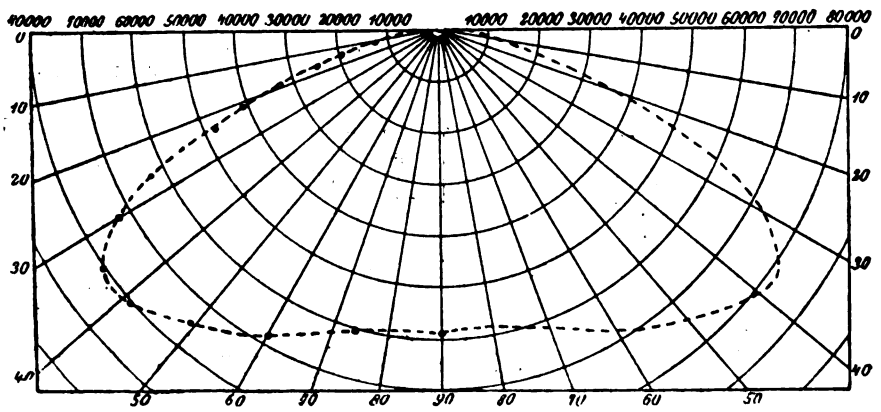


Fig. 4.

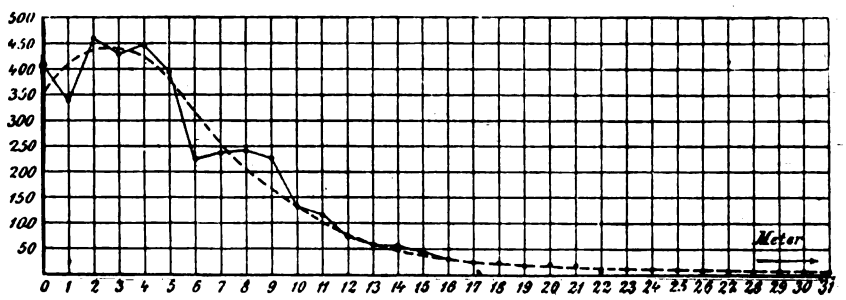


Fig. 5.

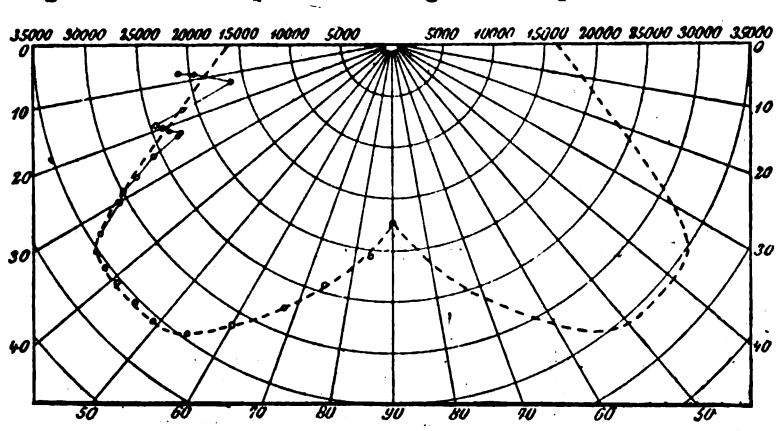


Fig. 6.

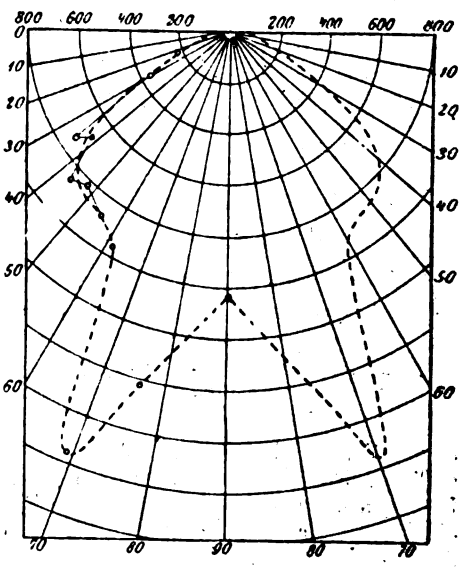


Fig. 7.

Digitized by Google

series groups when the measurements were taken, the lamp consuming 55·8 amperes at 89·3 volts terminal potential without a globe. Owing to the great intensity of the light obtained, the lamp could be examined only by night and in the open. It was suspended 8m. above ground, the measurement of the ground illumination being taken 1m. above the level. The results of the observations made are tabulated below (see Table III.).

TABLE III.—Large Continuous-Current Arc Lamp without Globe. 55·8 amperes × 89·3 volts = 4,980 watts.

Radial distance from the point of suspension in metres.*	Illumination obtained 1m. above the ground-level.
0	1,074
2	957
4	736
6	805
8	502
10	354
12	211
14	123
14	94
16	55·3
18	33·9
20	24·0
22	17·5
22	11·9
24	12 3
26	6·4
28	5·2
30	2·73
34	1·96
28	5 96
20	23·7
16	66 2
12	166
9	342
7	569
5	987
3	1,156
1	1,300

* 1 metre = about 3ft. 3in.

The mean curve plotted from these data is shown in Fig. 3. From the values denoted by this curve the light intensities given by the lamp when placed at different angles to the horizontal were calculated (see Table IV.).

TABLE IV.—Large Continuous-Current Arc Lamp without Globe. 55·8 amperes × 89 3 volts = 4,980 watts.

Angle relative to the horizontal.	Intensity of light.
90°	59,290
74°	60,650
60° 10′	67,660
49° 20′	75,090
41° 10′	80,680
35°	80,530
30° 20′	72 620
26° 40′	63 330
23° 40′	47,110
21° 10′	41,110
19° 20′	32,550
16° 20′	24,460
14°	19 280
11° 40′	11,690

From the above values the curve (Fig. 4) showing the diffusion of light obtained with the lamp without a globe was plotted.

Corresponding to an angle of 37deg. the curve shows a maximum of 83,000 candles. The hemispherical intensity of light yielded by the integration of this curve amounts to 49,730 candles, whence it follows that with a consumption of 55·8 amperes × 89·3 volts = 4,980 watts the specific consumption of the lamp per candle-power obtained amounted to 0·1 watt.

Similar measurements were made with the lamp fitted with a globe, when the mean consumption of current amounted to 59 6 amperes at a mean terminal potential of 77 3 volts. The corresponding observations made under these modified conditions are given in Table V.

Fig. 5 shows the mean of the above values plotted in Curve 4, from which curve the diffusion of light corresponding to different angles of the lamp relative to the horizontal plane has been calculated. These latter values are given in Table VI., from which the curve shown in Fig. 6 has been plotted. From these figures it may be deduced that the hemispherical intensity of light obtained with a consumption of 4,610 watts amounts to 26,890 candles, which gives us a specific consumption of 0·17 of a watt.

TABLE V.—Large Continuous-Current Arc Lamp with Globe. 59·6 amperes × 77·3 volts = 4,610 watts.

Radial distance from the point of suspension in metres.	Intensity of light 1m. above ground level.
0	406
1	339
2	460
3	429
4	447
5	395
6	224
7	238
8	244
9	227
10	133
11	118
12	73·7
13	58·6
14	56·9
15	45·9
16	30·0
17	23·8
18	24·5
19	18·4
20	19·2
21	17·6
22	8·7
23	10·3
24	12·2
25	8 9
26	6·9
27	5·6
28	4 9
29	4·1
30	4·8
34	3·6
38	2 07
43	1·64
50	1·18
34	1·36

TABLE VI.—Large Continuous-Current Arc Lamp with Globe. 59 6 amperes × 77·3 volts = 4,610 watts.

Angle of inclination to the horizontal plane.	Intensity of light.
90°	17,150
81 50′	20,710
74	23 980
66 50′	27,760
60 10′	31,700
54 30′	34 540
49 20′	35,860
45	35,760
41 10′	35,450
37 50′	35,400
35	35,070
32 30′	33,850
30 20′	30,960
28 20′	29,860
26 40′	27,300
25	25,930
23 40′	22 790
22 20′	22,240
21 10′	23,760
20 10′	23,790
18 30′	24,710
17	21,750
15	19,610
13 10′	16,250
9 10′	19,530
8	21,540

It follows from the above data that the specific consumption of these two lamps, without globes, relative to the hemispherical intensity of light obtained, amounted, roughly, to 0·1 of a watt. The lowest value which it has been my experience to come across hitherto in connection with other lamps amounted to 0 3 of a watt, the average, according to my observations, being from 0·4 to 0·5 of a watt. Hence the specific consumption of the new lamp is at least one-third that of the types hitherto in use. In other words, three times the amount of light may be obtained with the same consumption of energy. This, in my opinion, constitutes a very important advance.

(To be continued.)

An Electrical Cure for Tuberculosis.—It transpired during the proceedings of the International Congress of Medicine, held at Paris, that a new treatment of tuberculosis had been discovered by a Frenchman (M. Franciaque Croth). The treatment is stated to consist in the direct transmission of antiseptics by means of static electricity, and seems to have given satisfactory results.

Digitized by Google

SOME NOTES ON DR. R. C. SHETTLE'S VIEW OF THE ULTIMATE NATURE OF ELECTRICITY.

BY SPENCER L. FLETCHER.

The view taken by Dr. R. C. Shettle of the ultimate nature of electricity is briefly as follows: (1) that electricity is a substance which probably consists of ether in a state of condensation; (2) that the individual atoms of matter are surrounded with atmospheres of condensed ether, which give to them their electrical properties and power of chemical combination.

From this it would follow that a positively-charged body is one which is more densely charged with condensed ether than a neutral body, a discharge being merely the liberation of this condensed ether. The view that electrical phenomena are to be ascribed to the agency of a substance is by no means foreign or contrary to the electrical science of to-day. "Clerk Maxwell proposed a theory of the relation between electromagnet phenomena and the phenomena of light, based upon the assumption that each of these are due to certain modes of motion in the all-pervading ether of space, the phenomena of electric currents and magnets being due to streams and whirls and other bodily movements in the substance of the ether, while light is due to vibrations to and fro in it."*

In a recent text-book for the University of London, the following statements occur: "When we electrify a body we effect some change in a very imperfectly known substance called electricity, which is associated with all matter, and which can be transferred from one body to another. When bodies possess their normal amount of electricity they are neutral, and when they possess more or less than that amount the excess or deficiency is called a charge. . . . When two dissimilar bodies are rubbed together all that takes place is a transfer of electricity from one to the other, so that one acquires an excess, the other an equal deficit."†

The view that the ether of space tends to condense upon the ultimate particles of ordinary matter is supported by no less an authority than Dr. Oliver Lodge ‡ The velocity of light in glass, as proved by the experiments of Foucault, is about two-thirds of the velocity in air (186,000 miles per second). To what must this decrease in velocity be ascribed? Glass itself transmits vibrations at only a few thousand feet per second, hence we must ascribe the transmission of the light rays which traverse the glass, not to the material of the glass itself, but to the ether within it. We arrive at the conclusion that the ether which occupies the interstices between the particles of the glass transmits light with only two-thirds of the velocity of light travelling in the ether of space.

From the analogy of sound, it is known that wave motion is retarded either by a decrease in the elasticity or by an increase in the density of the medium traversed. Dr. Lodge prefers the latter cause, ascribing the diminution in the velocity of light when traversing glass to a condensation of the ether within the substance of the glass itself. This means that each particle of the glass is surrounded by an atmosphere of ether which is of greater density than the ether of space. It appears that these ether atmospheres might be transferred from one particle to another according to much the same laws as those which govern the production of electric charges by friction. The source of electrification appears to be really contact of dissimilar substances, that is, substances which have a natural difference of potential, the motion of one substance over the other merely serving to renew the surfaces in contact.

By the natural potential of a substance is to be understood (according to the views stated at the head of this paper) the pressure of its contained ether. This will depend upon the tendency of the individual atoms of the substance to condense the ether of space around them, and this will presumably be different for the atoms of the different elements. Thus, if two *different* substances were brought into close contact so that their ethereal atmospheres might coalesce, it seems quite conceivable that after separation their charges of "bound ether" should be found to be shared in a proportion differing from that in which they existed before contact. One would lose exactly what the other gained, and thus positive and negative charges (representing excess and deficiency of electricity) would be produced in equal amounts. If the two substances were identical in every way, the affinities of their particles for ether would be equal, and there would be no tendency during contact for an *unequal* distribution of the ether charges. Hence, with two substances which are identically the same, no electrification results from bringing them into contact. This is exactly in accord with experiment.

If we conceive the ether atmospheres of the atoms to be endowed with any property resembling surface tension, it is possible to form a theory of chemical combination. For if two atoms were brought so near together that their ether atmospheres touched, these would coalesce like two drops of water, and since the ether atmospheres are attached to the atoms the two would be held together. In cases where the atomic atmospheres were large, the interstices of a molecule formed of such atoms would be completely filled with condensed ether, and a superabundance would accumulate outside. Such a molecule, or a mass of such molecules, would, according to the above views, be positively electrified—*i.e*, in a condition to communicate electricity (condensed ether) to a neutral body. Should this be a metallic wire, the excess of ether of the positive body would coalesce with the ether envelopes of the atoms of the wire at the point of contact, and from these pass on to others, thus establishing an actual flow of condensed ether along the wire until its potential and that of the original body were equalised.

Conversely, the constitution of a negative body would be such that its atomic interspaces were only partially filled with condensed ether. The atoms would have small envelopes, which would coalesce only at the points of contact with one another, leaving interspaces between. (*Note.*—It would at first appear that a positive body which is completely saturated with condensed ether would necessarily lose its cohesive property, because when the atomic interspaces were full, there would be no "capillary" surfaces of condensed ether to exert tension between the atoms. The conception of ethereal atomic envelopes possessing surface tension implies, however, that the condensed ether has an affinity for itself as well as for the atoms of matter, and this, upon the present hypothesis, is the ultimate force which holds the particles of a mass together.) The layer of condensed ether upon the surfaces of the atoms cannot be infinitely thin, or the amount condensed within a mass of glass would not sufficiently fill the interspaces in which the light travels to seriously affect its velocity. And since refraction (which is due to the retardation of the ray on entering the denser medium) takes place even in the upper regions of the atmosphere, it appears that the ether envelopes must fill a portion of the atomic and molecular interspaces, which is by no means negligible even in a rarefied gas.

Let us trace upon these hypotheses the action of an electrolytic cell containing, say, a solution of sodium chloride (NaCl). In a dilute solution, the ions, Na and Cl, it is now believed, are travelling about separately in the liquid, the Na endowed with a positive, the Cl with a negative electric charge. In other words, the Na is associated with an excess, the Cl with a deficiency of condensed ether. The two electrodes are also positive and negative in the same way. When an atom of Na, with its excess of "bound ether," comes into contact with the negative electrode, there is a transference of ether from the Na to the electrode. When an atom of Cl which is negative or deficient in ether comes in contact with the positive electrode which contains an excess, there is a transference of ether from the electrode to the Cl. Thus electricity enters the liquid by the positive and leaves it by the negative electrode. The ions appear only in the near neighbourhood of the electrodes, for until discharged by contact with them they appear to be chemically inert. The action of a voltaic or primary cell may be explained in a similar manner. When dry zinc and copper are brought together in air, the zinc is relatively

* Silvanus Thompson's "Lessons on Electricity and Magnetism," p. 359.

† "General Elementary Science," electrical section, pp. 89 and 90; John Don, M.A., B.Sc.

‡ "Modern Views of Electricity"; Dr. Oliver Lodge.

Digitized by Google

positive, and electricity flows from zinc to copper. If, however, the zinc and copper are partially immersed in a dilute acid and contact is made, the zinc is relatively negative, and the current flows (above the liquid) from copper to zinc. It appears that of two metals dipped into a corrosive liquid, that one becomes negative which is more easily corroded. Let the exciting liquid be dilute H_2SO_4; of this, the H is positive, the SO_4 group negative (as proved by their going respectively to the negative and positive electrodes in electrolysis). The SO_4 combines with the zinc, forming zinc sulphate, which dissolves in the liquid; hence positive zinc atoms are continually being subtracted from the zinc plate. Meanwhile the positive hydrogen atoms discharge their excess of ether into the copper plate, and thus a current is kept up along the external circuit from copper to zinc. In the case of contact of the dry metals, ether is transferred from copper to zinc, because the atoms of the positive zinc have the larger ethereal envelopes, the inter-atomic interstices of the zinc are quite full, and an excess of condensed ether resides upon the surface of mass.

The ether envelope theory also explains to some extent why transparent solids are non-conductors and conducting solids are opaque to light. In metals the condensed ether, or at least a portion of it, appears to be capable of flowing from atom to atom within the mass of the substance, maintaining a uniform pressure throughout like a gas dissolved in a liquid. This would seem inconsistent with the rigidity necessary for the transmission of the transverse vibrations of light. In glass, on the other hand, the condensed ether appears to possess this rigidity, to be more rigidly attached to the atoms and less mobile. Hence glass does not conduct. Water, if quite pure, behaves like glass—transmits light, but not electricity. To render it a conductor, a catalytic agent must be present, as a few drops of acid. Even then the transfer of condensed ether through the liquid is only accomplished by means of actual movements of the atoms. It is not real conduction, but electrolytic convection. It thus appears that the condensed ether in an opaque conductor, such as copper, possesses a certain amount of mobility, while in a transparent insulator, such as glass, it is more rigid and resembles a jelly.

TAUNTON ELECTRICITY WORKS.

On Wednesday afternoon, at the Taunton Corporation electricity works, the Mayoress (Mrs. W. A. Wren) formally set in motion the new electrical plant which has lately been installed to meet the extended use of electricity in the borough. The opportunity was taken to make a presentation to Alderman and Mrs. Potter, on behalf of the Council and inhabitants of Taunton, as a mark of the esteem in which the worthy alderman is held by his fellow-townsmen for the energy and ability he has displayed in presiding over the Electric Lighting Committee, and having succeeded in making its work so successful, both from the municipal and financial standpoint. The afternoon's proceedings commenced in the electrical machine-room, where a large and fashionable company had assembled, including the Mayor (Mr. Councillor W. A. Wren) and the Mayoress, Alderman W. and Mrs. Potter, Colonel Welby, M.P. for the borough, and other members of the Corporation.

Alderman POTTER sketched the growth of the electric light in Taunton, and referred to the new plant that had had to be placed in the works since the Corporation assumed control of the undertaking. Now the Corporation had added, at a cost of about £5,000, a new electrical steam pump for the purpose of pumping water into the boilers, and also an economiser. With regard to anticipated results, he might say in the month of June last, when the new plant was not running, the number of units generated were 18,606, and the consumption of coal was 90 tons. In the month of July, when the plant was worked, the units generated numbered 24,115, and the coal consumed was 77 tons.

The Mayoress then set the new plant in motion, and the assembly adjourned to a marquee erected in the yard outside, where refreshments were served.

The MAYOR then made the presentation, paying a high tribute to Alderman Potter for his work in connection with the committee, and which had been of so great advantage to the town.

Alderman POTTER, on behalf of his wife and himself, thanked them sincerely for their kind gift.

A vote of thanks was accorded the Mayoress on the proposition of Mr. VAN TROMP, seconded by Colonel WELBY, M.P., and the proceedings concluded with hearty cheers for Alderman and Mrs. Potter.

The presentation consisted of a very handsome silver tray embellished with flat chasing of old design, with richly fluted edges. In the centre are the arms of the borough, and the inscription "Presented, with a silver tea and coffee service, to Mrs. Potter, by the Council and burgesses of Taunton, in recognition of the services rendered by Alderman William Potter, J.P., as chairman of the Municipal Electric Lighting Committee, August 15th, 1900." The tea and coffee service is of solid silver, fluted in Chippendale style, and was supplied by Messrs. Franklin and Hare, jewellers, Fore-street. A casket of silver was presented to Mr. Alderman Potter, on the front of which are Mr. Potter's initials, in blue and red enamel, and on the reverse side the inscription "Presented to Alderman William Potter, J.P., with a copy of the resolution of the Taunton Town Council acknowledging services rendered by him as chairman of the Electric Lighting Committee, 15th August, 1900." On each side are columns, being representations of the borough mace. The cover is surmounted by the Taunton arms, and the casket stands on velvet. It was made by Messrs. Drayton and Sons, and is a beautiful specimen of silversmith's work. The illuminated address, which is excellently done, was the work of Mr. Burrow, engraver, of Bath-place.

FORTHCOMING EVENTS.

SATURDAY, AUG. 18.

Battersea Vestry.—At 3.30 p.m., foundation-stone laying of Lombard-road central electric station.

AUG. 18-25.

International Congress of Electricians at Paris.—

Aug. 18.—General meeting, at 10 a.m., at the Salle des Congrés, Pont de l'Alma. Reception. Division into sections, etc., tickets, etc. Afternoon, visit to the Exhibition.

Aug. 20.—Sectional meetings, commence at 9 a.m., 44, Rue des Rennes. Afternoon, visit to the electric installation of the Chemin de fer du Nord at La Chapelle.

Aug. 21.—Sectional meetings, 9 a.m., 44, Rue des Rennes. Afternoon, visit to Chantilly. Luncheon at 5. Return to Paris at 7.

Aug. 22.—Sectional meetings, 9 a.m., 44, Rue des Rennes. Afternoon, visit to the works of the Paris Compressed-Air Company, Quai Jemnapes, and to the works of the Metropolitan Railway.

Aug. 23.—Sectional meetings, 9 a.m., 44, Rue des Rennes. Afternoon, visit to the electric works of the Orleans Railway and the works of Moulineaux.

Aug. 24.—Sectional meetings, 9 a.m., 44, Rue des Rennes. Afternoon, meetings of sections not having finished their work.

Aug. 25.—Closing meeting, 9 a.m., 44, Rue des Rennes.

WEDNESDAY, AUG. 22.

Institution of Electrical Engineers.—Paris meeting; reception in the British Royal Pavilion in the Paris Exhibition, 5 to 7 p.m.

WEDNESDAY, SEPT. 5.

British Association.—Annual meeting at Bradford.

SEPT. 18 21.

Iron and Steel Institute.—Paris meeting, Sept. 18, 19, 20, and 21.

Sept. 17.—Secretaries' office opens at the Société d'Encouragement pour l'Industrie Nationale, 44, Rue de Rennes, at 3 p.m. 6 p.m., meeting of council at Mr. Henry Chapman's office, 10, Rue Laffitte.

Sept. 18.—9.30 a.m., reception of the president in the hall of the Société d'Encouragement; reading and discussion of papers. 2 p.m., visit to the Exhibition. 9 p.m., Soirée Musicale et Littéraire by the Comité des Forges de France.

Sept. 19.—9 30 a.m., general meeting in the hall of the Société d'Encouragement; reading and discussion of papers. 2 p.m., visit to the Exhibition. 7.30 p.m., the Institute entertains the Reception Committee at a banquet at the Hôtel Continental, Rue Castiglione.

Sept. 20.—10 a.m., visit to the exhibition at Vincennes (locomotives, railway plant, and machine tools). 8 p.m., Group A will start for the St. Chamond Works. 10 p.m., Group B will start for the Hayange Works.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	217	City and Guilds of London Institute	238
Leigh Corporation Electricity Works	222	Catalogues and other Publications Received	238
The Evolution of Switch Gears for High-Pressure Alternating Currents	224	The Joint Committee on Municipal Trading and Cardiff	240
The Verband Deutscher Elektrotechniker	229	Questions and Answers	240
Some Notes on Dr. R. C. Shettle's View of the Ultimate Nature of Electricity	232	Light Railways	244
Taunton Electricity Works	233	Companies' Meetings and Reports	244
Forthcoming Events	233	Contracts for Electrical Supplies	245
Those Critics	234	Traction Notes	246
Correspondence	235	Lighting Notes	247
Visit of the A.I.E.E.	235	Provisional Patents	250
Conduit v. Trolley	236	Specifications Accepted	252
The Electrical Engineers' Corps in South Africa	237	Traffic Returns	252
		Companies' Stock and Share List	252

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

THOSE CRITICS.

We hold no brief for the Admiralty, nor shall we attempt to excuse departmental methods of procrastination, but we think that critics like Mr. Mr. F. T. Jane in discussing the late naval manœuvres might usefully occupy a little of their spare time in collecting information before they assume that all useful suggestions are pigeon-holed. In the *Chronicle* of Aug. 11, we find a heavy indictment against some unknown clerk for having shelved service suggestions relating to electric hoists on board men-of-war. Yet we are in a position to state that the question of employing electricity for various operations on board ship is not only not shelved, but is receiving careful consideration, and has for some time been under consideration. Hence the trouble is not in the absolute shelving, but in the lapse of time occupied in making up the minds of My Lords. It does not even come to this, for minds are made up. And yet much time is wasted before the final authoritative signature is given for the organisation or equipment of a special staff which must devote its sole attention to the problems arising from the use of electricity on board ship. The Admiralty officials must by this time have grown as used to the worrying of outsiders as an eel is to skinning, the result being that in the end the outsiders get their way. The waste of time, however, is alarming, as is the waste of money. Yet the system of irresponsibility continues. Outside opinion forced the introduction of breechloaders. Why? Because the conditions of the case all tend to the continuation of what exists. It is easy to go on in a stereotyped manner; it is troublesome to change for the better, especially when it is necessary to show that the change is for the better before it is made. A certain amount of experimental work is carried out, but there is no great meed of praise given to anyone who makes an improvement. Both services are permeated with a certain amount of cliqueism, so that ideas are not welcomed unless from the members of small coteries. Then usually the remuneration obtained for introducing something new to a Government department by a member of that department, is altogether out of proportion to that which would be obtained from outside sources. In other words, there is a lack of all incentive to introduce improvements. From the abstract point of view, it is wonderful that so much is done; yet *esprit de corps* counts for a good deal, and many men work hard to keep their particular department up to the mark. It is within the knowledge of many readers, for example, that years ago a number of experiments were made to use electric motors in the training of guns. The results of these experiments are fully known only in select professional circles, and we should not be surprised to see some critic condemning artillerymen for lack of appreciation in this phase of electrical work. It is to the credit of the naval authorities that so soon after the introduction of the dynamo and the modern arc and incandescent lamps, their value was seen and all ships fitted with them. The mere fact that this was so should go far to prove that no

Digitized by Google

clerk could really pigeon-hole a good suggestion for the increased use of electricity. Leaving aside this particular question for a far more important one, let us ask whether the majority of critics of public authorities ever considered the conditions surrounding the particular things they criticise. There is a fall of snow, always followed by howls because the various authorities do not keep the pavements and streets clear. There comes a week of hot weather, the streets are gritty and dusty, and the vestries and councils are anathematised because of the disgraceful state of the streets. There comes an unusual spell of dry weather, and, Oh! those water companies. The Admiralty builds and equips a ship. It is up-to-date to-day, but consider the remarks upon that ship and the Department because ten years hence it appears upon the list as one of the ships of the fleet. Really, according to the sentiments somewhat freely expressed of late, no ship belonging to the country ought to be reckoned a fighting unit after it has left the stocks. It is then out of date, its armament old, and altogether it is useless. Of course, if the world progresses, improvements come, and what is built is built, and in a measure is antiquated, but that is a thing which attaches itself to many of the things of this mundane life. Often there is much doubt as to what really is an improvement till the new departure had stood the test of trial; but whatever be the views held, one thing is certain—that the British first line of defence ought to be equipped with everything that is considered to be an improvement upon that which has gone before. Too much time should not be wasted before introducing improvements.

CORRESPONDENCE

"One man's word is no man's word,
Justice needs that both be heard."

CONDUIT v. TROLLEY.

SIR,—In the letter by J. Clifton Robinson entitled "The Case for the Trolley Tram in London," quoted from the *Daily Mail*, which appeared in your issue of the 10th, I trust we may see the commencement of a real vigorous campaign against the *folly* of the proposals of the London County Council (under the advice, it is understood, of Prof. Kennedy) to saddle London with the expense of a conduit system.

I will only ask you to admit one remark on the subject of the exaggerated unsightliness of the overhead trolley construction, which is, that her Majesty the Queen of these realms, during the splendid reception she had in Dublin last March, passed under 10 miles of trolley wires, the supports of which, instead of being in the way, gave an opportunity for an unprecedented beauty of floral decoration which would otherwise have been impossible.—Yours, etc., C. E. WEBBER (Major-General).

THE JANDUS ARC LAMP AND ELECTRIC COMPANY, LIMITED, v. WILLIAM JONES DAVY.

SIR,—In reference to the note appearing in your recent issue *re* the discontinuance of our action against William Jones Davy, we must ask you, in justice to the Jandus Arc Lamp and Electric Company, Limited, and to our many licensees, to state that proceedings in the nature of a test action upon the Jandus patents are now pending, in which we are advised that (as in the recent Johnson and Phillips action) we shall have a successful issue.

We shall then deal with the smaller infringers as we did with those licensees who, to their own detriment, elected to join hands with Messrs. Johnson and Phillips in disputing our rights under our licenses.—Yours, etc.,

A. A. GILLIES, Secretary.

(For the Jandus Arc Lamp and Electric Company, Limited.)

VISIT OF THE A.I.E.E.

The weather "did us proud" during the last few days, and consequently the excursion of the American and English electrical engineers on Sunday to Henley proved an extremely enjoyable outing. Monday was given over to business. The morning was reserved for visits of such of the members of the A.I.E.E. as chose to avail themselves of the privilege of going through the Board of Trade laboratories and the telegraph department of the General Post Office. In the afternoon a fair number assembled at the platform of the Shepherd's Bush Station of the Central London Railway, where they were taken in tow by the indefatigable secretary of the Institution, Mr. MacMillan. A few minutes' walk brought the party to the spacious enclosure of the company's generating station and workshops. The engineer of the company, Mr. T. Stevens, then explained the wonders of the place. The yard is connected with the sidings of the Great Northern and Great Western Railways, and contains a number of large buildings. The extreme loftiness and vast size of the workshops failed not to impress the visitors. A dozen or more motors which were laying about, casually, as it were, served well to illustrate the magnitude of the concern, while the inner "works" of others in various stages of progress showed that if not everything, at least a good deal of the work is done on the spot. The easy working, starting, and stopping of one of the motors upon which the visitors were allowed to travel through the yard, was greatly admired. Here it was where the kodakers took their opportunity and their snapshots. The engine-house came next, a building remarkably free from noise—there were three large machines running at the time—but its temperature of about 105deg. did not favourably compare with the atmosphere just left in the 2d. tube. We noticed an admirable cooling tower at the end of the building, and wondered why a fan to ventilate the engine-room had not been connected with it. The boiler-room was really much cooler. The elaborate condensing apparatus, scrapers, etc., alone repaid for the visit. Everywhere the same vastness of space prevailed. After leaving the works the party were taken down the 2d. tube again, without disbursement of the customary obolus, however, as the general manager, Mr. Cunningham, had taken charge of them, and the Bond-street Station, which is not yet open to the general public, was especially open for the occasion. The visitors expressed themselves greatly pleased with the company's decision not to disfigure the beautiful white glazed walls of the tunnels with advertisements. Mr. R. K. Gray took charge of those who wished to visit the sub-station at the Marble Arch, and both groups then spent some time at the large Davies-street station of the Westminster Electric Lighting Company.

On Monday evening the Institution had a dinner in honour of the members of the American Institute who were over on their road to the Paris Exhibition congress. The dinner was held at the Prince's Restaurant, than which no better place could have been chosen. It was largely attended, considering that London is out of season, and Prof. Perry made an excellent chairman. The speeches, both from members on our own side and from those coming over the Atlantic, were far above the average. Of course, we know that Americans are born orators, and it must have been due to the recent rubbing of shoulders that our own representatives rose to the occasion. It is not necessary to report the speeches, as they were all of a social character, though Prof. Perry commenced with claiming everybody as compatriots, even though they were accidentally born in some other land; and we really think that ere the end of the evening, every lady and gentleman

Digitized by Google

in the assemblage was ready to swear eternal sister and brotherhood. It was a happy gathering, admirably conceived and carried out, and will form a red-letter day to all who were present.

On Tuesday morning about 20 members of both the American and English institutions met at Victoria, including Mr. Carl Hering and Prof. Perry (the presidents), Mr. Pope and Mr. MacMillan (the secretaries), Major-General Webber, etc. At Chatham, which was reached at 11 a.m., a drag with four fine greys stood in waiting, and soon brought the party up to the dock gates, where they found a very large inscription: "Bring no matches into this dockyard," much to the concern of the smokers, who were not in a minority. Here they were met by Major Carr, the chief instructor of the Electrical School of Military Engineering, who proved an inexhaustible mine of information during the rest of the day. Further on the Admiral-Superintendent Swinton C. Holland made his appearance and welcomed the visitors. Presently a funny little engine came along with two large-sized trunks behind it, into which all were stowed away somehow in order to proceed on what seemed a 12in. gauge of rail through the yard. It is said of the "Black Maria" that its horses are so swift that they will take you in half an hour where it may take you six months to get back again. That funny little engine played a very similar joke. It took you along for about five minutes, and you had a walk back of about two hours afterwards. To see Chatham Dockyard sufficiently, two or three hours are nothing. Mr. Reid, C.E., joined the party, and explained the details of the ships now in the course of construction, and also of various appliances to be found in the workshops. There was the "Albemarle," laid down on Jan. 8 this year, in the slip, and showing already considerable signs of progress; further on the "Venerable," in the dry dock, just having the armour-plates put on (this ship was laid down on Jan. 2, 1899); and the "Irresistible," in the basin, about a year older, and nearly completed. There was much that was interesting, but little that was new, in the large workshops, barring, perhaps, the searchlights, a number of practical portable electric motors of various sizes, which can be coupled to a flexible shaft wherever power is required, and the clever contrivance for firing off torpedoes, consisting of two electromagnets, by means of which a metal ball is released suddenly. This, by means of a contact box, frees a circuit connected with a shaft, and thus brings an independent battery into play, by means of which the tube is fired. After visiting the boiler-rooms, where the galvanic baths were seen in operation, came the long, long tramp past dozens of her Majesty's ships, just returned from the manœuvres, up a steep hill into the schools. They are lofty and airy, and contain the appliances for the high theoretical and practical teaching for which they serve. The visitors all declared that they had never seen such a beautiful projecting lantern as the one shown by the instructing officers in one of the school-rooms. Power is laid on to the tables, thus giving every facility for demonstration. A number of very powerful searchlights, also serving for instruction purposes, were shown next. Automatic arc lamps only are now used. The school is divided into telegraph and electric light classes.

The work now being ended the play began, and soon the officers' quarters were reached. Here Major-General Sir Thomas Fraser, K.C.B., C.M.G., R.E., received the visitors and headed the table at the excellent and most enjoyable luncheon which followed. The mess plate and the throne and cushions of the late Emperor of China came in for their share of admiration during smoking time. In answer to an intimation to "come into the garden," the visitors passed through the Crimean arch on to the lawn of the commandant's house, and paid their respects to Lady Fraser. The "At home" took the shape of a garden party, where a long programme of music by the band of H.M. Royal Engineers, under the leadership of Lieutenant J. Sommer, R.E., proved the attraction on one end of the lawn, while the other end, near the refreshment tent, was not exactly quite deserted. However, five o'clock soon came along, and with it the coach, the train and the return journey.

On Wednesday morning the visitors, who expressed themselves vastly pleased with their reception, left for Paris.

CONDUIT v. TROLLEY.

Under the above heading we published an article in our last issue from the pen of Mr. J. Clifton Robinson, C.E., which appeared in the *Daily Mail* of Wednesday, Aug. 8. In its impression of the 10th inst. the same paper contained an interview with Mr. J. Allen Baker, L.C.C., which may be taken as representing the views of the other side—that is to say, the converts to the conduit system, the policy of the London County Council in adopting which Mr. Clifton Robinson so strongly opposes. The following remarks in defence of this policy elicited from Mr. Allen Baker during the course of the interview in question should therefore prove interesting:

"London is still asleep to the importance of tramways in modern life and the immense saving which is coming to us with the adoption of electric traction. On the New York conduit system, where, of course, labour and other expenses are much higher than in London, the working cost has been reduced to 5d. per car mile. At least an equal result might be anticipated for London. But assuming the working cost of electric traction to be 6d. per car mile (a figure that has been justified by trolley experience in various cities in the United Kingdom) the margin of profit on the present mileage would then, without any increase of car mile earnings, amount to the sum of £750,000.

"Loss of Time in Money.

"Thanks to the slowness of horse traction, at a low estimate an average of at least a quarter of an hour is lost by each passenger daily. If you reckon the time of the people as worth only the minimum labour wage of 6d. an hour, this loss of time even on the present traffic mileage might be valued at 2¼ millions a year, which will be saved when electric traction comes—an item which, of course, would be enormously increased by the natural development and extension of the system. The London County Council is now doing its best to ensure that we shall have a tramway system worthy the capital of this Empire. It is getting a Bill through Parliament which will enable it to transform all the present lines of horse traction to electric, and as early as possible it will lay down a conduit line from Westminster to Tooting. The Highways Committee of the Council is anxious to obtain many necessary extensions both in the centre of London and in the suburbs. But here it is frequently blocked by the vestries. Although the County Council is the supreme tramway authority in London, the vestries are the road authorities. By the present defective state of the law, the County Council cannot even be heard in Parliament in favour of extensions or new tramways until the consent of the vestries is obtained.

"Against the Trolley.

"So far as the Council is concerned, there is now no controversy about the method of traction to be used. We have decided against the electric trolley, and in favour of either the conduit or surface contact. This decision has not been taken without most careful consideration of all the facts bearing on the matter. We are not faddists, tied down to any one plan. Our one desire is to give London the best. I saw the conduit at work in Washington and New York, and I must say I was convinced it met the requirements of a large and crowded metropolis like London much better than any other system which we have before us and which has been practically tested. Before I had opportunity of seeing the actual returns of working expenses, I felt sure from my knowledge as an engineer that the conduit should be cheaper to operate (leaving the initial cost of construction out of the question) than the trolley. In the trolley there must be a certain loss of electricity in working, which, in a properly-constructed conduit where both currents are conveyed by insulated bars, is avoided. On the trolley you have the sparking of the wheels wherever any rubbish or dust comes between them and the rails. This is unsightly and frightens horses, besides causing a waste of electric power. The trolley needs constant repair, in mending broken wires, tightening slack wires, stays, guys, and the like. The ugly repair

Digitized by Google

van is constantly seen on the road wherever there is an overhead wire system.

"THE ÆSTHETIC OBJECTION.

"There are two other disadvantages of the trolley which must be mentioned, though I have no wish to dwell on them too much. There is the æsthetic objection to the unsightliness of overhead wires. No doubt people quickly become accustomed to these, but you cannot say that they add to the beauty of any place. In London the disadvantage of overhead wires would be especially felt. Owing to the necessity of guarding observatories and other centres of scientific observation, and for the avoidance of electrolysis in street mains, it has been decided by the Board of Trade that any overhead lines in London must have double return wires, or that there must be four rows of overhead wires for every double track. You would have eight wires across the street where lines crossed. In addition, of course, there would be the staying wires. At such a place as the Elephant and Castle, where half a dozen lines met, the street would be obscured by the maze of overhead wires. Notwithstanding all that has been done to make them safe, there is some danger in having so many live electric wires in the streets. You can find case after case in recent years where men and horses have been electrocuted by such wires breaking and falling.

"CONDUIT CHEAPER THAN TROLLEY.

"I said that I was convinced theoretically that the conduit ought to be cheaper to work than the trolley. I have since been able to obtain the actual working figures of the Metropolitan Street Railway Company of New York, the company which there owns the conduit lines. This company runs both conduit cars, cable, and horse cars. It finds that the operating expenses of its horse and cable cars are each about 8½d. a mile, while its conduit cars only cost 5d. per mile. In Chicago they have the horse, cable, and trolley running at the same time. There they find that while the cable costs 5½d. per mile, the trolley costs 6¼d. In other words, the conduit in both cases is cheaper than its competitors. It is urged against the conduit that it is very costly to construct, and that it involves great disturbance of the streets. It is admittedly more expensive to lay down than the trolley, but not nearly so much so as many try to make out. The cost of a conduit line, apart from the removal of street mains, may be about 20 per cent. more than a trolley line. Where the trolley line under Board of Trade conditions would cost about £10,000 per mile of single track, the conduit would cost a little over £12,000. But this initial extra cost should be fully compensated for by the economy in working expenses.

"DIFFICULTIES CAN BE OVERCOME.

"Much stress has been laid on the removal of mains that would be necessary in building a conduit line in Central London. The whole of this problem was carefully considered by the County Council before deciding in favour of the conduit. In construction it will not be necessary to go more than about 2ft. 6in. deep for the foundations and iron chamber of the conduit. It should seldom be necessary to move any pipes, save at crossings, and we are obtaining such powers as will enable us to do such removal cheaply and quickly. It is possible to begin and finish each section of a street in three or four weeks. In building conduits in New York the tramway company took from 14 to 28 days over each section. What we aim at is to give to London a tramway service worthy of the Metropolis of the Empire, uniting North and South and East and West London under one great system, giving to the millions of our workers the benefits of a rapid, comfortable, and cheap means of transit from centre to suburb, or to those whose homes are in the crowded central districts, to park and open space outside. Most of the objections raised to the conduit system have arisen from personal interest or from misapprehension caused by imperfect knowledge. It is naturally to the interests of manufacturers of electrical appliances to advocate a system where the main expenditure goes on electric plant, rather than one where the greater part of the money goes on the permanent roadway. But the Highways Committee of the County Council is content in this matter to leave the verdict to experience."

THE ELECTRICAL ENGINEERS' CORPS IN SOUTH AFRICA.

The following is an extract from a report received from Major Crompton, dated July 17 and 18, 1900, showing where the officers, non-commissioned officers, and men of the corps were at work on those dates:

Of the six who were taken prisoners, two escaped and the other four were released. Lieutenant Pott is reported to be convalescent, and to be returning home. Second-Lieutenant Bigge, who was wounded, has returned to duty. Of those in hospital, Sapper Dalton is reported to be doing well; Sapper Arundel is convalescent, and owes his life to splendid nursing; Sapper Brander is convalescent. No information is given as to the condition of the others reported in hospital. The men have been at work: (1) as electric engineers fitting-up and repairing electric light and power plant; (2) searchlight men; (3) arc-light men for working parties; (4) on telephone light lines; (5) as army telegraphists; (6) as railway telegraphists; (7) as Royal Engineers' working parties on crib and trestle reconstruction railway bridges; (8) as a fighting unit. Major Crompton reports that they have done well in each branch. Major Crompton has requested me to remember him to all the officers and the corps as a whole, and hopes that what has been done in Africa will help the corps both as regards its prestige and future popularity, and he feels proud to have had command of such a thorough good lot of men.

(Signed) R. S. ERSKINE, Major.
Officer Commanding Electrical Engineers, R E. (Vols.).

Major R. E. B. Crompton, Headquarters, Pretoria.
Captain F. L. Lloyd, Headquarters, Pretoria.
Captain A. Bain, Railway Telegraph, Elandsfontein.
Captain H. M. Leaf, Headquarters, Pretoria.
Lieutenant J. F. O'Shaughnessy, Railway Telegraph, Elandsfontein.
Lieutenant A. H. Pott (enteric), Viljoensdrift.
Second-Lieutenant J. H. Stubbs, Army Telegraph, Kroonstadt.
Second-Lieutenant H. H. Bigge (wounded), Hospital, Johannesburg.
Second-Lieutenant F. Powell Williams, Headquarters, Pretoria.
16721 Sergeant-Major G. A. Brown, Headquarters, Pretoria.
6263 C.-S.-M. E. Rorke, Headquarters, Pretoria.
21109 Sergeant C. T. Ruse, Headquarters, Pretoria.
6166 Sergeant J. H. S. Phillips, Headquarters, Pretoria.
6171 Sergeant W. S. Entwistle, Railway Telegraph, Elandsfontein.
6193 Sergeant J. H. Brown, Headquarters, Pretoria.
6173 Corporal H. Bicker-Carter, in charge detachment, Bloemfontein.
6192 Corporal A. H. Graham, Headquarters, Pretoria.
6191 Corporal A. Charlton (prisoner believed; sent back).
6179 Corporal W. Dalton (enteric), Kroonstadt.
6206 Second-Corporal J. H. Stone, Railway Telegraph, Elandsfontein (reported hospital).
6264 Second-Corporal E. M. Sellon (released).
6183 Sapper H. R. Allen, Headquarters, Pretoria.
6271 Sapper F. D. Arundel (enteric), Bloemfontein.
6199 Sapper H. Bertram, Bloemfontein.
6169 Sapper S. M. Bowrey, Headquarters, Pretoria.
6196 Sapper R. H. Brander (sick, dysentery), Bloemfontein.
6210 Sapper G. Charlton (escaped).
6194 Sapper D. F. Colson (released).
6180 Sapper W. C. Cook (sick, on orderly duty to Lieutenant Pott), Viljoensdrift.
6187 Sapper M. N. Crawford, Bloemfontein.
6267 Sapper H. F. Claxton, Headquarters, Pretoria.
6269 Sapper W. G. Carter, Headquarters, Pretoria.
6197 Sapper A. S. C. Devonshire, Headquarters, Pretoria.
6177 Sapper E. J. H. Elliott, Headquarters, Pretoria.
6170 Sapper A. J. Hodgson, Army Telegraph, Kroonstadt.
6203 Sapper R. W. Holliday, Railway Telegraph, Elandsfontein.
6178 Sapper W. H. Hossack, Headquarters, Pretoria.
6184 Sapper J. H. Hounsfield, Bloemfontein.
6188 Sapper E. C. Horsley, Headquarters, Pretoria.
6205 Sapper D. G. W. Hume, Headquarters, Pretoria.
6201 Sapper C. Landon (released).
6209 Sapper A. E. Levine, Headquarters, Pretoria.
6175 Sapper C. T. Love, Headquarters, Pretoria.
6168 Sapper S. W. Melsom, Headquarters, Pretoria.
6268 Sapper A. E. Minns, Bloemfontein.
6174 Sapper H. A. Paris, Bloemfontein.
6185 Sapper A. R. Peart (released).

Digitized by Google

6198 Sapper N. W. Pirrie, Headquarters, Pretoria.
6165 Sapper F. J. Phillips, Railway Telegraph, Elandsfontein.
6272 Sapper F. G. Payne (enteric), Bloemfontein.
6273 Sapper C. W. S. Paine, Army Telegraph, Kroonstadt.
6182 Sapper R. B. Roberts, Headquarters, Pretoria.
6186 Sapper J. Rook, Railway Telegraph, Elandsfontein.
6195 Sapper C. E. Silverthorne, Headquarters, Pretoria.
6190 Sapper F. C. Stevens, Railway Telegraph Instrument Shop, Pretoria.
6207 Sapper C. R. H. Thorn, Railway Telegraph, Elandsfontein.
6208 Sapper B. H. Tilley, Army Telegraph, Kroonstadt.
6270 Sapper J. D. Taylor, Army Telegraph, Kroonstadt.
6200 Sapper F. J. Wallis, Headquarters, Pretoria.
6189 Sapper E. J. West, camp cook, Captain Bain's Railway Telegraph Detachment, Elandsfontein.
6172 Sapper E. J. Wright, Railway Telegraph, Elandsfontein.
6266 Sapper A. O. Wiltshire, Headquarters, Pretoria.
6181 Sapper F. J. Young, Headquarters, Pretoria.

CITY AND GUILDS OF LONDON INSTITUTE.

The diploma of "Associate of the City and Guilds Institute" (A.C.G.I.) has been conferred upon the following matriculated students, who have completed a full course of study at the institute's Central Technical College, and have satisfactorily passed the examinations in the several courses:

Civil and Mechanical Engineering.—J. M. Bowrey (Jamaica Government Scholar), A. Bromley-Smith (London County Council Intermediate Scholar), J. F. Butler (John Samuel Scholar), A. H. Clark, W. H. C. Clay, R. H. Collins (Mitchell Scholar), A. E. Culley, F. Dennis (London County Council Intermediate Scholar), B. M. Duke, R. Freeman (Siemens Scholar), C. W. Jones (Haberdashers' Exhibitioner), A. J. Knight, S. Leslie, A. J. Munro (Fishmongers' Exhibitioner), F. Osbourn (London County Council Intermediate Scholar), W. J. Rusdell (Alleyn Scholar), J. W. M. Topley (Institute's Scholar), H. B. Unwin, J. A. Wickham.

Electrical Engineering.—M.V. Allen, F. C. N. Bergh (Durham County Council Exhibitioner), J. H. Brown, H. Berge, H. H. Crockford, B.A., W. A. Del Mar, E. Fawssett, P. Good, S. Gowan, H. J. Humphreys, A. P. Hutchinson, T. L. James (Institute's Scholar), H. L. E. Kennard, W. J. Line, F. G. Maunde-Thompson, D. H. Montgomerie, J. A. Parker (Clothworkers' Scholar), H. J. Thomson (David Salomons Scholar), M. A. Wood.

Applied Chemistry.—E. J. Denney, P. V. Dupré, J. A. Fortesquieu (London County Council Scholar), J. B. Gall (Mitchell Scholar), T. H. Page (London County Council Intermediate Scholar), T. R. Starkey, J. H. West (Institute's Scholar), W. B. Woodbridge.

Certificates have been awarded to the following students:

Students who have taken the regular course of instruction (including the third year course) at the Institute's Central Technical College for one or more sessions:

Civil and Mechanical Engineering.—E. S. Allsup (second class), P. L. Bowers (first class), F. G. G. Ford (first class), C. T. Gardner (second class), F. C. Henriques (second class), E. D. Kibble (first class).

Electrical Engineering.—H. R. Carson (first class), C. L. Faunthorpe (first class), R. G. Kindersley (first class), R. V. Lynn (first class), G. M. Newbery (first class), C. E. Newton (first class), W. G. Shee (second class), C. E. Vines (first class).

Chemistry.—J. R. G. Hopper (Surrey County Council Scholar) (first class).

Students who have taken the regular course of instruction (not including the third year course) at the institute's Central Technical College for one or more sessions:

Civil and Mechanical Engineering.—F. D. Arundel (first class), R. J. Francis (first class), E. J. W. Peck (first class), L. Pryce (second class), H. R. Scarlett (second class), J. B. W. Stroud (second class), F. H. Wroughton (second class).

Electrical Engineering.—W. G. Carter (first class), A. C. Stock (second class), J. H. Stone (first class).

Chemistry.—R. Blenkinsop (second class).

Students who have regularly attended a complete course of instruction for day students (extending over a period of two years for mechanical and electrical engineering students and three years for chemical students) at the institute's technical college, Finsbury, and have satisfactorily passed the several class examinations:

Mechanical Engineering.—D. A. Brown (London County Council Intermediate Scholar), F. M. Green, J. A. Merrett, S. S. Nevill, A. H. Roberts (London County Council Intermediate Scholar), S. W. Sims (London County Council Intermediate Scholar), P. Spalding, P. W. Warwick, A. C. Whish.

Electrical Engineering.—A. W. Bartlett (London County Council Intermediate Scholar), F. C. Baumann, G. Bish, J. Eustace, H. Frodsham, J. A. Gilfillan, E. C. Handcock, L. J. B. Hannan, J. T. Haynes, A. S. Herbert, F. I. Hiss, T. C. Hunt, W. J. Jeffery, C. R. Kemp, A. A. Kift, T. H. Langford, P. A. Laubach (London County Council Intermediate Scholar), W. U. Lonnon, B. H. Morphy (London County Council Intermediate Scholar), L. Murphy (London County Council Intermediate Scholar), M. Parker, R. L. Pearson, F. Pritchard (London County Council Intermediate Scholar), P. J. Robinson, F. R. C. Rouse (London County Council Intermediate Scholar), G. B. D. C. Saw, H. Seward, T. H. Vigor (London County Council Intermediate Scholar), W. S. Wright.

Technical Chemistry.—M. B. Blackler (London County Council Intermediate Scholar), J. W. G. Brooker, H. E. Course (London County Council Intermediate Scholar), J. V. Eyre, W. A. Handcock, H. Harding (London County Council Intermediate Scholar), J. Harris (London County Council Intermediate Scholar), F. T. Harry (London County Council Intermediate Scholar), E. Horton (London County Council Intermediate Scholar), H. E. Hoskin (London County Council Intermediate Scholar), A. Landau, W. J. A. Parish (London County Council Intermediate Scholar), W. Partridge, S. O. Richmond, T. R. B. Stevens, G. W. G. Tatham, T. C. Thomas, F. P. Whitaker (London County Council Intermediate Scholar).

Students who have taken a special course of instruction in one or more departments at the institute's Central Technical College for at least one session:

E. Brown, electrical engineering; W. L. Browne, civil and mechanical engineering; T. F. Burton, electrical engineering, chemistry, and mathematics; W. D. B. Duddell, electrical engineering; J. Gana, civil and mechanical engineering and mathematics; J. Lehmann, electrical engineering; H. E. Lyddon; civil and mechanical engineering, mathematics, and chemistry; L. L. Mercer, civil and mechanical engineering; H. Reé, electrical engineering; A. Rogers, civil and mechanical engineering and mathematics; S. de Stefani, electrical engineering; C. O. Thomas, civil and mechanical engineering and electrical engineering.

CATALOGUES AND OTHER PUBLICATIONS RECEIVED.

We have to acknowledge the receipt of several catalogues and leaflets from the General Electric Company, Limited. One of the former and larger publications deals with electric bells in a most thorough and comprehensive manner. Previous additions of this catalogue have rendered its general features familiar to the trade, but, of course, there have been many additions made in the revised issue, and what is, perhaps, more important, the prices of the thousand and one articles enumerated have been largely reduced in order, we are told, to enable the firm to keep pace with outside competition. At the same time, none of the reductions have been effected at the expense of quality. Personally, we happen to be acquainted with the company's huge factory in Salford, Manchester, where an establishment of over 1,000 hands is employed, as also with the methods in vogue there which enable high-class articles to be turned out at moderate prices. In their essential details of construction the cheaper class of goods manufactured by the firm are not inferior to the higher-priced articles of similar type, the relative cheapness being accounted for by economy in superfluous finish. An ammeter, for instance, fitted into a roughly-finished case should not give less satisfactory results than one placed in a highly-polished case, provided the internal workmanship is equal. In fact, for all practical purposes the instruments will possess equal value. Nor will an electric bell be necessarily less efficient because it is provided with a stained wood case instead of one of polished walnut. It is economy, then, effected in the less essential features of the apparatus which enables the General Electric Company to place reliable goods on the market at popular prices. We would not, however, give the impression that the cheaper-grade articles offered by the firm are of very rough finish; on the contrary, their finish is good enough for all ordinary purposes, the difference in appearance from the higher-classed articles being scarcely apparent. Labour-saving machinery also plays an important *rôle* in effecting economy of production at the Salford works, the firm having shown itself singularly alive to the possibilities of such apparatus. But to return to the catalogue. The compilers have succeeded well in their efforts to provide lucid descriptions and to arrange the numerous illustrations in a clear manner. The accompanying illustrations (Figs. 1 and 2), taken from the catalogue, show respectively a two-noted "motor" movement bell, which may be recommended for effect, and a compact ventilating outfit consisting of an

Digitized by Google

"Edison" iron-clad motor with an "Edison-Leyland" battery complete. The catalogue further includes many hundreds of illustrations of electric bells, indicators, and accessories, etc. Appended to the catalogue will also be found what constitutes a thorough manual of electric bell fitting, which cannot fail to be of great use to the technical and practical electric bell fitter,

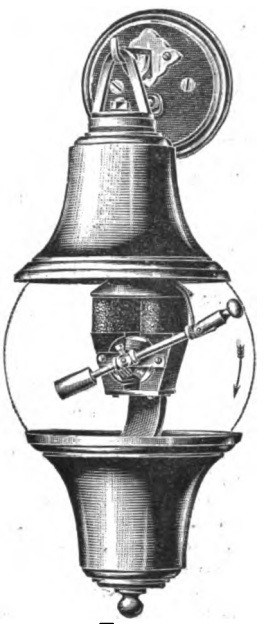


FIG. 1.

comprising as it does a complete set of diagrams showing connections for bell indicator circuits, etc., the outcome of many years' practical experience with this class of work. A copy of the same firm's new catalogue of wires, cables, conduits, casings, and wiring sundries has also reached us.

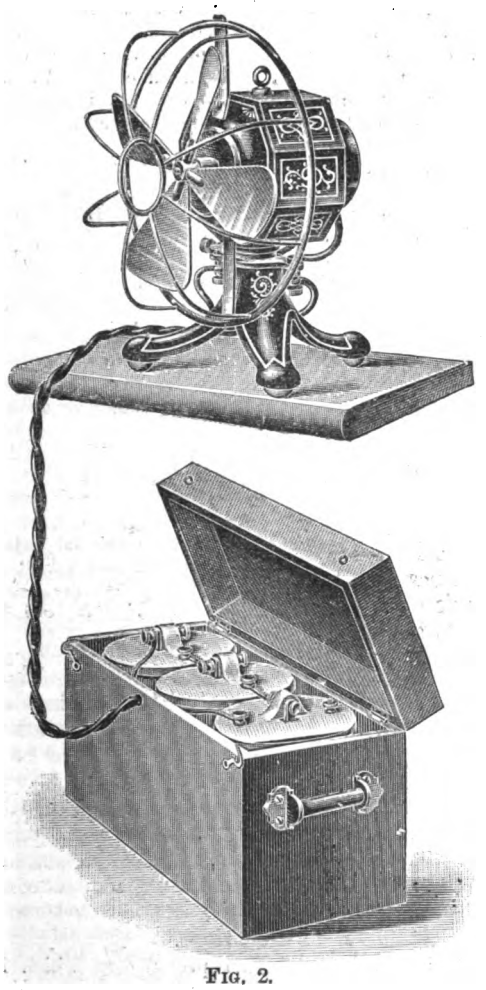


FIG. 2.

This is likewise a comprehensive volume of its kind, and represents the tenth edition of the firm's catalogue dealing with the above lines, although it is the first occasion upon which they have compiled a special list for wires, etc., independent of any other lighting or bell material. Wires and cables for electric light, bell, and telephone work are dealt with exhaustively, whilst in most useful rotation follow prices and particulars for casings, conduits, insulators, wiring accessories, and tools, the object of the special arrangement adopted being, we understand, to facilitate reference for purchasers of these particular classes of material. Another point of note is the section dealing with twin paper-insulated lead-covered wires and cables for house wiring, and also twin vulcanised wires and cables, which are now in great demand for conduit systems. The various systems of conduit are also very clearly enumerated in the list, more especially the firm's "Union" system, which, we understand, is finding extensive adoption. A novel feature with regard to conduits is the patent adapter block, shown on p. 232, for joining conduit to casing in a neat and workmanlike manner. Various new types of high-tension insulators are also shown, which, together with the other interesting features enumerated, should constitute the catalogue of considerable use to the trade, to whom copies are offered free on application to the head office of the General Electric Company, Limited, Queen Victoria-street, London, E.C.

Of less bulk is the same firm's new list of multipolar motors and lift controllers, briefly acknowledged in our issue of last week. These lists are intended for incorporation with the General Electric Company's big catalogue, a new edition of which is in course of preparation, and consulting engineers and contractors are invited to apply for copies in order to render the present list up to date. The same remarks apply to several leaflets dealing with new accessories, etc., just issued by the same firm.

Pamphlet No. 71 of the British Thomson-Houston Company, Limited, describes the Thomson tramway and portable recording wattmeters, already noted by us in our account of the Railways and Tramways Exhibition at Islington last month. Wastefulness of current on electric tramcars, due to the carelessness of the motormen, has been recognised by tramway managers as of serious importance, and the most effective method of checking it has thus far proved to be by installing in each car a tramway meter. Many tramway managers agree that the average waste due to carelessness of the motorman amounts to 20 per cent. or more of all the energy consumed. From tests recently made, as much as 25 to 30 per cent. difference has been found among motormen running the same car under almost exactly similar conditions. When proper records of the cars and of the motormen are kept, a saving of from 10 to 20 per cent. should be effected, and in some cases as high as 25 per cent. The profit from such economy is twofold. It saves, first, the cost of coal and water necessary to generate one-tenth to one-fifth of the total energy output of the station; second, it increases receipts by increasing car capacity in direct ratio of power saved, without enlarging the station. The electrical and mechanical construction of the street railway meter is of that extreme simplicity that ensures long life, great accuracy, and little liability to get out of order. It is especially designed to operate under the most severe conditions found in the electrical tramway service of to-day. Pamphlet No. 70 deals with magnetic blow-out lightning arresters for direct current. The function of lightning arresters in an electric installation is to relieve the conductors of any excessive electric potential differences that may exist between them and the earth, and at the same time to prevent the current of the generators following in the track of an electric discharge from conductor to ground. In the construction of lightning arresters for light and power circuits it is necessary, in order to afford protection to the circuit on which it is installed, that the path of the lightning discharge through the arrester provides a perfectly free path to the ground. A second consideration arises from the fact that electric circuits, however carefully insulated, are likely to have leaks to ground, especially in rainy weather, when thunderstorms are most frequent; the circuits usually must be equipped with several arresters to protect different sections of the line, and discharges may take place from the line to earth conductors simultaneously at several points. Under these conditions the generator current, though not of sufficient E.M.F. to start an arc across the air-gap of the arrester, is capable of maintaining one or several arcs started by a lightning discharge. These arcs, if continued, would not only destroy the arrester, but would in many cases permit such an excessive flow of current as to overload or destroy the generator or other apparatus. Eight types of the arresters are described in the pamphlet; these are adapted each for its special use, and should not be employed for circuits other than those specified.

From the British Westinghouse Electric and Manufacturing Company, Limited, we have received two interesting publications which cannot be classed as catalogues. One of these, entitled "Polyphase Induction Motors," describes various polyphase motors of Westinghouse manufacture in a very lucid manner, the text, as also the numerous illustrations, being well above average merit. Those wishing to learn something relative to the characteristic and general features of polyphase motors could not do better than obtain a copy of the booklet to add to their collection of similar publications by the firm in question dealing with other subjects. The approximate dimensions given for each type enhance the practical value of the publication. The other publication

Digitized by Google

received from the Westinghouse Company's publishing department is entitled "Electric Power," and illustrates the application of Westinghouse motors for various purposes. The illustrations cover a very wide range, and serve to indicate how electricity is making its way into practically every field where power is required. Brief references are given in four languages to each illustration, which, it only remains to say, are uniformly excellent, and should serve a useful purpose.

Messrs. John Spencer, Limited, Globe Tube and Engineering Works, Wednesbury, Staffordshire, have issued a very complete revised price-list of wrought-iron and steel tubes and fittings, etc., of every description for gas, water, steam, and hydraulic purposes; boiler tubes, compressed-air tubes, water-mains; telegraph, electric light, and telephone poles; overhead electric tramway poles; high-pressure steam mains for electric light and power installations; Spencer's patent welded flange tubes for high pressures, etc.

Messrs. Poth, Hille, and Co., engineers, merchants, and manufacturers, 27, Leadenhall-street, London, E.C., have just published a new illustrated price-list of "Empress" self-vulcanising jointing and engine-room supplies, "Eagle" high-grade emery and corundum wheels and grinding machinery, etc.

THE JOINT COMMITTEE ON MUNICIPAL TRADING AND CARDIFF.

The following communication has been addressed to us:

On Thursday week at a meeting of the Cardiff Electrical Committee the Town Clerk reported that, having seen the statements made by Mr. Dixon Davies in his evidence before the Joint Committee on Municipal Trading, he had sent the following communication to the Earl of Crewe, the chairman of the committee, and at the same time a copy to Mr. Davies:

"Town Hall, Cardiff, July 30, 1900.

"My Lord,—With regard to the Joint Select Committee on Municipal Trading, of which your Lordship is the chairman, I observe on a perusal of the minutes of evidence taken by the committee that on the 6th inst. Mr. Dixon Henry Davies, solicitor, and secretary of the Chesterfield Chamber of Commerce, was called and examined, and I find on p. 206, paragraphs 2,586, 2,587, and 2,588, that in answer to your Lordship as to the general result of his observations he expressed the opinion that the greatest objection to municipal trading was that it was not so dependable for the supply of the commercial necessities of the community as private trading, and upon being asked by your Lordship to give an instance in support of that opinion he quoted the case of Cardiff, and stated: 'The Cardiff Corporation started the supply of electrical energy some years ago. The works started some time ago, and were not quite up to date, and there were some failures—I believe frequent failures—and the Corporation, after taking the best advice they could get, resolved to extend their plant very materially, and they deposited a Bill for the purpose—for the purpose, that is, of enlargements where necessary—in order to make the electric light works efficient and keep them up to date and supply their customers. But on the Bill being submitted to the ratepayers of Cardiff, a poll was taken, and the poll was circulated with several heads, one of which especially included the expenditure upon the extension of the electric lighting, and the ratepayers by a very large majority refused to proceed with the matter.'

"In answer to the further question of your Lordship as to why the Corporation decided to adopt the rather unusual course of having a poll, he replied: 'I think there has to be a borough fund meeting to sanction the expenditure, and the decision of the meeting was challenged, and a poll was taken as the result of that challenge, so that the fact is that there you have an improvement—the extension of a concern which was extremely desirable from every point of view—from the point of view of the consumers, from the point of view of the owners of the works, the ratepayers, and yet for no reason at all except the capricious change of mind of the ratepayers—and when I say capricious I mean to say it was a change of mind which certainly would not have affected the shareholders in a company—the managers of the works were deprived of the financial resources necessary to keep them up to date.'

"I am desired by the Cardiff Corporation to state, for the information of your Lordship and the Joint Select Committee, that the evidence given upon this point as to what had taken place in Cardiff is entirely misleading, and, indeed, absolutely inaccurate, the facts with reference to electric lighting of the borough of Cardiff being as follows: In the parliamentary session of 1891 the Cardiff Corporation promoted a provisional order enabling them to supply electricity within the borough. That provisional order was in due course confirmed by Parliament, and the Corporation immediately took steps to put the powers thereby entrusted to them into operation, and in the construction of the works they were advised by one of the foremost electrical engineers of the day. The result was that the Cardiff electric light installation was completed in the year 1895, and in accordance with the terms of the order the Corporation were prepared to supply the compulsory area named in their order, and did supply that area, in addition to which they lighted the public streets (in the same area) by electricity. From time to time the Corporation have extended their works, and have laid their mains for some miles outside the compulsory area, and they are at the present time supplying electricity to buildings in several of the suburbs, in addition to which they are continually extending the public street-lighting by electricity. The Corporation have at all times shown themselves most desirous of taking the electrical energy to any part of the borough they may be desired, and with this object in view they have from time to time obtained the sanction of the Local Government Board to the borrowing of large sums of money for carrying out these works; and whereas the cost of laying down the installation in the first instance amounted to £45,000, the actual expenditure incurred by the Corporation up to the present time amounts to £90,000.

"Since the Corporation laid their installation they have never gone outside their resident electrical engineer for advice as to whether they should extend their plant or not. They have never deposited a Bill for the purpose of obtaining power to extend their plant or make enlargements of their works in order to make these works efficient, and keep them up to date to supply their customers. Indeed, they have at the present time all necessary powers to enable them to supply electrical energy in any part of the borough on obtaining the sanction of the Local Government Board to the expenditure. That being so, it of course follows that no poll on the subject of extending the electric light works was taken, and no expression of opinion has been sought or given by the ratepayers in reference thereto. As a matter of fact, whenever the Corporation have gone to the Local Government Board for sanction to the borrowing of money for electric light purposes there has never been any objection by the ratepayers, and none have opposed the same at the local enquiries which the Board have held from time to time.

"Your Lordship will therefore observe that the evidence of Mr. Dixon Henry Davies on the electrical supply of Cardiff is absolutely without foundation. My Corporation desire me to express their very strong disapproval of the action of Mr. Davies, and consider that before presuming to give evidence on a matter of this kind and thus misleading your committee, damaging the reputation of the Cardiff electrical light works, and creating a false impression as to municipal trading in Cardiff, he should at least have taken some trouble to make himself acquainted with the facts.

"Having regard to what has taken place, my Corporation consider it their duty to immediately submit this statement of the actual facts for the consideration of your Lordship and your Lordship's committee, and I am to express the hope that your Lordship will permit this communication to be recorded on the minutes of the Joint Committee.—I am, my Lord, your Lordship's obedient and humble servant, TOWN CLERK.

"The Right Hon. the Earl of Crewe, chairman of the Joint Select Committee on Municipal Trading, Houses of Parliament, Westminster, London, S.W."

The committee decided to have the letter recorded on the minutes.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

297. What is the lowest steam pressure at which it is considered economical to use compound non-condensing engines? In a small continuous-current station, 12 hours' run, steam pressure at engine 80lb., what types of engine and dynamo are likely to give best results and run with least noise with load varying from half to full load (1) with floor space limited; (2) unlimited? What should be coal and water consumption per horse-power, feed water between 150deg. and 200deg. F.?—J. S.

Digitized by Google

298. I have a slow-revolution large-unit engine driving a dynamo. The speed of the dynamo is not uniform enough, and I wish to know where to look for and how to remedy this defect.—T.

299. When the load is suddenly taken off an engine in ordinary cases it will race away, but in the case of an engine and dynamo direct-coupled a "dead short" pulls the engine up instantly. Please explain this fully?—W.

300. In designing a polyphase installation, what circumstances would guide you in selecting the number of phases and the frequency to be adopted?—G. R. B.

ANSWERS.

Question No. 291.—I have a line shaft from which are driven various machines. This shaft is driven by two exactly similar motors, one at each end. An ampere-meter is in circuit with each. I note these two never read alike, but vary sometimes by 25 per cent., first one and then the other being the higher. How do you account for this?

[With regard to the answers to question No. 291, there is a delightful lack of real analysis. The resultant condition of the ammeters may be due to a variety of causes, but no one reply really gives the whole of the causes acting; hence for once we give a considerable sample from the MSS. received.—ED. *E. E.*]

Answer to No. 291 (*awarded* 5*s.*).—The facts as stated in this question are not often to be met with in practice, and are very interesting, insomuch that they bear directly upon the theory of shafts. A clear and intelligent explanation of the facts can best be obtained by considering first the general principles for the stiffness as distinct from the strength of shafts, and this we will proceed to do.

If we had a shaft held firmly at one end and subjected to a twisting moment at the other end, and if a line were scribed upon it parallel to the axis of the shaft, and before the twisting force were applied, it would be found that on applying a sufficiently large twisting force that this line was no longer parallel to the axis of the shaft, but took a spiral direction. In general language, the shaft would be said to be twisted. Now, the amount of the twisting of a shaft is dependent upon its diameter, length, and value of the twisting moment. Further, if the angle of twist is less than the limiting angle to produce a permanent twist or set, the shaft will return to its original form after the applied force has been removed. In order to twist a shaft, work has to be expended upon it, and this work is stored up in the twisted shaft. Moreover, the shaft in returning to its original form is capable of giving out this stored energy, and thus doing work. The law governing the stiffness of shafts states that the angle of twist is inversely proportional to the fourth power of the diameter, and directly proportional to the length of the shaft and the twisting moment.

To return now to our question, we have here a shaft twisted in the same direction at each end by the motors, and in the opposite direction by the resistances of the machines. It follows from the above law, if the resultant twisting moment for the various pulleys is at the middle of the shaft, that each end of the shaft will have an equal angle of twist compared with the middle of the shaft. If, however, the resultant twisting moment of the pulleys occurs other than at the middle, the angle of twist will be greatest at that end furthest from the resultant twisting moment. Whilst the pull on the belts remains constant, this does not cause the power given out by the belts to be unequal, as each motor will take up the twist of the shaft at its end and then transmit its share of the total power. In the case in point, the machines must have been thrown on and off indiscriminately, or the power taken off by each machine must have varied greatly. When this is so, it will be readily seen that the angle of twist of the shaft at the motor ends will vary in sympathy with the change of load. Thus the energy being stored up or given out by the twisted shaft, as the case may be, will be continually varying at each end, and therefore the motors will necessarily make an effort to adjust themselves to each new condition. This will lead to a kind of racing action being set up at the motor ends of the shafts, and often the motors will be giving out either too much or too little power, and the result will be as observed.

How this twisting action of the shaft affects the motor power can be best illustrated by considering the action of a spiral spring extended by weights. If such a spring lengthened or shortened, say, 1in. on the application or deduction of 1lb., then if 1lb. were suddenly taken off the total weight on the spring, it would be found that the stored up energy in the spring would cause it at first to recoil more than 1in., though eventually it would settle down to a length 1in. shorter. Similarly, if a sudden increase of 1lb. were made in the total load, it would extend the spring at first more than 1in., though eventually remaining only 1in. longer. This is the kind of action that is going on in our shaft in question. Sometimes the stresses in the shaft will assist the motors to overcome the resistance, and at other times increase the resistance that the motors have to overcome.

It follows, of course, from what has been said that the shaft under consideration is not stiff enough, though probably strong enough, for the power going through it; otherwise the twisting effect would not be sufficient to produce these motor fluctuations.—E. W. T.

Answer to No. 291 (*awarded* 5*s.*).—Assuming that continuous-current shunt-wound motors are used, it appears to me that the following would account for the irregular division of power observed: It does not follow that because "M." has two apparently identical machines, built by the same manufacturer, that they will both have the same magnetisation characteristics; in fact, this is highly improbable, and if these are not identical it is easy to account for the inequalities described. For, let Fig. 1 be the characteristic for machine No. 1 and Fig. 2 that for

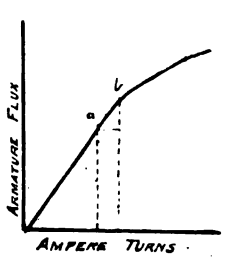


FIG. 1.

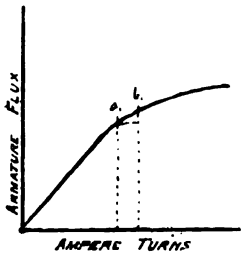


FIG. 2.

machine No. 2, and let the points, b and b_1, be the working points. Now, I presume, "M.'s" experience is that the voltage on his mains is not constant, but varies at least, let us say, 2 per cent. A 2 per cent. drop in volts corresponds to a 2 per cent. drop in ampere-turns, and in case of Fig. 1 considerably more than a 2 per cent. drop in flux, while in Fig. 2 the drop is less than 2 per cent. Machine No. 1 will now tend to revolve faster than machine No. 2, and will, therefore, do more work; hence a larger current flows. The reverse effect will take place when the volts increase, machine No. 2 now doing most work. This effect becomes all the more noticeable owing to the fact that motors are usually worked rather low down on the curve. A less variation in volts than that assumed would easily account for the 25 per cent. variation mentioned, as either machine has only to *try* and run faster than the other, when it immediately takes up more than its proper proportion of the load.—W. P.

Answer to No. 291 (*awarded* 5*s.*).—Supposing a shaft be placed, as in Fig. 1, with the top end firmly fixed, and a twisting movement is applied to the free or bottom end, it will be found that a certain amount of twist can be given to the shaft. If, then, three small sensitive pointers were fixed to the shaft so as to divide the shaft into three equal parts, the amount of twist, as shown by the angles through which the pointers move, would be found to be in the proportions 1 : 2 : 3, where 3 represents the angle through which the lowest pointer has moved; in other words, the angle of twist is proportional to the length of shaft twisted. Further experiment will show that if a twisting movement of a pound-feet produces a twist of $x°$, then a twisting movement of $y\,a$ pound-feet will produce a twist of $y\,x°$, or the twist is proportional to the twisting moment which is applied. Again, experiments will show that for different diameters of shafts, all of the same material, with the same twisting moment, the amount of twist will be inversely as the fourth power of the diameter; while another experiment will prove that with shafts of the same diameter, and

Digitized by Google

with the same twisting moment, the amount of twist will be inversely proportional to the modulus of rigidity of the material.

I have not attempted to prove the above statements, nor to give details of the way in which the experiments should be conducted, as this can be obtained from any good work on mechanics; but a knowledge of these results is essential for the due appreciation of the reason for the disparity in the readings of the two ammeters. Let us now consider for a moment Fig. 2. Here G H B represents a section of the shaft to which a twisting moment is being applied, with the result that the point G, which was formerly at H, has been twisted through the angle G H F to its present position. This angle, in accordance with the result of our first experiment, will be found to get less and less the further we get away from the point where the twisting movement is applied; in other words, an electrician might say that there was a certain lag produced in the shaft, and that this lag was inversely proportional to the distance from the point of application of the twisting moment.

Let us now consider the question more carefully. It is indefinite inasmuch as it does not state whether all the

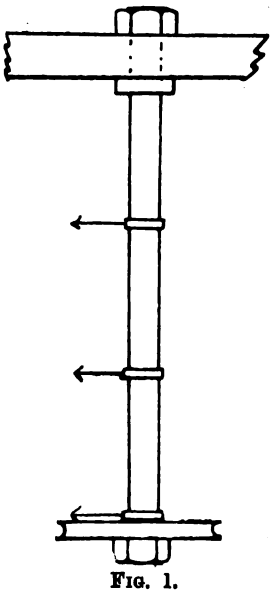


FIG. 1.

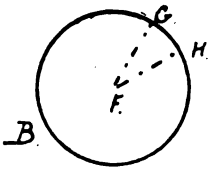
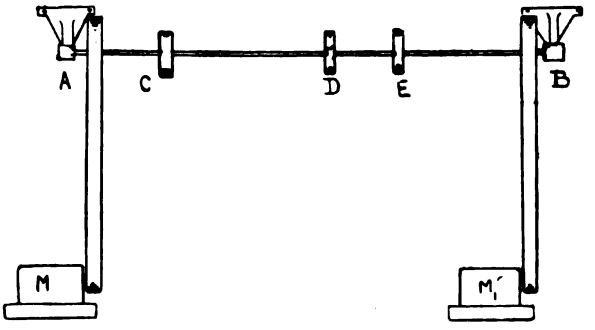


FIG. 2.

machines require the same horse-power, whether they all are equidistant from each other, or whether the power required by any or all is constant or fluctuating; while as no data is given of the size of shaft, horse-power, etc., no elaborate calculations can be made. Nor is this necessary, as simply a reason for the fluctuations is asked for, as, however, the readings "sometimes vary by 25 per cent.," it is safe to assume that there are large variations in the power required by the various machines. Suppose a shaft were driven by means of a similar motor at either end, and no pulleys or wheels of any sort were fixed to it, with perfect bearings it would be evident that each motor would do half the work, as there is no reason why one should do more than the other; again, if a main pulley is placed in the mathematical centre between the motors, and the power be transmitted from this pulley, each motor should do half the work; but I am afraid that in practice this would not be found to be the case. One bearing would not be so true as the others, or, perhaps, not so well lubricated, and hence would arise a variation in the angles of twist or lag, and one machine would get an undue proportion of the load. Wherever a pulley or wheel is fixed, through which the power is transmitted, the shaft may be considered to be to a certain extent held, and if this position is nearer one motor than the other, the amount of lag in the two portions of the shaft will vary, and the power transmitted by the two portions of the shaft will vary in proportion. If, now, the power is transmitted through various pulleys, and the amount transmitted through each is constantly fluctuating, not only is the shaft held at various points, but also the amount of this "holding" varies in such a manner that while at one moment it is lightly held at one end, the next moment it will be lightly held at another point, and so the work done by each of the two motors will constantly fluctuate, notwithstanding the fact that the total work of the two is nearly uniformly constant. This, I think, will be found to be the explanation of the different readings of the ammeters.—M.

Answer to No. 291 *(awarded* 5*s.).*—The erratic readings of the ammeters in question are probably due to portions of the load being thrown first on to one motor and then on to the other. This effect is brought about by the flexibility of the line shaft, and increased by the fact that the motors are placed at the extreme ends. A shaft transmitting power is subject to two strains—bending and torsion. The bending strain is dependent upon the weight of the shaft itself and of the pulleys mounted upon it, and also, to a certain extent, upon the oblique pull of the belts. For any given shaft the torsion varies directly as the length of shaft and of the arm at which the power is applied, and inversely as the diameter. The case in question is apparently that of a fairly long length of shafting driving machines placed at intervals. Let A B be such a shaft, M and M_1 being the motors, and C, D, and E pulleys for driving various machines. A shaft may be likened to a strongly-coiled cylindrical spring. When the motors are started this spring begins to coil up more closely, the action moving onwards from the driving pulleys to a position midway between the two, so that, considering a very brief space of time, the pulley, D, nearest the mid position is later in beginning to revolve than those nearer to the driving pulleys. With a perfectly steady load and no slip on the belts, the motors would settle down and divide the work equally between them. In workshop practice, however, the load on the shafting is never steady, as some of the machines are either being stopped or started, or else



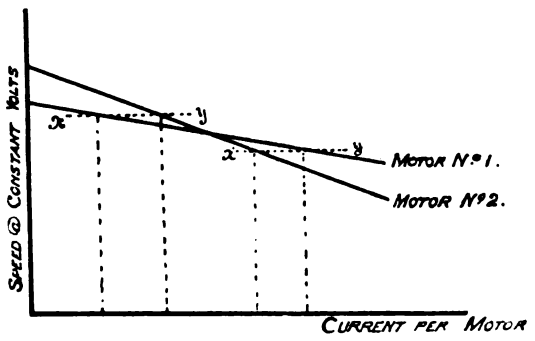
the load on the individual machines varies from time to time. It is possible in this way for a good deal of load to be thrown suddenly on to any one pulley, say that at C. Still thinking of the shaft as a spring, this increase of load on C tends to stop the revolution of the shaft at that point, and has to be overcome by a further coiling up of the spring. It is evident that the motion from pulley A will reach C before that from B, so that at at the instant in question the motor M will be doing more work than that at M_1; hence the difference in the ammeter readings. For every such variation of load the motor nearer to the seat of fluctuation will give a higher ammeter reading than that at the other end of the shaft. The foregoing is an exaggerated way of treating the question, but it enables one to understand clearly the nature of the action going on in a driving shaft.—P. S. T.

Answer to No. 291 (*awarded* 5*s.*).—From the question imagine the two motors are driving the shaft by means of belts or ropes. By this means of transmitting power there is always a certain amount of slip between the belt or ropes and the pulley. Call the motors A and B; they are both running together. First, A slips slightly, and B has to pick up the load; then possibly B slips, and A has to pick up the load. This slip may cause the pulley on, say, A to get hot; which would cause a much greater slip on A, and B would have to do quite 25 per cent. more load. While A having less work to do would soon cool, and B may be getting hot, and so the motors never read alike for any time.—F. C. F.

Answer to No. 291 (*awarded* 5*s.*).—The explanation of this action depends on the circumstances under which the excess current changes from one machine to the other. If, whilst the total load on the shaft remains approximately

Digitized by Google

constant, the load on the two machines, as shown by the ammeters, is found to be constantly varying in an erratic manner—first one and then the other having the larger amount; the effect is almost certainly due to changes of brush contact resistance. Such differences in resistance are particularly liable to occur with carbon brushes through carbon dust getting under them, or through the polish of the surface of the commutator varying. As the brush contact forms a large proportion of the whole ohmic resistance from terminal to terminal, and since the product (ohmic resistance × current) must have the same value for both motors (both running at the same speed and therefore having the same back E.M.F.) a considerable difference in current can easily be produced by this cause. If, on the other hand, the variations of excess current from one motor to the other depends on the actual total load on the shaft—*i.e.*, one motor always having the excess up to a certain load, and the other above that load—the cause is probably a difference in the characteristic curves, or a difference in the position of the brushes in the two machines. Assuming even that the motors are designed to work with the brushes in one fixed position for all loads, it is still quite possible that motor No. 1 has a slightly stronger field than No. 2, due to difference in quality of magnet iron or some such cause. Then in order to make both machines run at the same speed with the same current *on the average*, the brushes of No. 1 may have been fixed in a rather more backward position than No. 2, thus giving greater armature reaction and bringing the two speeds to the same value at about half load. The characteristic for shunt-wound motors



would then be somewhat as in the figure, with the result that at loads below half load motor No. 1 would have considerably less current than No. 2, whilst for higher loads No. 1 would have the excess. A very slight difference in the curves in this respect is enough to give a large difference in current at a given speed, as shown by the horizontal lines, $x\ y$ and $x^1\ y^1$.—Q.

Question No. 292.—If a company supplying at 100 volts charge a dearer rate in the night time than in the daytime, would it be possible to charge two batteries of 55 cells each in parallel in the daytime and put them in series for part of the night time so as to make the meter rotate backwards, and so wipe out part or all of the record of the energy consumed at the dear rate in the earlier part of the night?

Best Answer to No. 292 (*awarded* 10*s.*).—This question opens up several issues—viz.: (1) are electrical meters so constructed as to register in a positive manner if the current is passed through them in one direction, and in a negative manner if the current is passed in the other direction; (2) is it possible to operate cells in the way suggested; (3) would such a method be a financial gain; while (4) a doubt might arise as to the honesty of the scheme.

To take the points in the inverse order, I will pass over the question of the morality with one true anecdote: A man I knew had a gasmeter and a Root's blower. The gasmeter registered up to 2,000,000 cubic feet; when he had used 500,000 he found the meter was not large enough, so had it changed. The men took it out and went for their dinner. The man saw his golden opportunity, and, knowing no reading had been taken, applied his Root's blower to the negative end. Unfortunately for him, his attention was distracted by having to keep a watchful eye open for the approach of the inspector, so that when he finally saw him coming, and had to hurriedly disconnect the blower, he found, to his dismay, that not only had he blown off all his 500,000 cubic feet, but some 250,000 cubic feet in addition, and had to pay a little bill for 1,750,000 cubic feet, whereas a more honest man would have got off for 1,250,000 cubic feet less; and if "J. C. R." adopts his scheme, I should advise him to take precautions not to make the same mistake.

Dealing for a moment with the question of practicability, it is quite possible to operate cells in the way suggested, but whether it would be a financial success is another question. Some time ago the question was asked in this column if it would be advisable to charge secondary batteries during the time of the lower rate for current, in order to use the current from the cells during the time of the heavier charge, and the answers showed that owing to the charges for depreciation, maintenance, and interest, it was only in exceptional cases that this system would pay. Taking the case where the current is supplied at 100 volts, the circuit from the cells would be arranged for 70 or 75 volts, giving a loss of from 25 to 30 per cent. for the operation of charging and discharging the cells; but in this present case the loss will be 50 per cent., as the two batteries will be charged in parallel and discharged in series. It may be mentioned, *en passant*, that each battery will have to consist of considerably less than 55 cells, as such a number will require a terminal pressure of 135 volts for the charging current. Supposing the ordinary current required is 100 amperes; this will be equal at 100 volts to 10 Board of Trade units, and say the price is 3d. per Board of Trade unit, the cost will be 2*s.* 6*d.* per hour. Now, if two banks of cells have to be charged, each with 100 amperes, the cost for current will be 5*s.* per hour, and if these are coupled in series during the time of dearer rate, they can only give back 100 amperes, or 10 Board of Trade units, per hour; and if the dearer rate is double the cheap rate—and it is not likely to be more—it can only just clear itself, and not in any way affect the record of the normal current of 100 amperes required for lighting or power. If the proportion of the rates is, say, as 3 : 1, it might appear as though there would be a saving, but it must be remembered that there will be a heavy *contra* item for maintenance, etc., of the cells, which will more than absorb this saving. Further, it will be found that even if by an arrangement of charging the cells in series groups of 40, and discharging in series groups of 52, leaving the balance of charged cells over for discharge in another series the next day, whereby the loss in the cells might be brought down to 25 per cent., the cost of the cells and their upkeep would be found to eat up more than all the profit.

I think the above will be sufficient to show that it would not be wise to adopt the proposed scheme, and that it will be unnecessary to give a list of what meters are reversible in their action and which are not, for it is self-evident that if the meter is not reversible the whole scheme falls to the ground; but we may conclude that, both on the grounds of morality, self-interest, and practicability, the scheme is not feasible.—M.

Answer to No. 292 (*awarded* 5*s.*).—Though the arrangement mentioned in the question could be used, it would not be the most satisfactory one. The more direct way would be to charge a 50 to 55 cell battery, of the required capacity, during the day at the cheap rate by the help of a small motor-booster. This booster should be capable of supplying the extra 30 or 40 volts required in addition to the supply voltage of 100 in order to fully charge the 100-volt battery. At night, when the lamps have to be lit and the expensive rate comes into force, the supply mains would be entirely disconnected from the installation, and the battery alone would do all the lighting, etc. In this way 100-volt lamps would still be used, so that in case the battery should fail at any time, the lamps could be at once switched on to the supply mains without trouble. If no booster is used the number of cells must be reduced to about 40, so as to be fully charged at 100 volts, and the working discharge voltage of such a battery would be only about 75 volts, and lamps of that voltage would have to be installed, making the system less flexible than with a booster. A comparison of the annual cost of direct supply at the high rate and battery supply with a booster, as described above, will be found in the answers to Question No. 241, in the *Electrical Engineer* for Feb. 23, 1900.—Q.

Digitized by Google

LIGHT RAILWAYS.

The Board of Trade have recently confirmed orders authorising the construction of light railways in the county of Somerset, between Highbridge, Wedmore, and Cheddar; in the counties of Devon and Cornwall, from Bere Alston Station to Calstock, and the working of a portion of the East Cornwall Mineral Railway as a light railway; in the North Riding of York, from Sinnington to Rosedale; and in the county of Carnarvon, from Snowdon Station to Beddgelert.

Mr. F. Hopwood has held an enquiry into the proposed order authorising the construction of a light railway in the Bourne Valley. A long discussion took place as to clauses for the protection of Lord Portsmouth, and after other objections had been disposed of Mr. Hopwood intimated that he should recommend the Board of Trade to confirm the order and authorise the railway.

The Great Western Railway Company will shortly commence the construction of the light railway which they at first proposed to carry through from Salisbury to Pewsey. The intention is now to construct a light railway from Salisbury to Amesbury, with stations at Durnford and Woodford, the junction with the present Great Western line from Salisbury to Warminster being just beyond Skew Bridge.

At the last meeting of the Great Harwood Urban District Council, the Clerk stated, in connection with the light railway and the electric light joint conference, that those connected with the scheme were quite willing to confer with representatives from that Council with regard to the matter. The question was left in the hands of the Highways Committee.

Mr. Sellon and other representatives of the British Electric Traction Company waited on the Rhondda District Council on Friday last with a view to getting the Council to withdraw its opposition to the proposed light railway scheme for the Rhondda. The Council maintained their resolution to oppose the scheme. A public enquiry will be held by Colonel Boughey on Oct. 27.

At a recent meeting of the Mansfield Woodhouse Council a letter was read from the deputy town clerk of Mansfield stating that the Railway Commissioners, in the draft of the order they proposed to make regarding the electric tramway for the district, had refused to insert nearly all the clauses for the protection of the local authorities, and asked the Council to send a deputation to a joint meeting of the authorities interested.

The Light Railway Commissioners have granted an order authorising the construction of a light railway from Bury St. Edmunds to Attleborough by way of Ixworth, Stanton, Hopton, South Lopham, and Kenninghall. There would be a loop from Stanton to South Lopham, taking in Walsham-le-Willows and Botesdale, and there would be a branch connecting South Lopham with Diss. The estimate put in showed that, including £9,800 for stations, waiting-rooms, etc., the cost of making the railway was £213,302. The cost of the land was estimated at £13,600, contingencies were put down at £21,330, and incidental expenses at £2,767, making a grand total of £251,000.

COMPANIES' MEETINGS AND REPORTS.

WATERLOO AND CITY RAILWAY.

The half-yearly general meeting of the Waterloo and City Railway Company was held last Friday at Waterloo Station, Mr. Wyndham S. Portal presiding.

The **Chairman**, in moving the adoption of the report, said that the accounts showed an authorised capital of £720,000. Up to the end of last June £589,073 had been spent. For the half-year ended June the expenditure had amounted to £15,416, which included £10,922 for the construction of ways and stations, including engineering, and £4,493 for electrical equipment. The estimate of further expenditure on capital account for the current half-year was £15 000, and in subsequent half-year £10,000, making a total of £25,000. This they hoped would not all be required. They had £122 166 available balance of borrowing powers. The revenue account showed that during the past half-year the receipts from passenger fares, after deducting Government duty, were £14 069, compared with £12,815 in the corresponding period of 1899. The working expenses at 55 per cent. were £7,773, as against £6.640 in 1899. The difference between receipts and expenditure not being sufficient to pay the dividend of 3 per cent., the South-Western Railway Company had made up the deficiency of £2,375. They carried over £8,385 to the credit of the net revenue account, which also showed a balance of £155 brought from last half-year's account. The number of passengers for the half-year, exclusive of season-ticket holders, was 1,868.737, compared with 1,715,825 in the corresponding period of 1899, an increase of 152,912. The season-ticket holders on June 30 were 911, as against 747 in the corresponding period. The working company—the South-Western—had begun to run single cars of a new pattern every five minutes during the slack hours of the middle of the day, and they seemed to be much appreciated.

BLACKPOOL AND FLEETWOOD TRAMROAD.

Directors: George Richardson, 98, Westbourne-terrace, Hyde Park, London, W. (chairman); Richard Henry Prestwich, Homeleigh, Park-lane, Higher Broughton, Manchester (deputy-chairman); Robert Breese Barningham, 41, Victoria-buildings, Manchester; Robert Slater Boddington, Wynslade, St. Annes-on-the-Sea; John Greenwood, 1, Marsden-street, Manchester; George Readman, 9, Moray-place, Edinburgh. Manager and secretary: John Cameron.

Report of the directors (with abstract of accounts) to be submitted to the proprietors at the ordinary half-yearly general meeting to be held on Aug. 23, 1900, at the Company's offices, the terminus, Fleetwood, at 2 p.m.:

Including the sum brought forward from last half-year, the balance of profit, after providing for debenture interest, is £4,265. 5s. 11d., and the directors recommend a dividend at the rate of £4 per cent. per annum, which will absorb £3,000, writing off £100. 19s. 1d. from the cost of application to Parliament for further powers under Act 1898, £169. 7s. 6d. from preliminary expenses, and a sum of £500 for depreciation, leaving a balance of £494. 19s. 4d. to be carried forward to the current half-year. The number of passengers carried during the half-year was 660,006; the gross receipts £10,125. 17s. 2d. Owing to the fact that the early part of the year was unfavourable for the traffic, and the season three weeks later than that of 1899, the number of passengers carried and the gross earnings are considered satisfactory by the directors.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Maintenance of ways and works	363	19	1
Engine power	1,841	15	5
Repairs to cars	362	13	5
Traffic expenses	2,249	19	3
General expenses	626	7	10
Rents	558	4	2
Rates, taxes, and insurance	657	0	6
Compensation	79	9	0
	6,739	8	8
Balance carried to net revenue account	3,546	14	2
	£10,286	2	10

Cr. Income.	£	s.	d.
Traffic receipts	10,017	14	0
Bank interest	28	4	5
Transfer fees	12	3	0
Advertising	169	1	7
Sundry receipts	58	19	10
	£10,286	2	10

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Balance from net revenue account	4,265	5	11
Sundry creditors	1,759	9	0
Temporary loan	2,500	0	0
Contract tickets—proportion unexpired	108	3	2
	£8,632	18	1

Cr.	£	s.	d.
Capital account—balance at debit	4,909	4	0
Cost of application to Parliament for further powers (balance)	500	19	1
Preliminary expenses, including expenses incurred during construction (balance)	1,269	7	6
Stock of stores on hand	993	1	0
Sundry debtors	131	11	7
Rent, rates, and insurances paid in advance	151	7	1
Cash in bank and on hand	677	7	10
	£8,632	18	1

CAVEHILL AND WHITEWELL TRAMWAY.

The directors of this Company, having received a proposal from the British Electric Traction Company for the conversion of the Company's tramway to electric traction, after careful consideration unanimously decided to recommend the shareholders to agree to the proposal.

An extraordinary meeting of the shareholders was held last week, the chair being occupied by the **Venerable Archdeacon Smythe, M.A.**, who briefly explained the purpose for which it had been summoned, and called upon Mr. Nance to submit a resolution on the subject.

Mr. Nance then moved the following resolution: "That the directors be authorised to negotiate and carry out an agreement with the British Electric Traction Company in the terms of Mr. Frank Kerr's letter written on their behalf, and proposing to give the shareholders of this Company the right to convert their 15,000 ordinary shares into 6 per cent. cumulative preference shares at par upon certain terms therein contained.' In moving the resolution, Mr. Nance pointed out several reasons why the directors thought the proposal ought to be accepted.

The resolution was unanimously adopted.

Digitized by Google

LIVERPOOL OVERHEAD RAILWAY.

The twenty-fourth half-yearly meeting was held on Tuesday in Liverpool.

Mr. William Forwood, chairman of the Company, presided, and said that during the last seven years 58 million passengers had been carried, the trains having run almost five million miles. The receipts were £38,022, an increase of £1,530 on the receipts of the same period last year; £25,113 had been spent, £189 more than last year. They had to pay in interest on mortgage £3,400, leaving the amount available for dividend £14,402. They intended to pay that day a dividend for their preference shares at the rate of 5 per cent. per annum, absorbing £3,000, and they recommended the payment of an increased dividend at the rate of 3 per cent. per annum upon the ordinary shares, which would amount to £6,750. This would leave them a balance to carry forward of £4,452, against a balance last year of £4,320. The Chairman observed that they still held the record of punctuality; 97·3 of their trains had during the past half-year been on time. That was their best record for four years, their next best record being in the year 1896. It was proposed to increase the speed of the trains, and make the journey of 6½ miles with 15 stoppages in 20 minutes. It was also proposed to make use of the line at night, when the railway was eight hours idle, in conveying minerals. The above recommendation of dividends was proposed and carried.

STOCKPORT TRAMWAYS.

The twenty-third ordinary general meeting of the Stockport and Hazel Grove Carriage and Tramways Company was held last week.

Mr. J. D. Penney (chairman), who presided, moved the adoption of the accounts and directors' report.

Mr. Loose seconded, and the resolution was carried without comment.

The report was as follows: "We herewith submit our statement of accounts for the past half-year, which shows a profit, after placing £100 to reserve fund, of £631. 16s. 3d., which, together with £676. 4s. 10d. brought forward from last half-year's account, make a balance of £1,308. 1s. 1d. available for dividend. Out of this amount we propose to pay a dividend at the rate of 10 per cent. per annum, which will absorb £637. 10s., and carry £670. 11s. 1d. to next account.

Dr. Thomas Moore was re elected a director.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ilford.—The Urban District Council invite offers for free wiring. Tenders by 29th inst.

Luton.—The Electric Lighting Committee invite tenders for the supply and erection of meters.

Lincoln.—The Town Council invite tenders for wattmeters and demand meters. Tenders by Sept. 14.

Hamburg.—Two 30-ton electric cranes are required. Enquiries may be made at the Town Hall. Tenders by Sept. 10.

Warrington.—Tenders are required by the Corporation for installation of mains and fittings at town hall and market.

Worksop.—The Urban District Council invite tenders for the erection of electricity supply works in Canal-road. Tenders by 27th inst.

Plumstead.—The Vestry invite tenders for the supply and erection of various plant and machinery for electricity works. Tenders by Sept. 15.

Newport (Mon.).—The Guardians invite tenders for a complete installation of electric light at the new workhouse, Stow-hill, Newport. Tenders by 22nd inst.

Stockport.—The Tramways Committee invite tenders for 20 double-deck tramcars, complete with electric equipment for overhead traction. Tenders by Aug. 31.

Aberdeen.—The Town Council invite tenders for the supply of steel tiebars, fishbolts, and nuts. Tenders by 24th inst. Details in our advertisement columns.

Newcastle-upon Tyne.—The New Tramways Committee invite tenders for conduits and holes for poles. Tenders by 31st inst. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of cast-iron bases for tramway poles. Tenders by 25th inst. Details in our advertisement columns.

Fulham.—The Vestry invite tenders for wiring the town hall, Walham Green, for the electric light. Tenders by 24th inst. Details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of a 200-kw. steam dynamo for their electricity works. Tenders by Sept. 8. Details in our advertisement columns.

Southampton.—The Harbour Board invite tenders from crane builders for one 30cwt. portable electric wharf crane. Tenders by Sept. 10. Details in our advertisement columns.

Rochdale.—The General Purposes Committee invite tenders for the wiring and fittings required in connection with the electric lighting of the town hall. Tenders by 22nd inst.

Glasgow.—The Corporation invite tenders for the reconstruction of the Glasgow tramways, and the construction of new tramways as detailed in specification. Tenders by 24th inst.

Leeds.—The Tramways Committee invite tenders for the erection of a new boiler-house (all trades except ironfounders') at the generating station, Crown Point, Leeds. Tenders by 21st inst.

Shipley (Yorks).—The Council invite tenders for steam and exhaust pipes, storage battery, switchboard and connections, and cables. Tenders by 27th inst. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for the supply and delivery and fixing of sundry pipes, feed-water heaters, etc., at the Corporation electricity works, Eldon-road, Cardiff. Tenders by Aug. 31.

Cupar Fife.—Tenders are invited at once for an electric lighting installation at the Fife and Kinross District Lunatic Asylum, about 800 lights. Apply to Mr. D. Osborne, clerk to the Board, Cupar Fife.

Horton (Surrey).—The Asylums Committee of the London County Council invite tenders for the installation of boilers, engines, dynamos, etc., at the Horton Estate, Epsom, Surrey. Tenders by Sept. 22.

Newcastle-on-Tyne.—The Corporation invite tenders for the laying down in Newcastle of about five miles of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. Tenders by Aug. 22.

Manchester.—The Electricity Committee invite tenders for the work and materials in the trades of concretor, stonemason, and ironfounder required in erection of the electricity generating station, Bloom-street. Tenders by 21st inst.

Southampton.—The Guardians invite tenders for the erection and completion of electrical plant and installation for the lighting of the new workhouse infirmary, Shirley Warren. Tenders by Sept. 11. Details in our advertisement columns.

Aberdeen.—The Corporation Tramways Committee invite tenders for the supply of steel poles, bases, and brackets for extensions of their overhead system of tramways. Tenders by 25th inst. Details in our advertisement columns.

Vienna.—The Government Railways invite tenders for various supplies for lighting their stations, etc., in the districts of Vienna, Linz, Innsbruck, Villach, Triest, Pilsen, Prag, Olmütz, Krakau, Lemberg, and Stanislau from Oct. 1, 1900, to Sept. 30, 1901. Tenders by 30th inst.

Aberdeen.—The Electric Lighting Committee invite tenders for a twelvemonth's supply of paper or fibre insulated lead-covered feeder, distributing and service cables, electricity meters, and house main fuse boxes. Tenders by 28th inst. Details in our advertisement columns.

Hackney.—The Electric Lighting Committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, public arc lamps, meters, travelling crane, and workshop equipment. Tenders by Sept. 12. Full particulars in our advertisement columns.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the following plant: lighting switchboard, traction switchboard, and balancing transformers at their new electricity works, Strawberry-road, Pendleton. Tenders by Sept. 3. Details in our advertisement columns.

Whitby.—The Council invite tenders for the following plant: two water-tube boilers, pumps, condensers, pipes, etc., two steam dynamos, balancer, and boosters, switchboard and connections, battery, travelling crane, and cables, arc lamps, etc. Tenders by Sept. 3. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the supply, delivery, and erection of the whole of the plant and apparatus necessary to completely equip for electric traction their proposed power station at Vivash-road, Fratton-grove, Portsmouth. Tenders by Sept. 4. Details in our advertisement columns.

Grimsby.—The Corporation invite tenders to specification for the supply and delivery, in connection with the electric lighting of the borough, for additional steam dynamos: Section 1, engine; Section 2, dynamo; and extension of switchboard for dynamo No. 7, and traction work. Tenders by 18th inst. Details in our advertisement columns.

St. Petersburg.—The Posts and Telegraphs Department invite tenders for the working of the telephone systems in St. Petersburg, Moscow, Warsaw, Odessa, and Riga for 18 years from Nov. 1, 1901. Tenders by Aug. 28. All necessary particulars may be examined on personal application at the Imperial Russian Financial Agency, 107, Cromwell-road, London, S.W., on Mondays, Wednesdays, and Fridays, from 2 to 4 p.m.

Aberdeen.—The Town Council invite alternative tenders for the supply of 650 tons steel girder straight-track tramway rails, weight about 100lb. per lineal yard; 150 tons steel girder curve-track rails, weight about 104lb. per lineal yard, in standard lengths of 60ft. or 45ft., as may be decided; also for 60 tons fishplates, weight about 75lb. per pair. Tenders by 24th inst. Details in our advertisement columns.

Hanley.—The Electric Lighting Committee invite tenders for the supply, delivery, and erection complete of two Lancashire boilers and fittings, including steam receiver; water-tank, girders, and pumps; fuel economiser, with engine or motor; smoke chimney, exhaust fan, with engine, etc.; feed-water heater; forced-draught fittings, firebars, or other appliances to boiler furnaces; and coal conveyor and bunkers. Tenders by 25th inst.

Worthing.—The Corporation invite tenders for the supply and erection of the following plant: (1) three 96-kw. steam dynamos (vertical enclosed high-speed engines); (2) two boilers of the dry-

Digitized by Google

back marine type, with fittings, etc.; (3) steam and exhaust, drain and other pipes, in engine and boiler house, pumps, condensing plant, etc.; (4) cast-iron manhole covers; (5) cast-iron arc lamp posts; (6) stoneware casings; (7) cable work; (8) arc lamps; (9) storage batteries; (11) balancing transformers and motor-generators; (12) economiser; (13) five-ton overhead engine-room travelling crane. Tenders by Sept. 3.

Fenton (Staffs).—Tenders are invited for works in connection with the construction of a single line of railway (2ft. 6in. gauge) from Waterhouses to Hulme End, Staffordshire (about eight miles two furlongs), and incidental works connected therewith, for the Leek and Manifold Valley Light Railway Company. Plans, specifications, bills of quantities, and forms of tender may be inspected at the offices of the company's engineer, Mr. Joseph Forsyth, Heron's Cross, Fenton, Staffs, on and after Aug. 4, and copies of same may be obtained from him. Sealed tenders must be sent to Mr. Edward Challinor, secretary, Leek, by Sept. 1.

London, W.—The Central Electric Supply Company invite tenders for the supply, delivery, and erection of (Specification 2A) dry-back marine boilers, 11ft. 6in. diameter and 14ft. long, gangways, feed and drain pipes, etc., complete, as required for each of three blocks of boilers. Each or all of the blocks can be tendered for, each block containing six boilers. Tenders are also to be submitted for mechanical stokers, with the shafting and gearing for driving them. Alternative tenders are invited for (Specification 2B) water-tube boilers as an alternative to the dry-back marine boilers, including the mountings, feed and drain pipes, etc. Copies of the specifications, with forms of tender, drawings, and general conditions, can be obtained from the General Manager, 19, Carnaby-street, Golden-square, W., on payment of £3. 3s., to be returned on receipt of a bona fide tender. Specifications and drawings can be seen at the office of Prof. Kennedy, 17, Victoria-street, S.W. Tenders, on the prescribed form, endorsed on the outside "Electric Plant—Tender to No. — Specification," must be sent to Mr. F. J. Walker, general manager, before 10 a.m. on Aug. 20.

RESULTS OF TENDERS.

Brookwood Asylum.—The tender of Messrs. Shalders and Davis, Southampton, for electric light plant and wiring, at £5,600, has been accepted.

Sheffield.—The Corporation have accepted the tender of the Electric Construction Company, Wolverhampton, at schedule rates, for 12 months' supply of transformers.

Huddersfield.—The Corporation have accepted the tender of R. W. Blackwell and Co., Limited, for the overhead equipment of two short sections of tramways (total length about 2 miles 300 yards).

Blackpool.—Tenders for electrical appliances have been placed with the following firms; Leeds Steelworks, rails; Askham Bros. and Wilson, points and crossings; L. Cooper, patent jointing materials for tramways; Lowther Bros., trolley poles, storage battery, boosters, and switchboards; St. Helens Cable Company, cables and trolley wires. They were for the Marton tramways, and the total amount will be £27,000.

Nelson (Lancs.)—The following tenders have been received for the electric lighting at the Baptist Chapel, Carr-road:

Alliance Company, London	£468
W. Smith	248
Duckinfield	240
Hanwell	234
National Electric Wiring Company (accepted)	170

BUSINESS NOTES.

TRACTION.

Southport.—Since the electric tramways were opened on July 18, the receipts have amounted to £750.

Fiume.—A dynamite cartridge was exploded under a carriage of the city electric railway on the 9th inst., but without causing any damage.

Ince.—The District Council are considering the subject of purchasing the tramways in their district. They have six months in which to do so.

Newport.—At Tuesday's meeting of the Town Council the supply of electric motive power and the construction of a tramway up Stow-hill were discussed.

Stretford.—The District Council have confirmed the report of the Electricity and Tramways Committee as to the terms of agreement with the Manchester Corporation.

Newcastle.—At a meeting of the Tramways Committee of the Newcastle Corporation, it was announced that the erection of the new car-sheds at Byker would be proceeded with on Monday next.

North Metropolitan Tramways Co.—At the sixty-first half-yearly meeting of this Company, Mr. G. Richardson, who presided, stated that the adoption of electric traction depended on the London County Council, who had not yet made experiments on their line.

Bournemouth.—At a recent meeting of the Town Council a motion was carried for the purchase of land for the site of the future power-house for the electric tramways. The plans and estimates necessary to obtain the sanction of the Board of Trade are being prepared.

Prestwich.—The Electric Lighting and the Tramways Bill having received the Royal assent, the Council are now only waiting for the completion of the agreement with the Manchester Corporation.

Gosport.—The District Council have informed Mr. A. W. White that at present they were not prepared to enter into any negotiations to acquire the tramway or to enter into any arrangement with the company to promote a Bill for the extension and conversion of the undertaking.

Dublin United Tramways Co.—From the Company's traffic returns for the last week we learn that the mileage worked electrically is 43 miles, only one mile now remaining being worked by horses, as against 18 miles electrically and 26 miles by horses for the corresponding period last year.

Morecambe.—Plans and estimates are being prepared by the manager of the Morecambe electricity works for the application of overhead traction on the Morecambe Tramway Company's lines, which are at present worked by horse traction. It is proposed to erect an electric light sub-station at Bare.

Derby.—As already noted in our last issue, the Town Council have carried the resolution recommending the adoption of the tramway scheme. This will involve an estimated cost of £200,000. This scheme is to reconstruct the lines for electric traction, and also to extend them. The site proposed for the power-house, etc., is next to the electric light station.

Dewsbury, Batley, and Birstall Tramways Co.—It was stated at the yearly meeting of this Company on the 9th inst. that the alteration from a 15 to a 10 minutes' service of cars had resulted in 15 months in a loss of nearly £500. The shareholders present voted in favour of the 10 minutes' service being discontinued, and suggested that halfpenny stages be tried for three months. Both matters will be considered by the directors.

Leamington and Warwick Tramways.—A provisional order for the working of the tramway by electric traction in the borough of Warwick has been obtained, and negotiations are pending with the Corporation of Leamington with a view to acquire a similar order for that borough. When the requisite legislative powers have been obtained, the arrangements for converting the line into an electric tramway will involve the winding up of the existing company.

Bradford Contracts.—The Tramways Committee of the Bradford Corporation on the 9th inst. considered reports on the allegations as to the deviation from the specifications in the contract for the electrical equipment of the Corporation tramway extensions. A resolution was adopted expressing the committee's belief that in every case the substituted apparatus and materials were at least fully equal to those originally specified, and in many cases an improvement. The committee's action was subsequently confirmed at a meeting of the Finance and General Purposes Committee.

London United Tramways.—The whole of the lines from Shepherd's Bush to Acton; from Shepherd's Bush, *vid* Goldhawk-road, to Kew Bridge; and from Hammersmith-broadway, through Chiswick, *vid* Kew Bridge and Brentford, to Hounslow, are now complete in every detail, but a difficulty has arisen which is causing delay. At the instance of the Treasury a clause was inserted requiring the Company to take such precautions as were deemed necessary to prevent disturbance of the magnetic recording instruments at Kew Gardens Observatory, and the negotiations, which have been in progress for some time, have not yet resulted in a decision.

Warrington.—At a recent meeting of the Electric Lighting Committee, the Tramways Sub-Committee reported that the Bill for confirming the Warrington Corporation (Tramways) Order, 1900, was then about to receive the Royal assent. The sub-committee further stated that all the tramways proposed to be constructed by the Corporation had been allowed. They called attention to the provisions of the Tramways Act, 1870, which require the tramways to be commenced within 12 months and completed in two years. Having regard to the difficulty of carrying out so large a scheme of tramways within the time stated, it may be found advisable to apply for an extension of time in respect to some of them.

Bolton.—An estimate was submitted by the borough engineer to the Corporation last week of the cost of carrying out the relaying of the tramways, which was approved, and it was decided to apply to the Board of Trade for sanction to borrow the sum of £87,500 needed to relay the whole of the track. The engineer also reported terms with the Barrow Hematite Company for supplying 150 tons of rails, with fishplates. The chairman, vice-chairman, and general manager were deputed to interview the Farnworth District Council as to the electrical equipment of the Farnworth tramways, which is considered unsatisfactory. It was decided that, if desired, the pillars in the centre of the streets be drilled and used for electric lamp purposes.

Trams in the Lake District.—Some people have still queer notions with regard to electric tramways. We find the following in the *Daily Telegraph*: "Objections having been raised by the Bowness District Council to the tramway scheme of the British Electric Traction Company, a modified proposal has been presented, which the Council, by a majority of one, have accepted. There was strong opposition to the scheme on general grounds. One member expressed his belief that by lending itself to the convenience of the excursion element the scheme would drive away the better class of residents, while another asserted that if the tramway was introduced into the narrow roads of Bowness traffic accidents would increase by 50 per cent., and pedestrians, cyclists, and horses would be floundering about in every direction."

Digitized by Google

Burton-on-Trent.—At a conference between a deputation of the Burton Corporation and the promoters of the Woodville and Swadlincote light railways, on the 10th inst., Mr. Smith (of the firm of Messrs. Green, Smith, and Hood, of Liverpool), on behalf of the promoters, explained their scheme, which, he said, was for a light railway of standard gauge running from Woodville, through Swadlincote and Newhall, to Burton-on-Trent. Considerable discussion ensued, and it was intimated that there was a possibility of an arrangement whereby the whole of the lines on both sides of the river might be worked as one system. As to the question of motive power, Mr. Smith said he was firmly of opinion that the overhead system of electric traction was the only one possible.

Glossop.—At the quarterly meeting of the Town Council last week the question of constructing electric tramways in the borough was discussed, and an agreement was read proposing to transfer the tramways order to Edmundson's Electricity Corporation, Limited, to whom the electric lighting order for the borough had already been transferred. The Town Clerk said the Council had power to purchase on a fair valuation at any period of seven years, but they could not purchase the tramways without the electric light scheme. The overhead system would be adopted, and the cars would run from the Queen's Arms, Old Glossop, to the Palatine Hotel, Hadfield, a distance of four miles. The maximum fare would be 1d. per mile, and 2d. for the whole distance. It was decided to affix the common seal to the agreement and a deed of guarantee.

Waterloo-with-Seaforth.—The proceedings of the Tramways Committee, which were passed at the Urban District Council meeting last week, contained a complaint from a resident in Crosby-road with regard to the noise proceeding from the points on the electric tramway route. The contractors have been applied to, and have replied "that it very frequently happens that when a tramway begins working someone or other objects to the click of the points, but after a very short time this dies out. We would suggest putting in a lighter spring so as to reduce the click, or else inserting a thin piece of leather or a thin sheet of lead between the point of the tongue, which is done on some tramways, but, as a rule, very little notice is taken of the matter, and scores of tramways do not insert anything whatever." The suggestion is to be acted upon.

Battle.—The Urban District Council have received from the solicitors to the Hastings tramways an answer to a communication from the clerk stating that the Council would be prepared to oppose the application for a provisional order to supply electricity in the district, if the order meant that the company would have the power to supply the whole district at any time. The letter said: "The view of the company is that the whole of your district could be more efficiently and economically lighted from the generating station which will be erected in connection with the system of tramways which the company have just been authorised to erect in Bexhill and Hastings, but if there are any portions which could be more efficiently lighted from other sources, perhaps you will be so good as to indicate them, so that we may send the information to the company." The matter was discussed last week, and finally allowed to stand over.

Ayr.—At Monday's meeting of the Town Council it was reported that an offer of 3s. per pole for ground at Bellesleyhill, Prestwick-road, to be used as a car station for the tramways, had been accepted. The question of a separate generating station had been again under the consideration of the committee, and it had been decided to accept the Electric Lighting Committee's offer to supply energy at the rate of 1½d. per unit for the first 200 000 units, and 1d. per unit above that quantity, annually, the Lighting Committee to pay the tramway undertaking compensation at the rate of 9d. per car mile for any stoppages arising from deficiency or want of current. The question of the appointment of Mr. A. J. Fuller, the burgh electrical engineer, to carry out the electrical part of the undertaking had been under consideration, but no definite decision had been arrived at. Tenders for 10 cars with complete electrical equipment are to be invited.

Life-Guards.—At the inquest held on the 10th inst. on the body of a child which was killed by being run over by a tramcar at Halifax, the jury returned a verdict of accidental death, and added that in their opinion no blame whatever could be attached to the driver. During the evidence Mr. Spencer, the tramway manager, stated that although the life guard was only 1¾in. above the ground the child got under it all the same. There had been three or four instances in Halifax where the life-guard had picked up older children. There was, practically speaking, no life-guard yet in existence that would prevent this sort of thing. There were a good many in the market, but the Board of Trade had not yet seen a life-guard to their satisfaction. The solicitor also observed that in Bradford they had spent hundreds of pounds in getting a good life-guard, but unsuccessfully. It seems to us that not long ago a first prize was awarded in the competition of life guards at the Tramways Exhibition at the Agricultural Hall. An inquest was held at the Swansea Hospital on Friday on the body of Howard Stafford Rees, a boy of 13, who was run over by an electric car from which he had jumped off on Wednesday, and died at the hospital on Friday morning. The jury, after hearing the evidence, returned a verdict of accidental death, absolving the conductor and driver from blame, but adding a rider that the double cars should be guarded with guards in front of the hind wheels, which appeared to be somewhat exposed.

Sunderland.—At the Town Council meeting last week a report was submitted by the Tramways Committee recommending that arrangements be entered into with the contractors to construct the route *vid* Villette-road on to Christ Church upon the terms of their existing contract, the work to be done along with the Suffolk-street route; that children from three to twelve years of age be permitted to travel on the cars at half fare—this to apply to all sections; and that notices be served upon owners and occupiers of property in Vine-place, and application made to the Board of Trade to lay a double line of tramways in Vine-place, according to plan submitted to the meeting, the like in High-street West, near Londonderry Hotel, according to plan submitted to the meeting. A motion to adjourn the matter for a year having been rejected, the above report was carried. On Wednesday afternoon the first section of the Sunderland Corporation electric tramways was officially opened. The route completed is that between Christ Church and Roker, and the trials which have been made during the past few days have proved eminently satisfactory, everything working smoothly. The Sunderland Corporation Act of 1899 gave the Council power to construct 23 miles of single track, and of this it was decided to equip at once 12½ miles. On the advice of Mr. J. F. C. Snell (borough electrical engineer) it was decided to adopt the overhead system of tramways, and the contract for the entire reconstruction of the old lines, with the addition of the route mentioned, the electrical equipment and the first instalment of cars was let to Messrs. Dick, Kerr, and Co., of London and Kilmarnock, for about £126,000. In Fawcett-street rosettes are fixed to the house fronts. In the wider streets centre poles are erected with arms on either side, and in the other parts of the routes the wire is suspended from side bracket poles, and the trolley wire is hung at a height of 22ft. from the roadway. As the current is to be supplied by the Lighting Committee of the Corporation, more generating plant has been laid down. Four Galloway boilers, 28ft. by 8ft. 6in., have been put in, with mechanical stokers and economisers, and special elevating machinery to save handling of the coal. In the engine-room there are three new 450 i.h.p. steam dynamos, each engine being of the three-crank compound type, the generators having been made by the Sunderland Forge and Engineering Company, Pallion. The Corporation have ordered three different types of cars. One kind possesses only a single deck, as there is a low bridge on one of the routes. Six of the vehicles will be double deckers, carrying 68 passengers; these are for the Roker route. The remainder are double-deck outside-seat single-truck cars, which have accommodation for 56 persons. Each car is driven by two 25-h.p. motors, which are capable of propelling the car up an incline of 1 in 12 at a speed of eight miles an hour, and are equal to the task of starting the car, fully laden, from rest up a similar incline. The tramway contractors have just been instructed to proceed with the Villette-road extension.

LIGHTING AND GENERAL.

Motor Club.—Efforts are being made to start a local motor club at Newcastle.

Rochdale.—The lighting of the workhouse will probably be completed in six weeks.

Ryl.—The Urban District Council have obtained permission to borrow £15,250 for electric lighting.

Alnwick.—The Urban District Council are conferring with two electrical supply companies, and also with a refuse-destructor company.

Dorchester.—The Town Council will apply to the Board of Trade for a provisional order to enable them to light the borough with electricity.

Luthrie.—The Post Office authorities are now laying the telegraph to Luthrie, and hope to have the communication complete by the end of the month.

Shrewsbury.—At the recent quarterly meeting of the Town Council a very considerable extension of the electric lighting of the public streets was approved.

Bolton.—The appointment of borough electrical engineer, at a salary beginning with £500, rests between Messrs. A. A. Day, J. A. Jeckell, H. T. Street, and W. R. Wright.

Whitehaven.—It is reported that the new buildings in connection with the extension of electric light station will be ready for the reception of the machinery in about a month.

Braintree.—The Urban District Council are not in favour of the North British Electricity Supply Company's suggestion to obtain a provisional order to supply the Braintree district.

Dairy.—A letter from the North British Electricity Supply Company is before the Northern District Committee for consideration, with a recommendation that steps be taken to oppose any monopoly.

Bury.—It is proposed that eight arc lamps of 2,000 c.p. each be erected in the central part of the town. Plans are to be submitted with a view of ascertaining the cost of building an accumulator-house.

Bognor.—Some of the Guardians desire electric light to be installed at the workhouse. Recently a motion that the Visiting Committee should consider the matter was brought forward, but was defeated.

Beverley.—The Town Council have decided to apply for a provisional order empowering the Corporation to supply electricity within the borough, and Mr. Gibbings has been instructed to prepare plans.

Change of Address.—The offices of the electric lighting department of the Hull Corporation have been removed to the electric lighting station, Sculcoates-lane, Hull, and the Dagger-lane offices have been closed.

Digitized by Google

Ryde.—The long-continued opposition against the Corporation's lighting scheme was again much to the fore last week, when Colonel Smith, R.E., held an enquiry into the application to borrow £30,000 for the purpose.

Southport.—At the last meeting of the Council it was decided to light London street, Chapel-street, and Eastbank-street by electricity, and a motion was submitted authorising an application for power to borrow £1,900.

Cape Electric Tramways.—This Company have declared an interim dividend of 5 per cent. net, which is payable at the offices of the Company, 55 and 56, Bishopsgate-street Within, E.C., on or after the 22nd inst., by presenting coupon No. 6.

Imperial Tramways Co.—Warrants have been posted to the shareholders of the Imperial Tramways Company, Limited, in payment of an interim dividend at the rate of 7½ per cent. per annum on the ordinary shares for the half year ended June 30 last.

Charing Cross and Strand Electricity Supply Corporation.—Letters of allotment of the new issue of 30,000 new preference shares of the Charing Cross and Strand Electricity Supply Corporation, Limited, were posted to the shareholders on the 14th inst.

Friswell's Automobile Palace Co.—This Company was formed on 1st inst. with a capital of £40,000 in £1 shares, the object being to adopt an agreement with Friswell, Limited, and to carry on the business of cycle and motorcar manufacturers, engineers, machinists, etc.

Wellingborough.—The Urban District Council intend to apply, on or before Dec. 21 next, for a provisional order under the Electric Lighting Acts of 1882 and 1888, authorising them to supply electricity for all public purposes throughout the urban district of Wellingborough.

Accident.—During the thunderstorm of Friday last, a labourer employed by the Liverpool Corporation tramways was changing tram horses in Robson-street, when an electric wire fell on his head. He was severely injured, and died the same night in Stanley Hospital.

New Malden.—The Electric Lighting Committee are consulting Mr. Warden-Stevens on the proposed street-lighting, and the surveyor has been instructed to purchase Ordnance maps and indicate on them the positions of the lamps, and to afford every assistance in forming an estimate.

Barnet.—The Electric Lighting Committee have informed the Urban District Council that on terms similar to those embodied in the existing agreement with the Council, they would supply electric light to the whole of Manor-road, Barnet Common Estate, and to Sebright and Calvert roads.

Pontypool.—At a meeting of a committee of the Urban District Council on Wednesday, the question whether the Council should now apply for an order from the Board of Trade to establish electric lighting outside the area of the Pontypool Electric Light and Power Company was considered.

Johnson Electro-Germicide Co.—This Company has been registered with a capital of £2,000 in £1 shares, the object being to adopt an agreement with C. M. Johnson for the acquisition of a patent for improved means of destroying disease germs, and of an electrical generating machine and apparatus.

Association Programme.—We have received from the American Electro-Therapeutic Association a programme of the tenth annual meeting of the association, to be held at the Academy of Medicine, Room 44, 17, West Forty-third-street, New York City. Various interesting papers dealing with electricity will be read.

Killarney.—The Urban Council have not come to any definite decision concerning the offer of the electric light company to instal and light some additional lamps for £69. 12s. 5d. If the contract be given for three years they will contribute one-third of the cost, and if a five years' contract they will pay half the cost.

Perth.—Communications between the Electric Lighting Committee of the Police Commissioners and the Caledonian Railway Company with reference to an installation of the electric light in the station have resulted in a report on the subject by Mr. Dunn, which is at present in the hands of Mr. Patrick, the general manager.

London Gazette.—An adjudication order has been made out *re* W. V. Scott, 1, Shaftesbury-road East, Hammersmith.—Mr. W. M. Richards, 52, Belvoir-street, Leicester, has been granted his release as trustee *re* W. A. Charles and J. S. Blackwell (trading as the Central Electrical and Engineering Company), 14 and 111, Churchgate, Leicester.

Huddersfield.—On Wednesday the Corporation passed a resolution in favour of the recommendation of the Electricity Committee, which was to apply to the Local Government Board for sanction to borrow £30,342 for telephone purposes, to be repaid within 25 years, and the plans of the borough electrical engineer for the same were approved.

Yeadon.—The District Council are still considering the electric lighting question. At the close of a recent conference it was decided to take a *plébiscite* of the householders in the compulsory area of supply for ascertaining the number of lights likely to be taken up at a charge of 5d. per unit, and then submit the facts to a ratepayers' meeting.

Hampstead.—At the last meeting of the Vestry Mr. Greenhill moved that application be made to the London County Council for sanction to borrow £28,498 in respect of electric lighting extensions. It was necessary, he said, to pass the resolution at once, in order that time should not be lost owing to the holidays. The motion was carried.

Soler Aluminium Parent Syndicate, Limited.—This Company has been registered with a capital of £60,000 in £1 shares, the object being to adopt and carry into effect an agreement expressed to be made between Sir E. J. Reed of the one part and this Company of the other part; primarily to manufacture, sell, and deal in aluminium and alloys thereof, etc.

Compagnie Internationale d'Electricite, Liege.—We are indebted to Mr. H. Pieper, the general manager of this Company, for a splendidly illustrated pamphlet describing the works of the Company at Liège, and their exhibit at Paris. Generators and motors form the principal of the business, but the Company also manufacture a special kind of automatic arc lamp (Pieper's patent).

Swansea.—The advisability of the Corporation doing their own wiring is being discussed, and the chairman of the Electric Committee has replied, to enquiries on the subject, that he is not certain whether the agreement with the Free Wiring Company is executed, but, if not, he will gladly have the question discussed by the Council, as he is willing and anxious to assist consumers in every way.

Hull.—At a recent special and private meeting of the Electric Lighting Committee the electrical engineer reported that Messrs. Earles had made no further progress with the dynamos which they are making for the Corporation. The engineer was accordingly instructed to give Messrs. Earles the necessary notice to terminate the contract. The committee further resolved to notify this step to the sureties.

Aberdeen.—The estimates for the ensuing year for lighting are £11,800 against £8,650 expended last year, the increase being due to the proposed substitution of the electric light for gas in the central parts of the city for street-lighting, the streets to be thus lit being Union-terrace Bridge-street, Marischal street, Castle-street, Stirling-street, Exchange street, and George-street as far as Kittybrewster.

Sheffield.—The Electric Light Committee's last report states, with reference to service connections, that the manager recommended that no charge be made for leading in services for electrical energy up to a distance of 30ft. from the distributing mains, and that over this distance only actual cost price be charged. It appears that the recent breakdown in the Corporation electric light depôt is more serious than it was thought at first, and it is hinted that an almost complete renovation of the plant will have to be faced.

Stock Exchange.—The Stock Exchange Committee have appointed Wednesday, Aug. 29, a special settling day in Babcock and Wilcox, Limited, further issue of 90,000 ordinary shares of £1 each, fully paid, Nos. 440 001 to 530,000, and have also ordered these securities to be quoted in the official list. The committee have further been asked to allow the British Columbia Electric Railway Company's further issue of 1,600 5 per cent. non cumulative preference shares of £10 each, fully paid, Nos. 37,001 to 38,600, to be quoted in the official list.

Kingston.—The following accounts have been published by the Corporation: Electric light revenue—receipts—sale of electricity, £4,732. 2s. 6d.; arc lamps transferred, £900; arc (special) ditto, £96. 15s.; incandescent ditto, £86. 12s. 6d.; meter rents, £142. 15s.; miscellaneous. £899. 1s. 1d.; overdrawn account, £382 13s. 7d.—total, £11,811. 17s. Expenditure—overdraft (last account), £364 7s. 2d; generation, £2,890. 19s. 6d.; lamps, £26 7s. 3d.; distribution, maintenance, and management, £733. 7s. 4d.; loans, £2 674 5s. 7d.; wages, £1,492. 4s. 4d.; balance in hand, £285 3s.—total, £11,811. 17s.

Cardiff.—At a special meeting of the Electrical Committee Mr. Appelbee reported that Mr. Oswald Stoll had notified that the new Empire would be opened shortly, and asked for terms for supply of electric light. In order to give the supply desired—continuous current—it would be necessary to obtain a motor-generator, and he suggested that the committee should obtain that machine. It was decided that Mr. Appelbee should work out terms and discuss them with Mr. Stoll. At the ordinary meeting of the Town Council held this week several members complained of the small illuminating power of the new electric lamps recently put up on Canton Bridge. At the same meeting application was made to run motorcars for the convenience of passengers between Blackweir and that town until the Council had established the electric trams, which was approved.

Societe Internationale des Electriciens.—The administrative committee of this body has decided to divide itself into six sections, each of which will meet once a month, except during the vacation, in view of discussing questions which are of interest to the society, such as reports, meetings, admission of members, experiments in the central laboratory, high-grade school of electricity, scientific, and industrial missions. The sections are the following: (1) Production and utilisation of electricity as a motive power, will meet the first Monday in the month, under the presidency of M. M. Leblanc. (2) Electric lighting, will meet the first Tuesday in the month; president, M. Bochet. (3) Electro-chemistry, electrometallurgy, accumulators, batteries, the first Wednesday in the month; president, M. D. Monnier. (4) Canalisation, distribution, lighting, traction, etc., the first Thursday in the month; president, M. Grosselin. (5) Telegraphy and telephony, the first Friday in the month; president, M. Abraham. (6) Physical research, electro physiology, instruments, and measures, the first Saturday in the month; president, M. Armagnat. This division is to be commended, as small committees meeting more frequently, and discussing the subjects which they are more directly acquainted with, are more likely to bear fruitful results than fewer meetings where all members attend and where subjects are discussed which only interest the few.

Digitized by Google

Waterloo with Seaforth.—The Urban District Council, having received a number of complaints about the inconvenience caused to users of the telephone by noises on the wires, have decided to address a memorial to the National Telephone Company, explaining the difficulties under which subscribers were labouring, and asking that till the wires were put under ground something might be done to minimise the noise.

Electromotion Corporation, Limited.—This Company has been registered with a capital of £50,000, in £1 shares, the objects being to acquire a concession granted, or about to be granted, by the town of Nova Friburgo for the establishment of a public or private service of electric lighting and certain land and property known as Coscatel de Pinel, and including the waterfall situate in the municipality of Nova Friburgo, in the State of Rio de Janeiro, Brazil, etc.

Alfreton.—The Urban District Council have decided that the electric lighting area to be mentioned in the provisional order should be the Alfreton Ward. Mr. S. Johnson, the engineer (Mr. Barnes), and the surveyor are to inspect the district and settle as to the streets where private consumers are unlikely to be obtained, in which case it is suggested that such streets be struck out of the map and the provisional order, except for street-lighting purposes. In these streets a street-lighting cable only will be laid down.

Walsall.—Subject to the approval of the Local Government Board being obtained, and to the electric lighting undertaking paying to the gas undertaking an annual rent of £115, the Town Council will appropriate, for the purpose of the electric generating station, certain lands forming part of the site of the Wolverhampton-street gasworks. Application is to be made to the Local Government Board for their appropriation of the lands above mentioned for the purposes of the electric lighting undertaking.

West Highlands.—There is some talk of reviving the West Highland water-power scheme for the generating of electric power. The proposal under consideration is to trap the waters of Loch Erichd and convey them across country for a distance of 20 miles to the head of Loch Loven, where a waterfall of 110ft. would be obtained, giving a power equivalent to 23,000 h.p. The scheme, according to the estimate, will cost 1½ millions sterling. It is probable that the scheme will be opposed by persons interested in the North of Scotland.

Ashton-under-Lyne.—Mr. Robert Hammond has been engaged to inspect and report on the whole of the Corporation's existing station plant. The demand indicator system of supply will be abolished at the end of the present quarter, and a uniform rate of 4½d. per unit charged from that time and until further notice for all electricity supplied to private consumers for lighting purposes. Messrs. Lacey, Clirehugh, and Sillar propose to report on the refuse destructor as soon as they have satisfied themselves that the best value possible had been obtained therefrom.

Penistone.—At last week's meeting of the Guardians a deputation from the Penistone and Thurlestone Urban District Councils attended with reference to the question of the electric lighting of the whole district. The Clerk stated that the reason why the deputation had been invited to attend was that the quality of gas was not at all satisfactory, and also that a notice had been served of an increase in the price of gas. Finally, it was resolved that Messrs. T. A. Hinchcliffe (Denby Dale) and Henry Kaye (Clayton West) should represent the Board, and act in conjunction with the District Council.

King's Lynn.—At last week's meeting of the Council the engineer reported that the total number of applications for supply amounted to 210, being an increase of seven during the month, and that there were 372 street lamps (in addition to the arcs), being an increase of six. It was agreed that a main be laid down when required for new applications on the Spread Eagle Estate, and it was stated that the Local Government Board had sanctioned the loan of £10,000 for extensions, with the exception of £20, representing the debt outstanding on the gable end of the engine-house, which would have to be pulled down.

"English Illustrated Magazine."—The August number, well got up and sprightly as usual, contains another instalment by Mr. H. Drummond; another by Mr. Hulme Beaman's, "Adventures of Archibald P. Batts, Millionaire"; and a number of special articles, notably: "Israel in London: How the Hebrew Lives in Whitechapel," by George A. Wade; "Pompeii Up to Date," by Frederick Dolman, with excellent illustrations from photographs of the newer finds; and a very amusing sketch by Mr. C. W. Mason, entitled "Sam Lung and his Claim in Klondike," where the wily John and the 'cute Yankee measure swords, much to the profit of the Celestial.

Electric Enterprise in the West of Scotland.—In reference to the paragraphs that have appeared as to a project for establishing generating stations for the supply of electric energy throughout the West of Scotland, the *Glasgow Herald* is informed that another large scheme of a similar and comprehensive character for the supply of electricity for manufacturing, lighting, and other purposes throughout the industrial districts round Glasgow has been in preparation for a long time past, and is now matured. This scheme is being promoted by a number of gentlemen influential in the various localities embraced, and a Bill for the necessary parliamentary sanction will be introduced next session. The agents are Messrs. Maclay, Murray, and Spens, Glasgow.

Boiler Record Book.—The National Boiler and General Insurance Company, Limited (head offices, 22, St. Ann's-square, Manchester), are publishing a boiler record book, which will be found very useful by steam users, as by its means they will be able to maintain a concise and simple record of the important matters relating to their boilers. The information to be tabulated is classified under the following headings: number of boiler; year; dates of internal cleaning; dates of external flue cleaning; dates of thorough inspection; dates and particulars of special baring of brickwork or covering; repairs (if any) suggested in report; nature and extent of repairs carried out after suggestions in reports, or at any time; dates and particulars of overhaul of or substitution of fittings; general remarks.

Commercial Information Office.—We are informed that the Royal Commission at Paris has instituted a commercial information office for the use, without charge, of British exhibitors, visitors, and members of congresses. There is at the disposal of English members who may be attending congresses a spacious room where they can meet and discuss. This office is situated on the Quai d'Orsay, entrance by the side door on the east. A writing-room is provided for the use of members of congresses, and information on trade matters will be given as far as possible. In the office will also be found a comprehensive set of customs tariffs, information as to transport by land and sea, books of reference, directories, etc. Letters and telegrams can also during the congress be addressed to members as follows: telegrams—care of "Britpav," Paris; letters—care of Commercial Information Office, British Royal Pavilion, Quai d'Orsay. The office will be open daily from 10 a.m. to 5 p.m.

Electric Cargo Cranes.—The Tees Union Shipping Company, Limited, have recently installed at their wharf at Middlesbrough three portable electric cargo-discharging cranes. These electric cranes are similar to those installed by the Southampton Dock and Harbour Board. They have a power of five tons, and have been constructed by Messrs. Stothert and Pitt, Limited, engineers, of Bath and London, their consulting electrical engineer being Mr. J. G. W. Aldridge, of Westminster-chambers, London, S.W. At the new goods shed at Aberdeen Harbour three electric cranes are to be fitted up on the roof to discharge goods from vessels into the upper storey. These cranes are considerably more economical than the hydraulic ones. The current consumed is in direct proportion to the load lifted, whereas the cylinder of the hydraulic has to be pumped full of water whether to lift a maximum load or an empty chain. Another great advantage is that all the cranes can be worked from a central station, and separate boilers and fires are no longer required. The cranes, too, are not affected by frost, as are the hydraulic cranes.

Southend.—At the last meeting of the Town Council the Light Railways and Electric Lighting Committee reported on the tenders received for carrying out the following work in connection with the electric tramways and electric lighting: (1) for the erection of generating station, car sheds, etc., at the London-road depôt; (2) for the permanent way, road bed, paving, and bonding; (3) for steel girder rails and fishplates; (4) for boilers, fittings, and boiler-house accessories (Section A); (5) for steam generators, travelling cranes, switchboards, etc. (Section B); (6) for tramway and lighting feeders, and distributors (Section C); (7) for overhead equipment (Section D); (8) for trucks and car equipments (Section E). Out of 88 tenders received the lowest was that by Messrs. Dutilh-Smith, McMillan, and Co., of 29, Great St. Helens-street, and 32, South-road, Philadelphia, U.S.A., who offered to carry out the whole of the work for £87,500, which is £100 less than the estimated amount of the borough engineer. To the above amount must be added £3,375 for car bodies and £1,000 expenses, making a total outlay of £91,876. The above tender was accepted, as already noted in our last issue, and it was agreed that the sum of £10,900 was the proportionate part in the expenditure chargeable to the electric lighting account. Application will be made to the Local Government Board for allowing these sums to be raised.

Iron and Steel Institute.—The programme of the Paris meeting of the institute, Sept. 18 21, which has just been issued, promises a more than usually interesting meeting. The president (Sir Williams Roberts-Austen, K.C.B.) will deliver a special address, and M. Pinget, the secretary of the French Association of Ironmasters, will read a paper on the general progress of the iron and steel industry in France; Prof. Bauerman (Ordnance College, Woolwich) will describe the iron and steel exhibits at the exhibition; Mr. J. E. Stead (a member of the council) will give the results of his micro-chemical researches on iron and phosphorus; Mr. Colby (Pennsylvania) will discourse on the American methods of testing iron and steel; Mr. Dory (Bilbao) will speak of the washing of iron ore in Spain, whence we derive our principal supplies; and Mr. L. Katona will describe the latest improvements in the rolling mills of Hungary; and Baron Jupiner will read a paper on the constitution of slags in Austria. Other papers will be read by Mr. E. F. S. Lange (Manchester), on a new method of producing high temperature, and by Mr. Melland and Mr. Waldron (Mason University College, Birmingham) on the action of aluminium on the carbon of cast iron. The members will be entertained by the French ironmasters, and visits will be made to St. Chamond, in the Loire, and to the great ironworks at Hyanges, Lorraine. A number of excursions are projected, and members desirous of being invited to take part in either of these excursions may obtain all particulars from the secretary of the institute.

Institution of Junior Engineers.—The members of the Institution of Junior Engineers, in continuation of their annual tour, visited several works on Tuesday in Newcastle and district. In the morning they saw the works of the Newcastle and District Electric Lighting Company, which divides with another company the lighting of Newcastle, and which owes much of its capacity to the inventive powers of the Hon. C. A. Parsons, president of the institution. It was explained that the works, when opened in January, 1890, had three Parsons turbo-electric generators of 75 kw. capacity each, and that more recently a 500-kw. turbo-

Digitized by Google

alternator had been erected—in fact, had it not been that the Parsons steam turbo-generator occupies so little space, and is so free from vibration that no foundation is required for the machinery, the site could not have been utilised for the works. The company has at present turbo-generators representing nearly 1,720 kw. fixed, and has provision for 3,200 kw. The members were afterwards entertained at luncheon by the president, who intimated that he would be unable to preside at the summer dinner of the members on Friday night owing to his having to be present at the trials of the "Viper" at Portsmouth. After luncheon the members visited the Elswick works of Armstrong, Whitworth, and Co., inspecting the engine shops, heavy gunshops, cast-iron foundry shops for hydraulic and electric fittings, ammunition and small quick-firing gunshops, torpedo-tube factory, and the shops in which gun-carriages, mountings, and cartridge-cases are made. In the evening the members visited the engineering department of the Durham College of Science, Newcastle, where Prof. Weighton holds the chair of engineering.—*The Times.*

Glasgow.—The committee on electricity have submitted to the Corporation the eighth annual report and balance-sheet of the Corporation electricity undertaking, which embraces the year from June 1, 1899, to May 31, 1900, for the particulars of which we are indebted to the *Glasgow Herald*. The gross revenue amounts to £59 762. 2s., and the gross (or working) expenditure to £34 999. 15s. 11d., to which is added depreciation written off capital £3,181. 10s. 11d., the balance carried to profit and loss account being £21,580. 15s. 2d., out of which the committee had to meet the following requirements: (1) interest on loans, £15,256. 0s. 7d.; (2) sinking fund, £6,285; leaving a balance of £39. 14s. 7d., which has been placed to the credit of the reserve fund. The committee regret that, owing to the large amount which has had to be paid as interest on money borrowed for new works during the past year, which are as yet unproductive, it has not been found possible to write off in the account now submitted so large an amount in respect of depreciation as was written off in the previous year. With references to the charges to be made for the supply of electrical energy during the year 1900-1901, the committee recommend that these should be as follows: (1) Under the demand indicator system—(1) where a quantity not exceeding the maximum demand for 365 hours in the 12 months (being an average of one hour per day) is used, 6d. per Board of Trade unit; (2) all current consumed over the above quantity at 100 volts pressure, 2½d. per Board of Trade unit; (3) all current consumed over the above quantity at 200 volts pressure, 2d. per Board of Trade unit; (4) all current consumed over the above quantity at 250 volts pressure, 1½d. per Board of Trade unit. (2) Under fixed charged system—(1) a fixed charge of 4s. 6d. per annum for each 8-c.p. (32-watt) lamp or its equivalent fixed in consumer's premises (or £7. 0s. 8d. per kilowatt) for 100 volts supplies; 4s. 4d. per 8-c.p. lamp fixed (or £6. 15s. 5d. per kilowatt for 200 volts supplies, and 4s. per 8-c.p. lamp fixed (or £6. 5s. per kilowatt) for 250 volts supplies, this charge being spread uniformly over the 12 months; (2) an additional charge for all current used as recorded on the meter at the rate of 1½d. per Board of Trade unit. (3) All consumers who take a supply for the equivalent of five hours or more per day for 365 days per annum, to be charged throughout at the rates of 2½d. per unit for 100-volt supplies, 2d. per unit for 200-volt supplies, and 1½d. per unit for 250-volt supplies. (4) That a special rate of 3d. per unit be charged for supply to churches. (5) That for domestic consumers only a uniform charge of 3½d. per unit for 250-volt consumers, and 4d. per unit for 100-volt and 200-volt consumers be made, without the use of the demand indicator. (6) That for motive power purposes only, subject to such conditions as it may be necessary to enforce for the proper protection of the Corporation, a uniform charge of 1½d. per unit for 250-volt consumers and 2d. per unit for 200-volt consumers be made, also without the use of the demand indicator. (Note.—The charges under heads 4, 5, and 6 have already been approved by the Corporation.) The quantity of electricity sold to private consumers during the past year was 3 788,795 units, as compared with 2,566,016 units during the previous year, being an increase of 47·65 per cent. The number of consumers on May 31, 1900, was 2,852, as compared with 1,858 at May 31, 1899, being an increase of 994, or 53·49 per cent., during the year. There were 162 consumers who consumed the equivalent of five hours or over per day of their maximum demand throughout the year. The number of motors in use and supplied off the Corporation mains as at May 31, 1900, was 212, as compared with 78 at May 31, 1899. The total number of arc lamps erected and in regular use in the streets as at May 31, 1900, was 265, as compared with 227 at the same date last year, and the quantity of electricity consumed for street-lighting was 461,874 units, as compared with 258 334 during the preceding year. During the year the buildings at Port Dundas have been practically completed as far as the first section is concerned, and the temporary wooden shed which had to be erected within the line of the main building has been removed for some months past. The amount of steam plant erected or in process of erection and nearing completion as at May 31, 1900, at Port-Dundas was nearly 7,000 h.p., being rather more than double the amount of plant (3,300 h.p.) previously fixed in the Waterloo-street station. There is, therefore, 4,500 h.p. extra available at Port-Dundas to meet the coming winter's load, as compared with the amount available last winter. In addition to this, the buildings at Pollokshaws-road station have been advanced to a stage nearing completion, and the erection of the boilers, engines, and dynamos to an aggregate of 2,200 h.p. is now being proceeded with. This will provide an additional 2,200 h.p. beyond that above indicated to meet the demand of the coming winter, and after the wants of Pollokshields and other parts of the south side area in which mains will be ready for supply have been met, a considerable amount will remain available for assistance on the north side of the river if required. A further extension of plant for Port-Dundas station of about 5.000 h.p. is on order, and this is expected to be in full operation before May 31 next. An arrangement has also been made to put in additional plant of 2,200 h.p. in the Pollokshaws-road station after the close of the Glasgow Exhibition of 1901. This plant, consisting of two engines and dynamos, is due for delivery at the exhibition in January, 1901, where it will be erected and used till the close of the exhibition. About 20 miles of new feeders and 20 miles of distributing mains have been laid during the past financial year upon the north side of the Clyde, and about seven miles of feeders and five miles of distributing mains have been laid on the south side of the river, in addition to what had been laid before May 31, 1899. These feeders and mains the committee confidently hope may be put in use by October of the present year. The undertaking of the Kelvinside Electricity Company, Limited, came into the hands of the Corporation in August, 1899, and the committee are now putting in about 1,000 h.p. of new plant to meet the rapidly-growing demand in the Hyndland district of Kelvinside and also in the Dowanhill district as far as Byres-road. There is a steadily-increasing demand within the area of the Kelvinside estate, but it should be specially noted that during the past year 81 new consumers have been connected to the mains in the new tenements on the Hyndland-road district alone and that this number is rapidly growing, as many as 22 having been added since May 31 last. At the close of the financial year (1899-1900) the electricity rents that were still outstanding amounted to £6,279. 19s. 9d., and at about the middle of July there had been recovered a sum of £3,965. 12s. 5d. There was thus still outstanding at that time the sum of £2,314. 7s. 4d.

PROVISIONAL PATENTS, 1900.

JULY 31.

13679. Improvements in holders for electrolytic incandescent lamps. Bernard Mervyn Drake, Eustace Graham Sheppard, and the Nernst Electric Light Company, Limited, 82, Victoria-street, Westminster, London.

13680. Improvements in series resistances for electrolytic lamps. Sylvester Legh Powell and the Nernst Electric Light Company, Limited, 82, Victoria-street, Westminster, London.

13692. Phonographic recorder. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13693. Process of and apparatus for duplicating phonographic records, also applicable for other purposes. Thomas Alva Edison, 23, Southampton-buildings, Chancery lane, London. (Complete specification.)

13709. Improvements in and connected with index arrangement for telephone subscribers. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

13720. Improvements in methods of operating dynamo-electric machines. The British Thomson-Houston Company, Limited. 83, Cannon-street, London. (Ernst J. Berg, United States) (Complete specification.)

13721. Improvements in systems of electric meter control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles L. Perry, United States.) (Complete specification.)

13722. Improvements in contact devices chiefly designed for use in connection with electrical counting or recording devices. Alwyn Walter Staveley and Isaac Hardy Parsons, trading as Gent and Co., 4, South street, Finsbury, London.

13732. Improvements in electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

13751. A new or improved automatic device for the safe operation of electric conductors with or without guard wires. Conrado Sintas and Ernesto E. Schultz, 18, Buckingham-street, Strand, London. (Complete specification.)

13758. Improvements in incandescent electric safety lamps. Frederick Humphrey Hill, 298, South Lambeth-road, London.

13765. Improvements in automatic electric block systems for railroads. Judson Shoecraft and Charles Carroll Gardiner, 111, Hatton-garden, London. (Complete specification.)

AUGUST 1.

13786. Self acting charge and discharge indicator for accumulators and similar apparatuses. Heinrich Wilhelm Hellmann, 4, Wielandstrasse, Charlottenburg, Germany. (Complete specification.)

13805. Improvements in insulating supports for electrical conductors. Gilbert Wright and Christian Aalborg, Westinghouse-building, Norfolk-street Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 2, 1900, being date of application in United States.)

Digitized by Google

13810. Improvements in trolleys for electric traction having three wires for triphase currents. Alfred Bosshardt, 4, Corporation-street, Manchester. (Léon Gerard, Belgium.)

13811. Improvements relating to underground electric conduits. Hermann Hillischer, 45, Southampton-buildings, Chancery-lane, London.

13816. Improvements in or connected with storage batteries. Walter Osmond Rooper, 115, Cannon street, London. (Complete specification.)

13820. Improvements in or relating to starting switches and automatic controllers of electromotors. Ernest Francis Moy and Percy Henry Bastie, 37, Essex-street, Strand, London.

13822. Improvements in alternating-current electromotors. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

AUGUST 2

13839. Improvements in glow bodies and heaters for electrolytic incandescent lamps. Bernard Mervyn Drake and the Nernst Electric Light Company, Limited, 82, Victoria-street, Westminster, London.

13860. Improvements in controllers for electric motors. Thomas Steel Perkins, Westinghouse building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 13, 1900, being date of application in United States.)

13873. Improvements in electric switches. George Herbert Whittingham, 52, Chancery-lane, London. (Complete specification.)

13874. Improvements in automatic circuit controllers. George Herbert Whittingham, 52, Chancery-lane, London. (Complete specification.)

13892. Process for the production of heating bodies for exciting electrical incandescence bodies made of second-class conductors. Victor Isidor Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

13901. Improvements in electrical demand indicators. John Reid Dick and the Reason Manufacturing Company, Limited, Norfolk House, Victoria-embankment, London. (Partly by Arthur Wright, on the high seas.)

AUGUST 3.

13951. Improvements relating to electric muffles or furnaces. Julius Weiss, 45, Southampton-buildings, Chancery-lane, London.

13962. Improvements in electric signal registering systems. Christian Albert Jensen, 77, Chancery-lane, London. (The Yargae Signalphone Manufacturing Company, United States.)

13963. Improvements in and relating to cipher code systems for use in transmission of cable, telegraphic, and other forms of written messages. Elmer Francis Cassel, 77, Chancery-lane, London. (Complete specification.)

13966. Improvements in Roentgen-ray tubes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

13967. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

13968. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States.) (Complete specification.)

13969. Improvements in insulated electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William Le Roy Emmet, United States.) (Complete specification.)

13970. Improvements in armatures for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

13971. Improvements in rectifiers for alternating electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

13972. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

13973. Improvements in insulated electric conductors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William Le Roy Emmet, United States.) (Complete specification.)

13974. Improvements in rail bonds for electric railroads. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Jesse R. Lovejoy, United States.) (Complete specification.)

13975. Improvements in systems for controlling electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Barry, United States.) (Complete specification.)

13999. Improvements in arc lamps. Léon Bénard, 46, Lincoln's-inn-fields, London.

AUGUST 4.

14037. Improvements in or relating to electrical transmission gear for motorcars and other machinery. Henry Thomas Dawson and Henry Alfred Dawson, 18, Hertford-street, Coventry.

14053. A lightning protector for telephones. Charles Richard Cormac, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14054. Improvements in indicators for electric bells and the like. Julius Sax and Co., Limited, and James Aird, 226, High Holborn, London. (Complete specification.)

14063. Improvements in and connected with combined switches and fuses. Gilbert Cecil Pillinger and Albert Vandam, 322, High Holborn, London.

14067. Apparatus for generating and utilising electric energy. William Speirs Simpson, 166, Fleet-street, London.

14069. Improvements in lightning arresters. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Actiengesellschaft Electricitätswerke, vorm. O. L. Kummer und Co., Dresden.) (Complete specification.)

AUGUST 7.

14086. Improvements in wireless or Hertzian telegraphy. Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

14101. Improvements in coils or helices for electrical purposes. William George Heys, 70, Market-street, Manchester. (John Scott, Richard Varley, and James Chris Anderson, United States.) (Complete specification.)

14104. Improvements in electrodes for the use in electro-chemical processes. Otto Lauckner, 80, Watling-street, London. (Alfred Vogelsang, Germany.) (Complete specification.)

14121. Improvements in methods of and means for producing light. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (The General Electric Company, United States.) (Complete specification.)

14134. Improvements in or relating to electrical traction. Edward Joel Pennington, 111, Hatton-garden, London.

14139. Improvements relating to electric railway systems. William Burrage Purvis, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14164. A new or improved insulator. Heinrich Traun, 18, Buckingham-street, Strand, London.

AUGUST 8.

14170. A quick make and break switch for electrical purposes. Henry Herbert Hill, Swancot Cottage, London-road, Hampton, Middlesex.

14212. Improvements in or relating to electric furnaces. Alfred Julius Boult, 111, Hatton-garden, London. (The Union Carbide Company, United States.) (Complete specification.)

14215. Means of fixing electrical appliances to ceilings, walls, furniture, and the like. Johannes Körner, Paul Körner, and Eugen Mahla, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14237. A safety device or fender for electric tramways or the like. Carl Zimmerman, 18, Buckingham-street, Strand, London.

AUGUST 9.

14248. An improved electrical replacement indicator. August Eckstein and Arthur Edwin Mitchell, Peel Works, Adelphi, Salford, Manchester.

14275. Improvements in and relating to electro-chemical or copying telegraphs. George Cecil Dymond, 6, Lord-street, Liverpool. (The Kopier-Telegraph Gesellschaft mit beschränkter Haftung, Germany.) (Complete specification.)

14281. Improvements in telegraphy by means of alternating currents and imperfect contacts. Gustave Ferrié, 4, South-street, Finsbury, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 9, 1900, being date of application in France.) (Complete specification.)

14288. Improvements in electromagnetic apparatus for jacquards. Jan Szczepanik and Ludwig Kleinberg, 46, Lincoln's-inn fields, London.

14289. Improvements in electric switches. Arthur William Bundy Pearson, 72, Cannon-street, London. (Complete specification.)

AUGUST 10.

14324. Improvement in arc lamps. Frederick William Smith, Alfred John Smith, and Wallace James Lambert Sandy, 8, Clerkenwell-green, London.

14337. An electric releasing apparatus for pneumatic pressure brakes. August Brüggemann and Deutsche Waffen und Munitionsfabriken, 53, Chancery-lane, London.

15354. Improvement in magnetic separating apparatus. The Edison Ore-Milling Syndicate, Limited, 188, Fleet-street, London. (Thomas Alva Edison, United States.)

14355. Improvement in magnetic separating apparatus. The Edison Ore-Milling Syndicate, Limited, 188, Fleet-street, London. (Thomas Alva Edison, United States.)

14367. Improvements in electrical contact apparatus. Koloman de Kandó, 18, Buckingham-street, Strand, London.

Digitized by Google

AUGUST 11.

14373. Improvements in and connected with electrical fuse boards. Henry Oliver Farrell, 16, Kensington-road, Chorlton-cum-Hardy, Manchester.

14383. Improvements in or relating to electrical ignition devices for explosion motors having two or more cylinders. Edmund Woodward Lewis, 18, Hertford-street, Coventry.

14384. Improvements relating to rail points and overhead switches in electric tramways. William Carter and James Bowrey, Lloyds Bank-buildings, Bristol.

14409. Improvements in electric meters. Jesse Harris, 52, Chancery-lane, London. (Complete specification.)

14420. Improvements in combined electric meters and demand indicators. James Grieve Lorrain, Norfolk House, Victoria-embankment, London. (Arthur Wright, at present on the high seas.)

14422. Improvements in switches and apparatus for use in starting and controlling electric motors. Arthur Henry Adams, 11, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Sept. 1.

1899.

15816. Electromagnetic rail brakes. Wilde.

15882. Apparatus for operating two or more electrical regulating switches or resistance devices together or separately. Lucas.

16083. Controlling devices for electric currents. Cuénod.

16199. Switches for high voltage. Oppenheimer. (Actien-gesellschaft Mix und Genest.)

16267. Electrical apparatus for sorting articles according to one of their dimensions. Lock and Milner.

16293. Manufacture of leaden plates for secondary batteries or accumulators, and in moulds and tools to be employed in such manufacture. Davies.

16395. Arrangement for controlling electric elevators. Wahlström.

17815. Direct-acting electric generators and directly-driven electric compressors for air or other gases. Atkinson.

19090. Electric arc lamps. Wilby.

19261. Means for electrically rewinding clock or similar mechanism. British Thomson-Houston Company, Limited, and Holden.

19941. Electric tramcars with overhead collectors. Pick.

20145. Combination electric light fittings. Sevenoakes.

20316. Troughs for electric cables. Sykes.

1900.

1680. Picking up electric current sent from a generating station by a railway car and returning it. Sayer.

7814. Boiling and vaporising fluids by electricity. Sayer.

11120. Ploughs for conduit electric railway cars. Gottsberger. (Date applied for under International Convention, June 4, 1900.)

12018. Electric propulsion for motor road vehicles. Ryan.

12537. Electric accumulator plates. Ribbe.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Aug. 11	804	767	+ 37	7,738	6,881
Birmingham Tramways Co.	,, 11	4 398	4,825	+ 427	137,836	130,909 *c*
Blackburn Corp'rat'n	July 28	456	488	+ 31	11,478	13 084
Blackpool Corporatn.	Aug. 9	1 374	1,315	+ 59	14,087	11,107
Blackpool-Fleetwood	,, 11	1,904	2,167	- 263	7,787	7,981
Bradford City Trams	,, 12	503	471	+ 32	9,503	7,724
Bristol Tramways Co.	,, 10	4,061	4,489	- 428	—	—
Central London Ry.	,, 11	5,042	—	—	—	9,365 *c*
City & South London	,, 12	1,555	1,033	+ 522	9,001	5 687
Cork E. T. and L. Co.	,, 9	521	545	- 24	12,662	11,464 *c*
Dover Tramways ...	,, 11	317	334	- 17	6,156	5,819
Dublin U.T., elec. cars	,, 10	3,729	1,353	+2,376	—	—
Dublin S.D. Electric	,, 10	999	1.284	- 285	—	—
Glasgow Corporation	,, 11	8,827	9,068	- 241	—	—
Halifax Corporation	,, 12	914	886	+ 28	14,859	11,447
Hull Corporat'n E.S.	,, 4	1,312	1,357	—	— *a*	23,422 *d*
Liverpool Corporat'n	July 28 *b*	9,054	7,651	+1,403	223,780	196,624
Liverpool Overhead	Aug. 12	1,876	2,074	- 198	10,375 *c*	10,067
Sheffield Corporation	,, 12	2,544	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *d* Since July 5. *e* From July 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	½-¾
British Insulated Wire, Ord., 1-40,000	5	—	11½-12½
—— 40,001-100,000	—	—	10½-11
—— 6 per cent. Cum. Pref., 1-27,500	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	—	96½-100½
British Electric Works, Ordinary, 50,001-96,000	1	—	½-¾
—— 6 per cent. Cum. Pref., 1-50,000	1	—	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2½-2¾
—— 4½ per cent. Debenture Stock	100	..	108-112
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	13-14
—— 5 per cent. Pref.	5	—	5½-5¾
Crompton and Co.	5	—	3¾-4½
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	2-2½
—— 5 per cent. Debentures	5	—	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	—	91-93
—— 5 per cent. Second Deb. Stk., Prov. Crts. 70 p.ct. pd.	—	..	68-72
Electric Construction	3	—	1¾-2½
—— 7 per cent. Cumulative Pref.	3	—	2¾-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	35-39
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	..	5½-5¾
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-1
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8¼-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6-6½
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	6¾-7½
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	7½-8½
—— 6 per cent. Cumulative Pref.	10	—	13-13
—— 5 per cent. Debenture Stock	100	..	122-123
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	10-10½
London Electric, Ordinary	3	—	1-1½
—— 6 per cent. Pref.	5	—	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-100
Metropolitan, Ordinary	10	..	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-98
Notting Hill Electric Lighting	10	—	15½-16½
Oriental, 1879	1	—	1½-1¾
—— £5 Shares	5	—	7½-7¾
—— £4½ Shares, New	4½	—	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8-9
Westminster, Ordinary	5	—	12-13
—— 80,001-109,437	2½	..	8¼-9½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	5 5½
—— ,, ,, deferred	5	..	5 5½
City and South London, Consolidated Ordinary	100	—	56-59
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120-125
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	13½-13½
Waterloo and City, Ordinary	100	—	90 93
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
Brisbane Tramway	100	—	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary	10	..	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100	..	123-126
—— ,, ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4-4½
—— 5 per cent. Deb. Stock, Red.	100	—	103-106
—— Prov. Cert., all paid	—	..	96-99
Isle of Man Electric Power, 5 per cent. Pref., 1-10,000	5	—	5½-6½
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. Pref.	5	—	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-18
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
Telephones.—			
National Telephone, Ordinary	5	—	6½-7½
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	4½-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	97-100
Oriental Telephone and Electric Company	1	—	¾-1½

Digitized by Google

NOTES.

A New Lamp.—According to *La Réforme*, a new form of electric incandescent lamp has been produced at the works of Messrs. Wrede and Jungblatt in Menin and Jemappes (Mons), which tests made at the municipal electricity works, Brussels, proved to consume 40 per cent. less energy than the ordinary type of incandescent lamp. The lamp, it is further stated, may be used without any special holder.

Electric Lighting in Greece.—The Hellenic Electric Society of Athens, which has already obtained concessions for lighting several towns in Greece, has just obtained a concession to light the district of Euripe in that country. The company for this purpose propose to use the canal of Euripe, by which turbines are to be driven. Failing the success of such an installation, the electrical machines are to be driven by means of gas-engines.

Cablegrams by Telephone. — The Postmaster-General has given his sanction to an agreement made between himself, the various cable companies, and the National Telephone Company, whereby Liverpool merchants will be allowed to have transmitted over the wires of the National Telephone Company any cable messages which arrive for them after business hours. This concession has been gained through the exertions of the Liverpool Chamber of Commerce, and the facilities will be given as soon as the formal deed now in preparation has been completed.

Gas Journals Please Note.—The following extract from a sermon on "Burden Bearing," delivered by the Rev. W. Muzzel at St. Paul's, Withington, will be of interest to our gas contemporaries. In this sermon the Rector said that "Nature was often made to share our burdens, and he wished the people of that church would assist Nature by illuminating the place with the electric light, so that their lives might be spared for a few years, as God intended them to be spared, instead of running the risk of being poisoned by having to breathe (especially in the close, warm weather) the vitiated and poisonous atmosphere caused by bad gas."

Electric Treatment for Lead-Poisoning.—The North Staffordshire Infirmary is now to be fully equipped with electrical apparatus of the most modern description for an extensive investigation on the treatment of lead-poisoning by electricity. The necessary money to provide this equipment has been subscribed principally through the interest of the Duchess of Sutherland, who commenced the movement at a drawing-room meeting, at which the present results obtained by the electrical treatment of workpeople affected by lead-poisoning were described. The electrical equipment at the infirmary in question will, besides electric baths, include a complete set of X-ray apparatus and an electric cautery for surgical work.

The Time-Limit Lamp.—We gather from the columns of the *Electrical Review* of New York that a German firm has recently placed on the market a type of incandescent lamp which can be made to automatically extinguish itself after a given number of hours' burning. The way this is effected is as follows: In the base of the lamp is fixed a copper tube containing a central part of copper wire and filled with a solution of sulphate of copper. A current is arranged to pass through this solution from the wire to the tube, so that a continued electrolytic solution of the wire takes place. As soon as the wire is all dissolved, the circuit is broken and the lamp goes out. The size and length of the wire may be set for any given number of hours, and the lamp thus becomes automatic in its action. We should have thought a more easy way of effecting the same result would have been to have made the gas given off in a voltameter actuate by pressure a mercury switch against a hydrostatic head.

North-East Coast Institution.—We have received a copy of the *Transactions* of the above Institution of Engineers and Shipbuilders, which is issued in August this year. It contains the proceedings of the seventh and eighth general meetings of the institution, in which the following papers were discussed: "The British Naval Engineer, and his Present Position and Influence on our Sea Power," by Mr. B. B. Morison, and "The Training of Young Engineers," by Mr. W. C. Borrowman. There is also in this volume the adjourned discussion on Mr. W. H. Atherston's paper on "The Fouling of Ships." The volume is of exceptional interest in view of the first-mentioned contributions to the *Transactions* of the institution.

Electric Lighting in Toronto.—The city engineer of Toronto has prepared extensive estimates for the buildings and machinery of a municipal electric lighting station for that city. He makes the total cost come out at £190,000. An arc lighting plant to supply 1,350 arc lamps through the streets in the town would cost a further sum of £60,000 if overhead wires are allowed, or £102,000 if the mains are laid underground. The engineer estimates that the cost of running these arc lamps, including interest and depreciation, would be about £12. 12s. per arc lamp per annum if the wires are overhead, and £14 per arc lamp per annum with underground wires. We trust that the municipal scheme will go through at Toronto, and that the work will be given out amongst Canadian firms, who have proved themselves well to the fore in electrical matters.

Telegraphic Interference.—The Government of the Argentine Republic is about to connect Buenos Ayres with Rosario by an underground cable, the length of which will be approximately 150 miles. The need for this cable is said to arise from the continued interruption in the land line service. Amongst the causes of these interruptions it is said that small spiders have played a considerable part. These insects abound in the district, and have used the telegraph wires as the foundations for their nets. Their cobwebs connecting the various wires do not interfere with the signalling on fine days, but after dew or rain has accumulated upon them they form almost a short-circuit between the conductors. The most annoying feature in connection with the variable resistance between the conductors so caused is that it is almost impossible to predict what state the line will be in at any particular time. The consequent interference with the signalling has resulted in the submarine cable project above referred to.

The New Alaskan Cable.—This cable, which is to connect St. Michael to Unalaklik and also to Cape Nome, is to be laid, all being well, during the present week. The first section of this cable is 55 miles long, the Cape Nome section is 132 miles long. In each case the core consists of $^{7}/_{24}$ wire insulated with a cover of rubber $\frac{1}{64}$in. in thickness. Over this is laid kerite up to a diameter of $\frac{3}{32}$in., and then a layer of tape; over this is built up a serving of three-ply tarred jute to an outside diameter sufficient to receive an armour of 16 No. 12 B. & S. galvanised steel wires. Over the armour is laid two reversed layers of three-ply tarred jute. Before armouring, the cable was subjected to a test of 5,000 volts alternating between core and the surrounding water, while an insulation resistance of 800 megohms per mile had to be obtained on every section. This is said to be the longest submarine cable manufactured by an American firm, the order being placed with Mr. W. R. Brixey, of New York. It is hoped

Digitized by Google

that the cables will be laid and ready for traffic by the 6th prox.

The City and Guilds Exhibition.—The programme of the technical examinations of the City and Guilds of London Institute for the advancement of technical education for the session 1900 to 1901 has reached us. We note that the examiners for the ensuing year will be as follows: in telegraphy and telephoning, Mr. J. Gavey; in electric light and power distribution, Prof. W. E. Ayrton, F.R.S., and Mr. W. B. Sayers, M.I.E.E.; in electro-plating and deposition, Prof. W. G. McMillan. In mechanical engineering the two examiners are Prof. Hudson Beare, M.I.C.E., and Prof. W. E. Dalby, M.I.C.E. The policy of the institute in making frequent changes in the *personnel* of their examiners is one that is to be highly recommended. If one has the same examiner year by year the questions are very apt to become stereotyped, and the various teachers throughout the country can then prepare their students by cramming them for the stereotyped questions. When the examiner is changed frequently, and is also selected from the highest ranks of the profession, as is the case with the City and Guilds of London Institute, only those teachers who really instruct their students in the groundwork of the profession are able to score in the examinations.

High-Voltage Trolley.—The following is an abstract of an article by Mr. Walter Reichel, contributed to the *Elektrotechnische Zeitschrift*, on some experiments made since 1898 by Messrs. Siemens and Halske, of Berlin, on high-voltage trolley working. The object of the experimental line was to determine if polyphase transmission at 10,000 volts enabled current to be taken off overhead wires by means of sliding contacts and reduced by transformers on the motorcars to a lower voltage for supply to the polyphase motors. The principal results of these trials are that it was proven to be feasible to take the currents off by sliding contacts at 10,000 volts and at speeds up to 37 miles an hour. It is well known that the ordinary under-running trolley wheel does not maintain uniform contact with the trolley wire at speeds above 25 miles per hour. The design of a sliding contact practical for higher speeds was, therefore, the main object of the experiments. The officials of the villages where the trial line was erected required a system of safety wires to be drawn below the trolley wires, in order to prevent an accident in case a wire should break; therefore, a sliding contact along the underside of the trolley wire could not be tried. Two other systems were tried: sliding contacts making contact with the upper side of the trolley wire, and lateral sliding contacts. The latter, which are shown in Fig. 4, proved to be the better. Trials were made with three line potentials—750, 2,000, and 10,000 volts—and at various speeds up to 37 miles an hour. The sliding contacts were found to work better at 10,000 volts than at a lower voltage, and proved to be entirely practical for the purpose. We are indebted for the abstract to the *American Electrician*.

Tramway Brakes.—The New York State Board of Railway Commissioners has issued its report on the official tests it made recently on brakes for street cars. The Commission concluded their report by stating that while satisfactory results were obtained on the tests, there is still much room for improvement in brakes for tramcars. The Commission feel that the public tests made by them will result in still further improvements in this direction, or in the development of new inventions which will reduce the distance within which a car going at a certain speed can be stopped. The Commission proceeds to congratulate itself on having done all it is able to do to conduce to the use of better brakes on the majority of the roads in the State of New York. The best brake, as found by actual experiments on the tests referred to above, was found to be that of the Electrical Selector and Signal Company. This brake is of the electric type. The next one in order is of the friction type, exhibited by the Peckham Brake and Wheel Company, while the third brake in order of merit was a hand-power one. After a careful consideration of the whole subject of brakes for electric tramcars, the Board has determined that, except in special cases where the liability to accident is very remote, the single chain and spindle hand brakes now generally used shall be replaced by more powerful brakes, made by one of the manufacturers recommended. As this list of manufacturers includes 14 or 15 firms supplying electric brakes, air brakes, friction brakes, and hand-power brakes, it will be seen that the Commissioners allow a wide range of personal selection to the managers of electric tramways in the State of New York. We gather from the general reading of the report, however, that the Commissioners have hardly the power possessed by our Board of Trade to enforce their recommendations.

The Speed of Warships.—We notice in the *Scientific American* an article congratulating the shipbuilding firm of Messrs. Cramps and Co. on the successful steam trials made on the Russian cruiser "Variag." According to the specification, the speed over a one-mile course was not to be accepted for this cruiser, but the Russian Government insisted on a steam and speed trial lasting over 12 consecutive hours. We understand that during a preliminary run made by the builders, the cruiser averaged 24·6 knots over an hour's run. On the official trial, which lasted only seven hours, owing to a slight breakdown in one of the high-pressure cylinders, a speed of 23·65 knots was attained. This result is most satisfactory for a cruiser of the tonnage of the "Variag," but is not at all on a par with the speed obtained on the "Viper." It will be remembered by our readers that on this ship, which is equipped with Parsons steam-turbines, a speed of 37·1 knots was obtained. Our contemporary goes on to criticise the proposal to use steam-turbines for ordinary marine work, and quotes Admiral Melville to the effect that the turbines consume such enormous quantities of steam. Comparisons between the steam-turbine and an ordinary reciprocating engine are rendered somewhat difficult, owing to the fact that one cannot indicate a steam-turbine in the same way as can be done with the reciprocating engine. It has been shown, however, by a number of steam consumption trials working against a brake, that with superheated steam a steam-turbine can be designed to give almost as economical results as a reciprocating steam-engine. For marine work the turbine has the further advantage that it has no oscillating parts to cause vibration in the ship. The vibration which is caused by the engines ordinarily used on board a ship is responsible for great waste of energy, and we shall not be surprised to find in the long run that the steam-turbine has commercial advantages on its side.

The Wannsee Railway.—As promised, some further particulars are duly given in the *Elektrotechnische Zeitschrift* in regard to the equipment of the Wannsee Railway, briefly referred to in our issue of the 17th inst. For the time being the number of electric trains run per diem is limited to six, but this number will eventually be increased to 30, the old service of steam-hauled trains being meanwhile retained, as previously mentioned. The distance traversed at each run amounts to 12 km., the object of the innovation being to obtain reliable data relative to the electrical haulage of trains with a view to the extensive introduction into Germany of electric traction for main-

Digitized by Google

line work. Messrs. Siemens and Halske have supplied the electrical equipment, and are conducting the experiments. The train supplied provides accommodation for 410 passengers, weighs 210 tons, and consists of 10 three-axle cars. The two third-class end cars, which carry the driving motors, differ in outward appearance from the other third-class cars only in that a glass-protected look-out is provided in place of the ordinary end partitions. The extreme end of each motorcar is provided with a driving platform and the necessary controlling apparatus and measuring instruments, besides the air-pump and boiler in connection with the Westinghouse brakes. The necessary propelling power is furnished by six series-wound motors, having an output of 150 h.p. each. These motors are coupled direct to the axles of the motorcars. The train is controlled from the forward car. The motors of one of the motorcars are permanently connected in parallel. At each side of the train are attached six collector shoes, which collect the necessary driving current from conductor rails laid parallel to the bearing rails in much the same manner, it would appear, as the current is collected by the electric train working the Kensington-Earl's Court section of the Metropolitan Railway.

A Thermo-Electric Motor.—We notice in a German contemporary an illustrated description of a proposed thermo-electric motor, designed by Mr. C. Mayer. The novelty in the apparatus is that it is proposed by it to generate electricity, and in the same machine to convert this electricity into mechanical motion. For this purpose a machine is built up, which is in section not unlike the old Gramme machine, with a disc armature. The field-magnet system is, however, exceedingly different, consisting of a field of the unipolar type, although the pole surface is not continuous. The disc armature is wound with short-circuited thermo-electric couples. The outside junction of this is subjected to heat from a gas-burner, the cold junction being at the inside of the core. In this way the inventor will get a current circulating round the core. The field-magnet system is also, by means of thermo-electric couples, short-circuited round the poles, and here again the external junction is heated by means of gas-burners, while the inner junctions are the cool ones. The arrangement of magnetic parts is such that the armature will then be inclined to move in the same way as the well-known Faraday disc. Air vanes on the armature will then draw air up past the internal junctions of both the exciting and armature thermo-electric couples, tending to keep the same cool. Although it is not shown in the drawings, we presume that the hot junctions will be screened from draught, so that the cooling action will only take place on the inner junctions. Nickel and iron are suggested in the article as the two metals to be used. It is proposed to regulate the power and speed of the machine by regulating the gas-burners, but another method of regulation—*i.e.*, of regulating the output by altering the current in the exciting circuit and taking the same from the external source—is suggested. No information is, however, given in our contemporary as to the effectiveness or otherwise of the apparatus.

The Cost of the Horse-Power Hour.—In their "Dictionnaire du Commerce" MM. Yves Guyot and A. Raffaldvich give interesting figures concerning the cost of small power for agricultural purposes, from which the following are taken: A man can exert a mean pull of 15·4lb. on a crank of 14in. radius, working eight hours a day, at a speed of 30 revolutions per minute. The daily wage of the man being 2s. 10d., the horse-power hour will cost 3s. 5d. Again, a horse weighing half a ton working a capstan 13ft. in radius exerts a mean pull of 121lb. at a speed of 180ft. per minute during eight hours. The cost of the horse's daily keep being 3s. 2½d., the cost of the horse-power hour will be 9½d. A bullock working under the same conditions exerts an effort of 143lb. at a speed of 133ft. per minute. The cost of the bullock's day's work being estimated at 2s. 10d., the cost of the horse-power hour will be 10¾d. A movable steam-engine of 3 h.p. to 8 h.p. working at high pressure without condensation, the price varying from £40 per horse-power for small powers to £30 per horse-power for mean powers, burns approximately 6·6lb. of coal per horse-power. The cost price of 1 h.p. produced by an engine of 6 h.p. working 10 hours daily during 150 days, comes out at 2$\frac{1}{10}$d. A fixed petroleum motor consumes about 0·5 litre to 0·8 litre (mean ¼ gallon) of mineral oil or paraffin per horse-power hour, and costs from £24 to £32 per horse-power, the locomobile motors costing slightly more; the cost price per hour for 1 h.p. can be estimated at 3½d. with petroleum and at 3½d. with paraffin. For a windmill developing a force of from ½ h.p. to 3 h.p., and costing from £40 to £120, the cost of the horse-power hour comes to just over 1d. With a waterwheel, the price of which, including masonry and installation, varies from £16 to £32 per horse-power, the cost of the horse-power hour comes to about ·33d., and for a turbine, the price of which varies, under the same conditions, from £12 to £20 per horse-power, the cost of power is about the same.

The Conductivities of Oxides.—In a contribution to the *Elektrotechnische Zeitschrift* Mr. J. Sohlman gives the results of some experiments which he has conducted in order to determine the relative conductivities of various oxides and oxide combinations when heated. The experiments showed that the conductivities of different oxides, and especially the temperature at which they commenced to be appreciably conductive, varied very considerably. Such oxides only as Mr. Sohlman deemed of possible utility for lamp filaments were experimented with. The oxides of beryllium, magnesium, and calcium proved to be very bad conductors even at high temperatures, requiring especially high temperatures in order to render them appreciably conductive. On the other hand, oxide of zinc showed better conductivity, its conductive stage being more readily attainable. Comparing the chemical properties of the oxides experimented with, it was found that with one exception those of relative bad conductivity possessed strong bases, while those of good conductivity were characterised by a more or less pronounced acidulous formation. The results obtained have led Mr. Sohlman to conclude that the conductivity of an oxide is a periodical function of the atomic weight of the particular element concerned, as is the case with many other physical properties of the elements and their combinations. The conductivities of the chemical combinations between oxides of different bases (salts) show a dependence upon the chemical properties of the constituent elements, though the ultimate conductivity generally varies very greatly from the conductivities of the component elements. It may also be observed that oxides which differ only very slightly in their bases may yield combinations which possess conductivities differing very considerably from those of the separate components. For instance, oxide of thorium in combination with oxide of lanthan, which has only a slightly stronger base, yields a substance which is a good conductor, while each of the oxides mentioned taken separately is a bad conductor.

The Manchester Corporation as a Trader.—The chairman of the Manchester Corporation Gas Committee has issued a memorandum dealing with the finances of his

Digitized by Google

department on the questionable policy of making large contributions to the rates out of the profits earned in that department. The statement reads as follows: "The gasworks of the city of Manchester were transferred by the Commissioners of Police to the Corporation in 1843 for the sum of £198,817. Since then there has been expended on the works £2,827,124, making a total of £3,025,941. During these 57 years the gross profit made out of the gas undertaking has been £5,227,086, so that if the Gas Committee during this period had been permitted to use their own profits for their own benefit, the whole of the gasworks would have now been paid for without having to borrow any money at all, and the ratepayers of to-day would have had a balance in hand of £2,201,145. Instead of this, the ratepayers have no balance, but owe £1,026,456, and have to pay nearly £40,000 a year for interest upon borrowed capital, which never need have been borrowed. What has been done with this profit of £5,227,086? The sum of £2,398,471 has been paid over for city improvements and in relief of the rates, £1,017,191 has been paid in the shape of sinking fund, £752,808 has been used to write down the value of the works as depreciation, and £1,058,616 has been paid for interest on borrowed capital. So that over a million of money has been given away when it ought to have been in the gas consumers' pockets. This brings up the total amount to £5,227,086." It will be clearly seen from the above that the state of affairs would have been very different if the gas had been supplied to the ratepayers without making a profit. While up to the present electric light undertakings cannot show quite such a good return, owing to the short length of time during which they have been at work, there is every indication that the electric lighting undertaking in Manchester could contribute largely to the general needs of the Corporation, but we trust that the Electric Lighting Committee will adopt the more enlightened policy of supplying electrical energy at prime cost.

Electricity as a By-Product.—We have referred before in our columns to a contribution read by Mr. H. T. Yaryan before the American Society of Mechanical Engineers on the supply of heat from an electrical station by means of exhaust steam heaters. We now have before us a more extended copy of the paper in question, which is printed in the *Journal of Electricity* of San Francisco. The author confines his attention to actual figures obtained by the Toledo Heating and Lighting Company for the six months ending Jan. 1, 1900. During this time the company supplied heat to 199 houses, and electric light to 450 houses. The actual receipts from the heating load were £1,980, while the electric lighting only brought in £1,813. The costs of operating were as follows: coal and other fuel, £1,008; salaries and wages, £566; repairs, stores, rates, and taxes, £379; making a total cost of £1,953. The system of distributing heat as practised at Toledo is as follows: Exhaust steam heaters receive the steam on its way from the engines and heat up circulating water to any desired temperature. This hot water is either passed direct to the consumers of heat, or else is delivered into a storage tank to be used later on in the day when the output of electricity is small, so that the exhaust steam is not sufficient for the heating load. The circulating system consists of two wrought-iron pipes laid side by side in the ground, and protected by planks with air-spaces between, the air acting as a heat insulator. About 8,550ft. of hot-water pipes have now been laid under the road, and it is estimated that the total loss by radiation from the mains is only from 15 to 20 per cent. of the heat used in the houses. In fact, the drop in the temperature between the hot water at the station and the farthest consumer is only 12deg. F., whereas the water used enters the houses at about 160deg. F. This heating system is in use for seven months in the year, and the company now propose to introduce a system of pipes to be used in the summer time to distribute brine chilled down below the freezing point. Mr. Yaryan estimates that when this is done the company will be amply remunerated by its income from the heating and refrigerating plants, while the electric lighting will be obtained as a by-product. We hope that in this case the income from the electric lighting will benefit the engineer who has so carefully laid out the system.

Institution of Junior Engineers.—The members of the Institution of Junior Engineers are this year holding their annual tour in the Newcastle-on-Tyne district. The selection of this district was somewhat natural, seeing that the Hon. C. A. Parsons is this year the president of the institution. Amongst the works they have visited were those of the Newcastle and District Electric Lighting Company, the plant of which is largely due to the inventive capacity of the Hon. C. A. Parsons. It was explained that the works, when opened in January, 1890, had three Parsons turbo-electric generators of 75 kw. capacity each, and that more recently a 500-kw. turbo-alternator had been erected—in fact, had it not been that the Parsons steam turbo-generator occupies so little space, and is so free from vibration that no foundation is required for the machinery, the site could not have been utilised for the works. The company has at present turbo-generators representing nearly 1,720 kw. fixed, and has provision for 3,200 kw. The members of the institution also visited the Elswick works of Armstrong, Whitworth, and Co., inspecting the engine shops, heavy gunshops, cast-iron foundry shops for hydraulic and electric fittings, ammunition and small quick-firing gunshops, torpedo-tube factory, and the shops in which gun-carriages, mountings, and cartridge-cases are made. Other places on the River Tyne and in the surrounding district were visited by the members, to whom a hearty welcome was extended by the Newcastle-on-Tyne Corporation. We notice that they also visited the Newcastle-on-Tyne Electric Supply Company's works, so that they were able to make a comparison between two stations running in the same town to supply electrical energy, the one equipped with steam-engines and the other with steam-turbines. At these latter works the supply is given on the single-phase alternating-current system, the pressure at the consumer's terminals being 100 volts. The generating pressure is 2,100, and the transmission to sub-station and house transformers is by means of rubber concentric cables drawn into iron pipes. The standard type of plant installed is Robey horizontal compound engines driving, by means of cotton ropes, Brush alternators. Steam is supplied by Lancashire boilers, working at a pressure of 120lb. per square inch. The total number of lamps supplied is the equivalent of 69,640 8-c.p. lamps. It was stated that large extensions were now taking place to afford a continuous-current supply; the plant being by Messrs. Belliss and Messrs. J. H. Holmes, and the cables by Messrs. Callenders, laid on their solid bitumen system.

Telephones in London.—Although the holiday season is now on, with a consequent diminution of traffic in the London streets, those unfortunate individuals who have not yet been away into the country, or the more unfortunate ones who have come back, are constantly reminded that the Post Office authorities are undertaking the construction of a new telephone system. A large number of the principal streets in the City are now in the hands of the various contractors to whom the

Digitized by Google

laying of the earthenware conduits to receive the telephone cables have been allotted, and we must do these contractors the credit of stating that they are proceeding with their work with the least possible delay. In spite of this the inconvenience to the public is great, and it is difficult to seek consolation in the thought that a perfect telephone system will be available in a year or two. The inconvenience is, of course, quite unavoidable, as overhead wires are out of the question, but we should like to be assured that as soon as Newgate-street, for instance, has been relaid that it will not be taken up again to receive the conduit wires which have to be laid down by the Charing Cross and Strand Electric Supply Corporation under their provisional order. We know of one case in which the Post Office authorities absolutely refused to work with an electric lighting company in simultaneously opening up the streets, although a large financial saving would have resulted. This saving is, however, a comparatively small matter compared to the financial value of the great inconvenience and delay which is caused to the general public by the double breaking up of the public thoroughfares. It is interesting while on the subject of telephones in London to see from the report of the past year of the Postmaster-General the progress of telephone business throughout the country. Thus the number of post offices open for trunk telephone business on March 31 last was 299, an increase of 13 in the year. The trunk lines in use consisted of approximately 68,657 miles of wire, and 7,250 miles of wire were in course of construction. Out of the sum of £2,300,000 authorised by Parliament for the purchase and development of the trunk system, the expenditure up to March 31, 1899, may be stated approximately at £1,531,209. The expenditure during the year was approximately £176,968. Contracts involving the expenditure of more than £500,000 have been made, and works necessary for the establishment of a Post Office exchange system in the London area are in progress. It is expected that the system in the City and in certain other important districts will be in working order early next year.

Paris Educational Awards.—Amongst the awards to English exhibitors granted in connection with the Paris Exhibition, we notice a long list in connection with education. For instance, in connection with technical education grand prizes have been awarded to the City and Guilds Institute examination department, to the London County Council, and to the Central School of Arts and Crafts, while the Educational Department of South Kensington has also received a grand prize. From our inspection of the exhibits of English institutions in the Paris Exhibition we are somewhat surprised at the number of gold, silver, and bronze medals which have been awarded to the various technical schools throughout the country. Our surprise is not due to the exhibits themselves being defective, but to the slipshod way in which these exhibits were arranged. In the first place, it would have been much more reasonable for the various technical colleges to have united under one committee in preparing a joint exhibit than for each college to prepare a distinctive exhibit. A committee of the kind we indicate above would thus have been able to supervise the arrangement of the exhibits, so that, while avoiding repetition, a clearer idea would have been given of the best methods of giving technical instruction in this country. With the present want of system in the arrangement we noticed something of this kind: One of the technical colleges was explaining by exhibits the manufacture of a tin teapot; the drawing which showed how to obtain the exact shapes in the flat of the various tin plates which had to be cut was framed and hung at one end of the exhibit. This drawing was surrounded by articles of needlework made at the same school. Elsewhere on the stand the tin plates themselves were on view, and further on again, surrounded by an exhibit of shoes, was the teapot made according to the drawings. While we are prepared to grant that the space allotted to the school was small, the exhibit as finally arranged was chaotic and almost useless. Again, in another exhibit of another technical school we saw a galvanometer made by a student which was not at all fit to be shown as an international exhibit. These faults in the arrangements of the exhibits were not to be found in the educational section devoted to the French nation, who, of course, had more room at their disposal. We are pleased to see that the educational systems in this country have been so honoured by the awards at the Paris Exhibition, but trust that these awards will not lead their recipients to think that they have nothing to learn in the art of imparting instruction.

Polyphase Motor Work.—In the August number of the *American Electrician* there is described what is said to be the largest isolated plant using induction motors in the world. This is a plant used by the Deering Harvester Company, of Chicago. The firm in question has a most extensive business, covering a wide range of manufacturing subjects, and up to 1898 its various workshops were all driven by isolated engines, working on to long countershafts. In that year the first experiments with electrical driving were commenced, with such success that there have been continuous additions ever since. The present extent of the installation may be gathered from the fact that already there are at work two machines of 1,100 kw. and one of 750 kw. Owing to the arrangement of the machinery, large motors have been used to drive the various departments rather than installing small motors to drive individual machines. Thus the size of motors used, of which there are 65, varies from 20 h.p. to 100 h.p. The frequency of the three-phase supply is 40 complete cycles per second, and the motors are constructed for six or eight pole, giving a speed of either 800 or 600 revolutions per minute. The pressure on the mains, which we take to be the voltage between any two wires of the three-phase system, is 600. A novel feature in this installation is that there are no starting resistances used in the rotors. Owing to the large amount of inflammable particles which are always flying about in the woodworking and hemp departments of the company, great care had to be taken to prevent fires, consequently a short-circuit rotor was used, and a liquid resistance is inserted in the main circuit when starting up the large motors. As an example of the capacity of this resistance to reduce the starting current, a 75-h.p. motor was started up on the water resistance against practically full load with a current of only 300 amperes per phase. This gave a drop of voltage of 75. If the motor was switched directly on to the mains 600 amperes passed through it, and the voltage fell from 600 volts to 475 volts. An interesting experiment was made at this factory of leaving all the motors in circuit and starting up the generators slowly. The field magnets of the generator were, of course, fully excited, and it was found in this way the whole of the motors could be conveniently run up to speed without taking any large current. The value of this property of induction motors will be very great in factory work, as there will be no need to operate the individual starting switches of the motors when closing down at meal times. If the main generator is shut down and slowly started after the interval, all motors in circuit will start up without any damage, just as though they were connected by gearing to the main engine.

Digitized by Google

THE ELECTRICAL ENGINEERS' CONFERENCE IN PARIS.

[BY OUR SPECIAL CORRESPONDENT.]

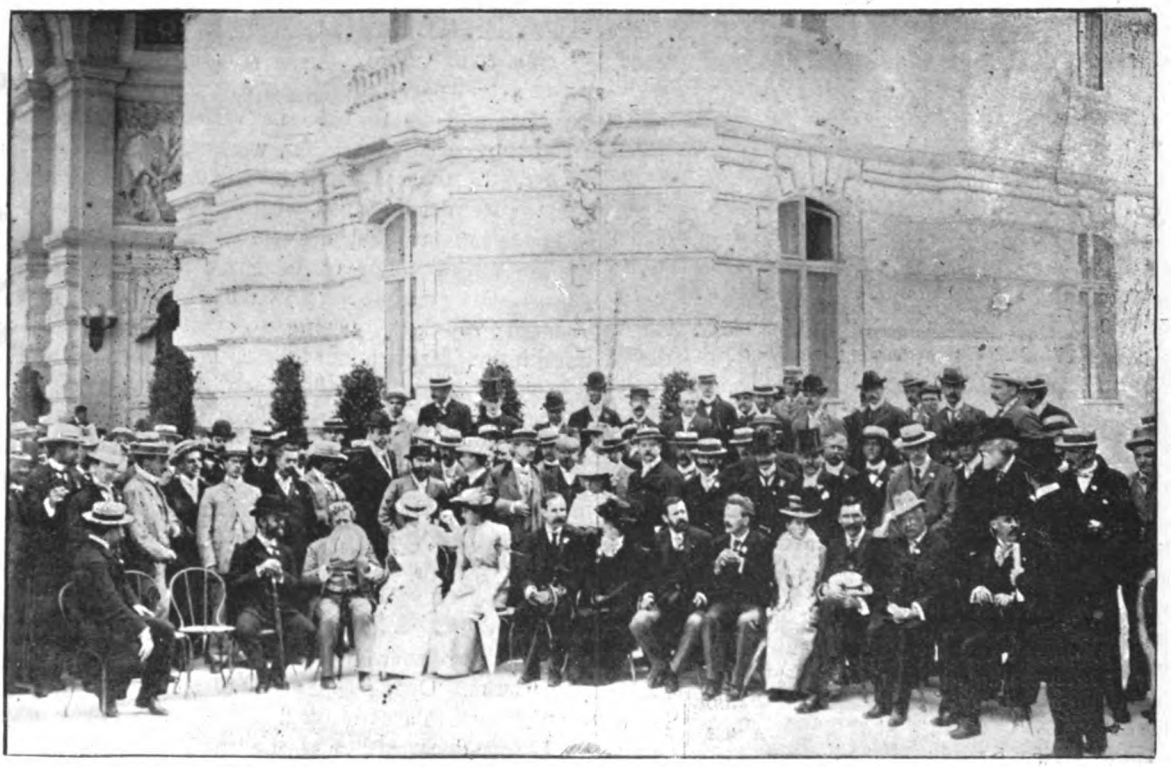
Those responsible for the combined meeting of the Institution of Electrical Engineers and of the American Institute of Electrical Engineers in Paris last week were well rewarded for their labours by the unqualified success of this interesting gathering, and it is probable that the success may even have exceeded their anticipations. In taking advantage of the Universal Exhibition they were certain of securing a good attendance of members, and in bringing the two bodies together, the subject under discussion was treated upon much broader lines and in a more interesting manner than could have otherwise been the case. It was, indeed, felt that the experiment had justified the holding of similar meetings in the future, but if this is to be done it is to be hoped that the conference will be extended over more than one sitting, for it is obviously impossible to thrash out a question, which may be discussed from several points of view, in the course of a couple of hours.

The meeting was held on the Thursday morning in the American Pavilion of the Exhibition, an imposing structure built in the Roman style and containing a large amphitheatre surrounded by tiers of galleries. Unfortunately, the building is not remarkable for its acoustic properties, with the result that those speakers who were not endowed with particularly vigorous lungs had to be invited to "speak up." The meeting was presided over by Prof. John Perry, F.R.S., president of the Institution of Electrical Engineers, and by Mr. Carl Hering, president of the American Institute of Electrical Engineers. There were upwards of 100 members present, including representatives of the electrical engineering industry not only from Great Britain and the United States, but also from France and Japan.

Mr. CARL HERING opened the proceedings by saying that there would be two presiding officers at that joint conference, and that Prof. Perry, as senior officer, would conduct the affairs of the meeting. He took the opportunity of thanking the members of the Institution of Electrical Engineers for the great pleasure they had given the American Institute in joining them in that international gathering. It was quite a venture on their part to hold a meeting so far away from home, but when they found how heartily the British engineers had joined them the success of their venture was at once assured. He was certain that all the members who were present, and a good many who were not, would hope that this first meeting would be the beginning of a series of similar meetings, and that the next gathering would be held in the United States. Mr. Hering then translated his address into French and German.

Prof. PERRY said that his remarks would be very brief. He could only say to the Americans who were now their hosts that their visit to England gave them very great happiness indeed. He thought that every Englishman who joined in the parties felt that it gave them more pleasure than even the Americans themselves expressed. There were no minutes to be read at this meeting, as it was the first of its kind, but minutes would be prepared, and, he hoped, read on a future occasion. He concluded by extending a cordial welcome to those present.

Prof. E. MASCART remarked that he must first of all address the Institution of Electrical Engineers and thank them for the honour they had conferred upon him in electing him vice-president. He was extremely touched by this mark of esteem on the part of the members of that body. In joining forces the two institutions of England and America had set a good example, and he hoped that it would be the forerunner of other meetings of this kind, which would include the electrical engineering societies of all the leading countries. They had been asked to go to the United States for the next conference. He would greatly desire to do so, for he had preserved a charming souvenir of the visit he paid to that country some years ago, but unfortunately his travelling days were now over. He thought, however, that a good many members would respond to the invitation, and as the result of the example now set by the two leading bodies many would no doubt go from England, France, Germany, and perhaps other countries. In the name of the French societies, he thanked them cordially for having selected Paris for the first meeting of the associated institutions.



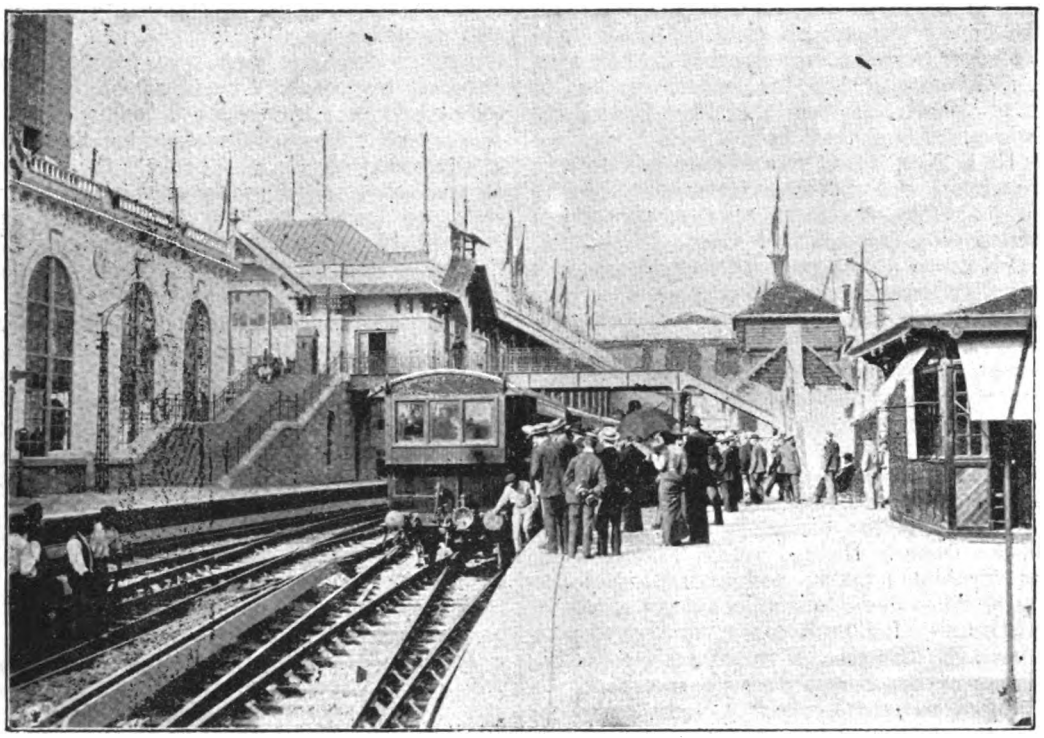
Group outside the American Pavilion, Paris.

Prof. PERRY announced that the subject for discussion was "The Relative Advantages of Alternate and Continuous Current for a General Supply of Electricity, especially with Regard to Interference with other Interests." He called upon Mr. S. Z. de Ferranti to open the discussion.

Mr. FERRANTI said that he was greatly honoured by being allowed to open the discussion at this most fortunate meeting. He called it "most fortunate" because they would agree with him that nothing could be better than that the American and English Associations of Electrical

Digitized by Google

Engineers should have a joint meeting. There was only one thing in his mind which was still better, and that was the holding of the meeting in Paris, and thus showing what a great tie really united them all, and how much more friendly their feelings were than was often supposed. The subject for discussion was left to the English association, and he could assure them that it was a matter of no little difficulty to decide upon what they should discuss. They might possibly think that the subject chosen was simply a revival of the old contention between alternating and continuous currents. He hoped, however, that it was no such thing. Matters had greatly changed since the days when the advocates of each of the two systems were, he might almost say, bitter enemies, and when it was thought that everything that was done by the other side was wrongly done. They now found that this was not the case, and that there were great merits and particular uses for both systems. But, as he said, things had changed, though not changed so much as was likely to be the case in the future. What they had to consider was, what electrical science would be 10 or 15 years hence. They knew what had already been done, but he thought that few of them, though it was their life's work, realised what electricity was going to grow to, and what a great and universal part it was going to play. In this light they must consider what were the best lines to be worked upon. It was no longer the small business it used to be. The small isolated systems had to be worked upon isolated plans, but it was now a question of utilising and transmitting big powers over large areas. With regard to the advisability and desirability of the systems of continuous current as against the alternating, many of them knew that he had consistently worked with alternating current, and they would appreciate that his knowledge of the other system was not what it should be as compared with the knowledge of those who had worked exclusively in that direction. In opening the discussion, he desired to dissociate from their minds what he had done in the field of electrical science. He put a few points before them to hear what the general opinion was upon this important subject. He believed that there were undoubtedly particular cases where the alternating or continuous current had its own application, but, looked at from a new point of view, the question that presented itself was, Which would be the possible system in the future? He said "possible," because many of them had had very serious experience with electrolytic effects which were produced by large volumes of continuous current, and he asked if, in the event of this system being developed and extended very considerably, it would be possible to satisfactorily preserve any metal work in the earth at all? They had not only to deal with the lead coverings of electric cables, but there were any amount of constructional ironwork, rails, gas-pipes, water-pipes, and all sorts of things, which were being laid down on an increasingly large scale every day in the streets all over the country. The amount of property invested underground in one or another of these forms was being continually multiplied, and the capital represented by these installations was reaching such a high figure that it became a serious question for them to consider, not only in the light of the present, but more especially of the future, as to the lines upon which they should go, and how best to protect this immense property, which might be injured by the work they were doing. Of course, alternating currents were not free from producing some harm, but the difference between the harm effected by the alternating and continuous currents was very great; and he thought that it required their most careful consideration and investigation to find out how they could diminish these troubles, or see whether it would not be necessary to employ the alternating current, which produced far less detrimental effects, and see how to overcome the disadvantages which were left with it. He hoped that a good many of those present would supply valuable information upon this subject, and after giving it their careful consideration would publish their views through the electrical Press, or else at another combined meeting of the two institutions. He trusted that the discussion upon this subject would save much trouble in the future, and prove of great service to the electrical industry at large.



Boarding the Electric Train, Champs de Mars Station, Paris.

Mr. ARNOLD, of Chicago, said that they had all heard that the man who invented alternating current was liable to be murdered on the spot, but after Mr. Ferranti's remarks he thought that they were on the right track after all. It would, perhaps, bring out a discussion upon the practices of the different countries if he briefly outlined the methods obtaining in the United States. There they started in the large cities with the direct-current system as advocated by Edison, and one day he read an opinion from Mr. Edison as to the advantages of the alternating and direct current. Mr. Edison said that the alternate current was inspired by the devil, and that no good would come out of it. Mr. Ferranti had proved to the contrary. They had started in their large cities with the direct-current system, and in small cities having a large area of distribution with the

Digitized by Google

alternating system. In the large cities the direct system was replacing the alternating system. In Providence they had replaced the alternating system with a direct current of 500 volts, and the same thing was taking place at St. Louis. He made this statement to show that the direct current was holding its own in the large cities, but he thought that the alternating current would be more generally used in the small towns and in the large cities for outlying work. As regarded electric lighting, there was not, so far as he was aware, any means of equalising the load which would allow of utilising the alternate current under certain conditions. Coming to railroad work, they started with a 500-volt system, and gradually increased it to 600 and 700 volts, and were now utilising it for the sections of roads adjacent to the station, and were serving the more distant sections with alternating current. He thought that this arrangement would be modified when the alternating current would predominate and the sub-station would be suppressed. Mr. Ferranti was working in this direction, and others were doing the same thing in the United States. He hoped and fully believed that their efforts would be attended with success.

Sir W. H. PREECE said that he felt in the same position as the blank leaf between the Old and New Testaments. He was there as a past-president of the Institute of English Electrical Engineers, but he was also honorary member of the Institute of Electrical Engineers of America. He therefore spoke in the blank-page capacity. He also held the position of never having compromised himself by associating himself either with the direct-current system or with the alternating-current system; but he had used one or the other when he thought that he could get advantages by so doing. He believed there were circumstances where the one was essential, and different circumstances where the other came in. They wanted to consider the subject before them from different points of view. In the first place, they had to deal with the generation of current, and in that respect they started exactly from the same source, for they must remember that the ordinary dynamo was nothing more nor less than a simple alternator. They had not only to consider the generation of the current, but also its distribution and its transmission to great distances. Mr. Ferranti had commenced his remarks by referring to some of the disturbances. He dealt with the electrolytic effect upon pipes and metallic coatings. There was another serious disturbance which had caused them many anxious moments, and that was the disturbance of alternating currents upon telephones. He had always said that the telephone was capable of taking care of itself, and the alternating engineer had never to trouble himself about it. Again, another source of difficulty they had met with in their practice were the disturbances to railway signals, for though under normal conditions alternating currents could not affect railway signals, there might be some rushes to earth due to those strange effects that were once called Ferranti effects. There were sudden effects of momentum in alternating circuits which raised the voltage, with the result that there were great surges of current. Such things had and would provide false signals on the block system unless some step was taken to prevent them. That was with regard to disturbances. Another thing that was not a frequent occurrence, but was, nevertheless, very serious in consequences, were the fires that had occurred through the surging effect to which he had alluded. Now, in determining the necessity for the use of either system, they had not only to consider the points he had enumerated, but also the purposes to which the systems were to be applied. They might take electric lighting, motive power, traction, and transmission to a distance. He did not think that there was a single man in that room who would deny that the only practical and possible way of transmitting energy to great distances was by the triphase-current system. No high-pressure continuous plant had yet been constructed which could possibly do what was being done between Niagara and Buffalo, as well as in California, Switzerland, and other places. There could, therefore, be no question that for long-distance transmission, alternating currents were distinctly preferable. With respect to motive power, they were confronted with quite another question. There was no doubt that at the present moment the triphase motor was as good as, if not better than, the continuous-current motor under all circumstances. Mr. Arnold referred to the fact that in his country the continuous current was holding its own, and was displacing the alternating current. He believed the converse also had taken place. The moral was that there could be no serious faults in either, and that one system was as good as the other. An important question was the necessity of standardising the frequency. He could not remember all the causes of these differences in frequency, but he would start with Niagara, where the frequency was 25. There was another large installation where it was 45. In many places in England the frequency of 50 had been introduced. At Deptford they started with 65, and in the City of London he thought it was 97, and probably 100. In the first alternating system in London a start was made with 130. They thus found that the frequency had varied in different parts of the world from 25 to 130, and this showed that there was something wrong somewhere. It might be that certain services required certain frequencies. He believed that the American engineers had established a standard, which was 25 for motive power, 50 for ordinary distribution, and 100 for house distribution where each house had its separate transformer. He thought that the joint meeting would do some good if it would decide that the time had come to determine some standard of frequency, to be applied to different sources. He further wanted to call attention to one line of progress that was being made in England, and that was the distribution of triphase current at high pressure to great distances by means of underground cables. Nearly all the experience in America had been with overhead wires. The largest underground system that he knew of was that established by Mr. Ferranti between Deptford and Trafalgar-square, a distance of nearly eight miles, but underground mains to convey triphase high-pressure currents were destined to undergo a great extension in future years. Engineers should give more attention to the capacity in cables than had been done up to the present time, for when they got long lines conducting 5,000 volts great trouble would be experienced owing to the effects of capacity.

Dr. A. E. KENNELLY, of Philadelphia, remarked that the occasion was a most opportune one for discussing the lowest frequency for alternating systems, as well as for clearing up some of the mists that still hung over the question of alternating and direct current supply. He thought that they would generally agree that not only in America, but also in England and Europe generally, where there was a densely-crowded area to be lighted up with incandescent lamps, nothing better could be done than to employ the direct current at a pressure at which it was to be supplied, and if the area was to be very narrow and contracted there was no need to go above a single lamp—that was to say, 100 volts. As, however, the area extended, the amount of copper put down became so large that a greater pressure was obligatory—say, of 250 volts—and when still greater areas were reached 500 volts would have to be employed. There then came a limit beyond which it would be uncommercial to supply direct current for direct application. Alternating currents must then be resorted to. In many of the large cities of America the heart of the city was supplied by the alternating system on the three-wire plan, and the other portion was supplied by the alternating current of higher pressures. Dealing with electrical traction at a distance, the speaker referred to the anomalous condition of affairs resulting from the employment of the two systems in combination on the American tramways. He said that this method created a great deal of difficulty, and necessitated considerable expense. There was a special set of transformers for reducing the alternating current and another set to reduce the direct current required. It was difficult to understand how such a remarkable confusion arose. He thought it might be claimed to be due to the fact that the electric motor for tramways came into existence gradually as a direct-current system. If, however, in the future all the difficulties were cleared away, it might be expected that this anomalous condition of affairs would be removed, and there would be nothing more than the plain alternating-current system to the utmost limit. The only disadvantage lay in the difficulty of maintaining a stated

Digitized by Google

pressure of distribution. The difficulty which was met with in the distribution by direct current on electrical railroads supplied from distances in this way, was the electrolytic one. There had been much trouble in America on this account. Many pipes had been destroyed, and much damage done, but the difficulty was giving way to careful engineering. It was much less serious at the present time than in the past, because engineers now knew what to do. The damage had occurred not so much to large mains as to surface pipes, and also, of course, to telephone cables, where the covering was continuous, and where there was practically no joint. By careful attention the danger of electrolytic corrosion could be, to a large extent, overcome by not exceeding the pressure of one volt over the danger area, and by carefully bonding the track, etc. The alternating-current motor for tramway purposes had been standardised and perfected, but one disadvantage which had not been pointed out in its employment was the increased danger resulting to those who sustained shocks. A shock of 500 volts with a continuous current was not as a rule very dangerous, and though a great many such accidents happened daily, very little injury appeared to have been caused. But with 500 volts of alternating current the shock might be much more serious, because, as was known, the danger arose from the disorganisation of the heart's action. With the continuous current only one shock was received, from which the victim might speedily recover, but with the alternating current hundreds of shocks were received, and which might be sufficient to disorganise the heart beyond all chance of repairing the mischief. There were, of course, other difficulties with alternating-current transmission in railroads, but it seemed to him that these were of minor importance. There was the difficulty of it affecting compass needles and delicate apparatus of all kinds. The worst that could happen was the banishment of the magnetic observatory to the furthermost recesses of the Continent. This might be a disadvantage in some respects, but a distinct gain to the community.

Prof. AYRTON said that the special point to be attended to in the discussion was, as Mr. Ferranti had said, the advantages of direct and alternating currents with respect to interference. There was no doubt whatever that in many cases there had been a large number of electrolytic and telephone interferences. A serious interference of a special kind had grown up during the past few years with submarine cables, and a case in point was the trouble with the cable at the Cape of Good Hope. Then there had been interferences with the magnetic observatories, to which Dr. Kennelly had referred. There was, of course, no question about the interferences, but there was a decided question as to how these should be dealt with. Should an endeavour be made to destroy the attack, or should the attack be allowed to remain and an endeavour made to improve the defence? Ought an endeavour to be made to carry out each undertaking in such a way that it would not cause interference with anyone else? Or should both sides start by assuming that they were at war? If the magnetic observatories were sure of being attacked, all they could do was to try and defend themselves. The British Board of Trade said that there were not to be more than a difference of potential of seven volts between the points of rails if used as return. If he remembered rightly, the regulations did not say how long the line might be with such a restriction, but whether the lines were very long or very short the seven volts would always apply. It had been conclusively shown, however, that the seven-volt rule was not sufficient. It did not give enough protection in the case of a submarine cable which landed near where a tramway ran. It did not give sufficient protection in the case of electrolysis and in the case of any magnetic observatory which might be located in the neighbourhood of the tramway. In the case of the telephone it was possible to obtain a very good defence, and to make the telephone people more or less independent of the attack, by employing metallic returns, and it was the ease with which the defence could be carried out that led the committee of the House of Lords a few years ago to decline to place restrictions in the way of tramways. The conclusion come to in England was that the telephone system was so shockingly bad through cross-talk that if there were no tramways or distribution on a large scale, it would still be necessary for the telephone companies to resort to metallic returns. This did not, of course, apply to water-pipes and gas-pipes, and where good return circuits were not obtained these were electrolysed. He now came to a very important point which had not been suggested—namely, that the electrolytic disturbances would be very different in character if direct currents were used to what would be if alternate currents were employed. If a general system of alternate currents was adopted, would there be freedom from electrolysis? That was a point which had interested him for some time past. He had been making some observations in Geneva, where the pipes had suffered, and it was not clear whether, in the event of alternating currents being exclusively employed, the pipes would be free from electrolysis. Some time ago he showed an interesting experiment by taking an ordinary sulphuric acid voltameter and sending first a direct current and then an alternating current through it. Exactly the same thing occurred in both cases, the hydrogen coming off twice as fast as the oxygen. It could not, therefore, be assumed that no electrolysis took place because the alternating current was employed. Curiously enough, Mr. Trotter, of the Board of Trade, had sent a specimen showing the same thing, which could be inspected by the members present. The label stated that it was one of a pair of lead pipes buried in the earth and corroded with a current of one ampere. It was not like the covering on the cables sent him from Geneva. In the letter accompanying the specimen Mr. Trotter stated: "I add the words 'alternating current' from Deptford in order to show that it was no fancy laboratory current. The pipes were about 6in. apart, the sides facing each other. It took 100 volts. Three coatings of varnish were painted on the lead, but they failed to protect it." It was clear, therefore, that alternating currents would not give protection with any certainty, and it was equally clear that it was very important to examine under what circumstances alternating currents produced electrolysis and under what circumstances they did not. That was a subject which had attracted a great deal of attention, and he should be glad to hear from the meeting the results of any experiments that would enable them to decide upon what should be done with lead pipes in order to protect these from any action from alternating currents. Then they had to consider how best to arrange the water or gas pipes so as to prevent the attack from injuring these. Contrary to what Dr. Kennelly had said, he thought that a good deal could be done to avoid the attack, and he was happy to say that the London tramway companies had not looked at the matter from the point of view that Dr. Kennelly had suggested. The tramway companies did not say that they were going to lay down lines, and if any harm was done to the observatories the latter could go away. The position taken was to ask the observatories to state the least that should be done to secure immunity from disturbances, and the result was that a committee was appointed by the Board of Trade to carry out experiments with a view of avoiding the disturbances produced by the railways and tramways. When the difference of potential did not exceed seven volts, what was the result? Without giving a long account of the various experiments, he could say that these results—for which thanks were due to Profs. Perry and Hooker—were as follows: that within the neighbourhood of the observatories the tramway companies undertook to cut up their lines into one-mile sections; that each mile should be absolutely isolated electrically from the rest of the tramway system; and that it should be fed at the middle of the section. Current should be brought to the trolley wire at the middle and taken away from the rail at the middle of the mile section; and, further, that no point of any rail should be allowed to exceed one-half of a volt, which should be the maximum of difference of potential. They of the observatories had assured themselves, partly from calculation and partly from experiment, that with such a difference of potential the magnetic instruments would not be disturbed to an amount that could be detected by ordinary observation. He was very happy to say that the tramway companies, although they were American tramways, receiving their apparatus from the United States, were looking at the matter from a more liberal point of view,

Digitized by Google

and were prepared to do what they could to prevent disturbances to the magnetic observatories if these would tell the companies the least that was required. There was still another point with reference to alternating currents and tramways. While he was in the United States, he was told that one of the reasons why the alternating current was not used there was because of the difficulty of getting good contact between the trolley pole and the wire when the latter had snow upon it. It was said that there was more difficulty with the alternating than with the direct current. Since that time, in 1897, there had been certain electric railways on the Continent which were using alternating current with overhead wires, and it would be interesting if anyone could state if any difficulty were experienced in getting contact.

M. CORDA, who addressed the meeting in French, said that the polyphase current had a great advantage over other systems for distribution in large towns. The alternating current possessed a great advantage in its application to motive power. He thought that the ideal motor with simple current had not yet been invented. He would refer particularly to a special case where the advantages and inconveniences of polyphase currents, as compared with continuous currents, were very evident, and that was distribution of power in large works, such as sugar refineries. In these installations the polyphase current was spreading very rapidly on account of the simplicity of the receiver. He had been required very often to make plans and calculations for the employment of the two systems under exactly the same conditions, and the conclusions he had arrived at led him to call their attention to two points. The polyphase current was better as regarded working cost. In the works referred to, high tension could not be adopted, owing to the viscosity of the material dealt with, and could not exceed a tension of 500 volts. There were numerous motors working as many as 500 centrifugal pans. Of course the works did not want to spend too much money upon the mains, and the current was distributed by naked cables placed just far enough out of reach to avoid danger. It was apparent that if the central station was far off the self-induction of the line began to play a big part, and the exciter had to be put on the same machine as the receiver. He concluded by referring to the question of compounding the alternators, which he thought was very important; for when the distribution of continuous current was limited to 200 volts, and when it was necessary to employ large currents, the difficulties he had spoken of presented themselves.

Prof. CROCKER, of Manhattan, said that as the subject had been almost covered, and time was very short, he would confine himself to a few points. The subject of the discussion was with special regard to interference. He himself did not think that this was a very important point. There were two interference effects produced by electric currents, and he thought that these might be classed as the inductive and leakage effects. Under the inductive he should include the magnetic effect. The continuous current was purely magnetic, and this was the cause of its disturbing influence upon magnetic apparatus. For example, it affected a magnetic observatory, but there were not many magnetic observatories in the world, and, as Dr. Kennelly had stated, these might be relegated to a point where they would not be interfered with. It did not seem to him that the progress of electrical art should be influenced very greatly by the disturbances to a few magnetic observatories, and certainly instances of such disturbances would not be very numerous. He was therefore inclined to dismiss the point as one of little importance. The alternating current also had an inductive effect, and that was the inductive current taking place in the field. He regarded this as a very serious thing, because there were more telephones than magnetic observatories. Sir William Preece had said that this inductive effect could be largely avoided by metallic circuits, but there were cases where wires were wanted overhead, and under these conditions the inductive effect could hardly be eliminated, because a transposition of the wires was not a complete preventive. In certain cases, and in smaller towns, rounded circuits were used, and it seemed that the production of currents was more serious than the production of a magnetic field. He would say on that account that the alternating current was more guilty than the direct current—that was to say, its disturbing effect without leakage was greater than that of the direct current. The leakage effect was certainly very serious with the direct current, and produced an electrolytic effect, which was the most serious interference that could be produced on other apparatus. Now, the leakage was something that be controlled to a large extent. The production of a magnetic field was very elusive, and overhead the leakage was very small. If the leakage took place underground at several thousand volts, it would produce a short circuit. He had occasion once to test the entire underground network in New York City, which had been purposely split up into sections to be tested, and found that the leakage was not excessive. It was much less than 1 per cent. He believed that in electrical conductors a considerable or an appreciable leakage was a temporary condition of things that would be overcome. The single-wire trolley system was all leakage, as the current went into the earth, but here again, by the use of return feeders, bonds, etc., that promiscuous flow into the earth had been reduced, and he thought that it could be still further reduced until it became an insignificant quantity. If it could be reduced to one-fifth of a volt, that would be below any dangerous electrolytic limit, so that apparently the interferences were not so very different in the two cases. That was to say, the alternating current had greater inductive effect and the direct current had much more serious electrolytic effect, but this latter could be largely overcome by more perfect construction. With respect to the motor question, Sir William Preece had said that he knew of cases where direct current had been replaced by alternating current. He himself knew of cases where the alternating had been replaced by the direct current, so that there was no conclusive deduction to be drawn from these facts. So far as efficiency was concerned, the two motors were almost identical. He had compared the efficiency of the respective motors, and found that at, say, one-third load the two curves coincided almost exactly. The agreement was remarkable, except at low powers, when the direct-current motor had a higher efficiency. In reply to Sir Wm. Preece, he said that the efficiency was not over 90 per cent., but he could give no accurate figures on the point, as he was only making a general comparison of the two systems. This led him to contend that the direct-current motor was more efficient with light loads. As regarded speed, the two systems were the same. The machines were equally good for constant speeds, but when variable speeds were wanted the direct-current motor had a great advantage. This applied not only to stationary motors, but also to tramway and electrical railway motors, and it was on account of this variability that the direct-current motor had advantages for power purposes over the alternating. He did not think that it would have been fair to the direct current to allow that point to pass unnoticed.

Mr. W. M. MORDEY said that he had discussed the question of earth drop on the return circuit of tramways with some of the American visitors, and there was an impression that the Board of Trade seven volts rule could not be adhered to. He had carried out very severe tests with a 25 line of railway, and found that under the fullest load the drop at any point never exceeded five volts. It would be noticed that in the tramway installations the indicating station might show more than seven volts, but, as a matter of fact, the instrument always recorded considerably more for momentary effects than the real effects. If switched on at six volts, it would show 10 volts. One of the chief differences between English and American practice was that a great deal of attention had been given in England to the question of earth drop. The result had been an exceedingly good one. He hoped that English electricians would learn from their American friends some experiences as to electrolysis. What was wanted to be known was the tension that could be employed. He must pass over a great many points, but he would ask them to bear in mind one cure for all trouble of this sort, whether alternating or direct, and that was the double insulated return, which could be applied in all cases. He did not know whether the future would be for the alternating or direct current, but he could not help thinking

Digitized by Google

that its simplicity would result in the alternating being used. Simplicity of transformer would force them to use the alternating current in traction right down to the rails. He could not say whether this would be done by Mr. Leonard's system, where he had an alternating motor on the car; but whatever system might be employed, the alternating current would be used all the way through. The rotary transformer employed so far was a makeshift system, and must be suppressed. If the capital represented by sub-stations, rotary transformers, and the like were put into conductors, it would be simpler and more economical. If the thing came to grief, the copper and aluminium could be taken up and sold. Some of them would doubtless be going to Switzerland, where they would see some interesting railway works, and he would call their attention to the fact that if a train could be started on the Jungfrau it could be started on the severest gradients anywhere else. Then he desired to say one word on the question of effect upon existing interests, and that was with respect to the scientific laboratories and the observatories. He was glad to hear from Prof. Ayrton that there was a chance of laboratories being allowed to remain in large centres. If they were removed from these centres, it would be a great disadvantage. There was a striking example in the Board of Trade, which possessed a standardised laboratory that was supposed to be the only accurate institution of its kind in England. He did not know whether it was accurate. He only hoped it was. On the plea that electric traction works underground would interfere with the measurement of the earth's magnetism, influence had been exerted to prevent the carrying out of the underground electric railway, which was a considerable convenience to London. That was an action it was difficult to refer to calmly. There was no proportion between the enormous advantages of this undertaking and the measuring of the magnetism of the earth. Such small matters as this could not be allowed to stand in the way of an enterprise which was for the benefit of the population of a vast city.

M. MAILLOUX, of New York, remarked that there was only point which he thought had not been fully discussed. In his country a broader interpretation would have been taken of the question submitted to them, because if other industries were reacted upon, it often involved a question whether they could be continued. One of the important points which had been neglected was the influence of the power factor on electric current. Prof. Crocker had pointed out very clearly the similarity in the results obtained with alternating and single current motors. The influence of the power factor on speed was important, because when the speed varied there was a variation in the magnetic field. It was, however, not so important when the E.M.F. varied in the alternating current. In the United States there were several isolated plants which assumed the dignity of central stations. It was under these conditions that many of the difficulties brought under their notice had occurred. A case in point was an installation for manufacturing coffee, where electric current was furnished by a central station, and it was found that, owing to the enormous current due to starting the motors, the machinery in the coffee mills was sometimes put out of action. One of the great objections to the alternating-current motor was that it took such a large amount of current at starting. This was a serious factor as affecting the working potential of a line. Where the motors were running at an approximate load and speed, the problem was simple, but where the motors were stopping and starting and the line distance was great, and the distribution of the load was such as to load some feeders more than the others, the question merited the serious attention of engineers. It was for that reason that the direct current was employed. He wished in that direction to refer to the very pertinent remarks made by their French colleague with reference to one of the factors which oftentimes affected the selection of systems, and that was the cost of the wire. It was true that for large distribution and for large buildings, as well as for underground, where twisted conductors were obliged to be used, the cost of the wiring was naturally great. In the United States the problem was already solved, since their rules compelled them to use iron conduits with two conductors; but in the case of the larger conductors they were obliged to use iron conduits, but not two conductors returning in the same conduit.

Prof. SILVANUS THOMPSON remarked that no observation whatever had been made upon the likelihood of interference on board ship. This was of vital importance, and yet, extraordinary as it might seem, almost all the ships that were equipped with electric light had the continuous current, and, moreover, the very worst kind of continuous-current dynamo had been put on board, and that was the bipolar. He hoped to see a complete revolution in the electrical equipment of ships. No reference had been made to the somewhat greater danger of fire from the leakage of continuous-current conductors when carried through damp districts. Nor had any reference been made to the fact that while for arc lighting there was some advantage in using continuous current, there was an advantage in employing the alternating current for incandescent lamps, not that there was any higher efficiency, for that had long ago been disposed of, but if continuous current was used for incandescent lamp purposes, and the distribution took place over a large area, it would be necessary to go to the high-voltage lamps; and if anyone had taken the trouble to measure the efficiency of the high-voltage incandescent lamp, it would be seen that this efficiency was low as compared with the low-voltage incandescent lamp. He thought that there would be a revolt when it was known what a low efficiency the incandescent lamps of high voltage possessed. He had heard of 650-volt incandescent lamps, but that was impossible with continuous current. He was very sorrow to hear Dr. Kennelly rake up that old question of the greater danger of alternating current. He thought it originated with the Edison controversy, when an attempt was made to damn the alternating current. He did not think that the alternating current was more dangerous than the high-tension continuous current, and, in fact, the shock of the alternating threw the victim back, and did not cause him to contract on to the wire as the continuous current did. With reference to electrical traction on a large scale, he would like to renew the suggestion of Mr. Mordey to those who had not seen the electrical railways in Switzerland to visit that country, and see how the three-phase system was employed for starting the trains on high gradients under severe conditions. He would ask if it were not a question whether all the motors did not give the same force in starting. The three-phase motor, instead of being worse than the single-current motor, was distinctly better. A little more than a year ago one of the railway companies in London devoted a sum of £30,000 to carrying out experiments for an underground line, and the only thing they had tried and succeeded in doing was simply what had been done in Switzerland 15 years ago—that is to say, drive a train by putting down a third rail at the side. If trains were to run at 100 and even 150 miles an hour driven electrically, there would be no chance of success if dependence was placed upon a thing which had a commutator on it. He ventured to say that for exceedingly rapid transport the only chance of success was to take advantage of the flexibility and adaptability of the alternating current.

Mr. WARD LEONARD said that he would merely say that after having experience with what was possible with the continuous current for rapid starting by acceleration, and after having seen one of the most recent installations of the alternating-current system for traction work in Switzerland, he felt when the car started as if there were one donkey-power in front, and it did not convey the impression of the strong accelerated power required for traction. His ideas might be biassed, but when one came to consider the question of rapid acceleration, perfect control, etc., the possibility of all this was found in the continuous current, but no promise, as yet, of its being done in the alternating apparatus. But when one came to consider the question of electrolysis, great difficulties were met with, and it seemed uncommercial to attempt to work continuous current underground. In transmitting over long distances they were all agreed that the alternating current was preferable. What should be done was to put the continuous-current motor on the vehicle, and find some means of transforming

Digitized by Google

the alternating-current energy into continuous current energy in the vehicle itself, and thus eliminate the difficulties met with in electrolytic troubles, and enabling the transmission of unlimited powers over unlimited distances. This only touched upon one point of the general distribution of power which would arise in the future in railway practice.

Prof. PERRY, in closing the discussion, said that it would be preferable not to take any vote, as the discussion was incomplete, and, after describing the arrangements that had been made for the visits, announced that an international electrical engineering congress would be held at Glasgow in connection with the exhibition next year, when there would be nine electrical sections.

After the discussion, M. HOSPITALIER briefly referred to the more interesting exhibits to be found in Class 23, which related to the production and utilisation of electricity. He called special attention to the compound alternator of Maurice Leblanc, which was a very ingenious machine, and also to the mechanism of the Société Alsacienne de Constructions Electriques, and to the 30,000-volt dynamo of the Société de l'Éclairage Electrique, which, he said, was nearly the limit up to which high potential could be produced. There was also the system of distribution of continuous current shown by the Compagnie de l'Industrie Electrique, of Geneva, which was a very interesting one, and another notable exhibit was that of Siemens and Halske, who carried out some very curious experiments, and showed sparks produced at 12,000 volts. As regarded motors, there was nothing particular in the continuous-current line, as this system was now pretty near perfection, and they were not likely to find any great progress. The alternating-current motor, however, had made a good deal of headway, principally in the question of starting, and there were many interesting starting devices in the Exhibition. A three-phase motor shown by M. Buchot was interesting, because, without putting resistance in the motor, great torque in starting was obtained. In tramways there was much which was interesting, but most of this was to be seen at Vincennes, and they would be able to inspect systems of surface contact that were not used anywhere outside of France. He also called attention to the electric locomotives exhibited by Schneider and other firms.

General WEBBER said that in the short time at his disposal it would be impossible to give any complete idea of what was to be found in Class 27 at that marvellous Exhibition. At the head of the exhibitors in that class were Jules Carpentier, Siemens and Halske, James White, of Glasgow, GANZ, of Budapest, and several other firms who had extremely novel and interesting exhibits. Many of the more noteworthy things calling for the attention of electrical engineers were to be found in Class 15. He wished them to particularly bear in mind that the classification, though it might be in some respects a little inconvenient for visitors, was intended to emphasise the practical spirit of the scientist and the scientific attainments of the engineer, by showing instruments used by the savant and also by the engineer in the workshop, with the result that the exhibits were distributed in different classes instead of all being grouped in one section. He called attention to the application of electricity to cooking, which system was being employed in one of the Exhibition restaurants; and he also referred particularly to the use of electricity on ships-of-war; Siemens and Halske having, among other exhibits, a very complete show of moisture-proof telephones.

Mr. GAVEY, after referring to the harmonic system of telegraphy, said that there was also a special cable recorder of a unique type, consisting of a long vertical wire placed between the poles of a magnet. Under the head of telephones, the great changes which had taken place had been mostly in the direction of improving the central exchange switches. The improvements were being carried out in two directions—first, in increasing the number of subscribers that could be put upon the multiplier; and, secondly, in improving the signalling arrangements in such a way as to considerably reduce the labour of the operator. Amongst the exhibits, he would call their attention to the automatic signalling apparatus of the Western Electric Company, of America, and to the very interesting display of the Société Electrique des Téléphones. The American Wireless Telephone Company showed some ingenious appliances, and another thing they would see in this section was a system of carbonising carbon, by means of which the material could be cut and worked in the same way as graphite. As regarded State exhibits, they were recommended to see those of Great Britain and Belgium, which were of a particularly complete and interesting character.

Mr. HERING said that there was not much novelty in Class 29. The Méry lamp had a high coefficient of temperature through the interposition of an iron wire. Metallic salts were mixed with the carbon, which resulted in a white deposit in the immediate vicinity of the arc, and this increased the reflecting power. Prof. Wedding had found that with this lamp 13 watts per candle-power of hemispherical illumination could be obtained. Wisemann claimed that by using a low voltage in the arc lamp he could get a higher efficiency. Ganz also had an interesting lamp with a curved arc. He called attention to the fine exhibit of chandeliers in the French section, and, in dealing with meters, said that there was a great variety, but nothing particularly new. The principle of the Thomson meter was the one most generally used. The Holden meter was also of interest, and the Aron meters were exhibited in large numbers. He concluded by referring to the exhibits relating to metallurgy in the French Section, and, in speaking of accumulators, made special mention of the Fulmen and Phenix batteries.

Mr. HERING proposed a vote of thanks to the American Commissioners for allowing the conference the use of the American Pavilion, and this was seconded by Prof. PERRY and carried unanimously.

Mr. GILBERT informed the meeting that a Pan-American exhibition would be held in Buffalo in 1901, and he invited the electrical engineers to visit that exhibition, which he said would contain the finest collection of mechanism and appliances relating to the electrical engineering industry that had ever been brought together.

VISITS TO THE EXHIBITION.

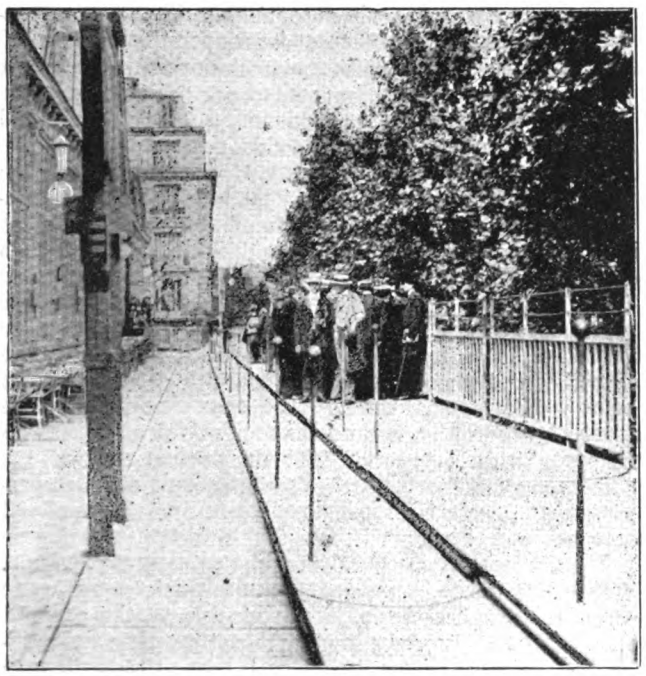
The afternoon was devoted to visits to the Exhibition, when the members were divided into groups and conducted over the Palace of Electricity, where the more interesting exhibits were pointed out to them by M. Hospitalier and other gentlemen. Assembling at the headquarters of the Institute of Electrical Engineers in the American Section, they were first of all taken over the Foreign Machinery Hall, where attention was directed to the installation of C. A. Parsons and Co., of Newcastle-on-Tyne, who have a 500-kw. alternating machine and a 70-kw. continuous-current dynamo operated by the firm's turbines. Galloway's vertical engine, coupled to a dynamo by Siemens Bros. and Co., of London, then came under notice, and leaving this exhibit the members were conducted through the German Section, with its fine display of steam-engines and flywheel generators. After inspecting the stand of Messrs. Siemens and Halske, of Berlin, M. Hospitalier led the group to the Swiss Section, where they saw the machines constructed by the Compagnie de l'Industrie Electrique, which are destined to transport force by continuous current from St. Maurice to Lausanne. They then visited the two switchboards situated behind the Palace of Electricity, the one for continuous current, which supplies the Champ de Mars with light and power, and the other for the alternating current, that serves the Esplanade des Invalides and the banks of the Seine up to the monumental entrance at the Place de la Concorde. Two switches are used for each main, and connect up one of two generators of about the same output, so that either of them can be employed for distributing energy by means of that particular main. A stand that aroused great interest was that of a firm of cablemakers (Pirelli and Co., of Milan) who showed a number of incandescent lamps fed by triphase current at 25,000 volts. Unfortunately, the current was not switched on at the time of the visit, owing to some of the lamps undergoing repair. Going into the French Section, M. Hospitalier said that there was very little of a particularly novel character to be noticed, though one exhibit worthy of attention was the compound exciter shown by Alexandre Grammont, of Pont de Cherui. This system was not perfect, but the maker had gone to work

Digitized by Google

in the right direction, and it might be expected to result in further developments in the compounding of motors. As time was limited, M. Hospitalier could only point out some of the leading features, and the group separated to examine the machines in detail.

The Electric Platform.

On Thursday morning the members visited the moving platform and the electric railway in the Exhibition, and proceeded first of all to the transforming station of the Société Industrielle de l'Electricité procédés Westinghouse, which is situated at the rear of the prominent Schneider exhibit. This installation is supplied with triphase current at 5,000 volts from the Westinghouse alternators in the generating station at Molineaux, four miles distant, and transforms it into direct current at 550 volts for propelling the moving platform and the railway, and for power and lighting purposes generally. There are two separate installations of transformers, which are absolutely identical. The moving platform is started by a 600-kw. dynamo driven by a 850-h.p. induction motor of the three-field type, and running at 290 revolutions at full load. The machine is shunt wound, and runs at 550 volts, the shunt winding being, of course, adopted on account of the very heavy starting current required. The switchboard has some



On the Electric Platform at Paris.

interesting devices, among which may be mentioned the automatic circuit breakers of the laminated brush type, which are thrown out by simply raising a lever with the finger, and another excellent device is the high-tension fusible cut-out, which is extremely simple, and, therefore, effective.

After seeing the platform started, at which moment the meters indicated about 200 volts and 900 amperes, the members left the Westinghouse station and went on to the platform itself. This installation is perhaps too well known now to need any detailed description. It may be said, however, that the platform, which has a length of 2 miles 199 yards, is practically composed of three parts—that is to say, a fixed, a low-speed, and a high-speed platform. The moving parts run at about 4 km. and 8 km. an hour respectively. The low-speed platform has a width of 2ft., and the high speed 3ft. 7in. The platform is built up of sections, each alternate one having rounded ends, and the intermediate ones curved ends. The former run on rails by means of small wheels, and the others are merely supported on metallic guides bolted underneath the rounded sections. The platform is worked by 170 series-wound motors, each developing up to 5 h.p., and a great economy in tractive effort is obtained by an arrangement of springs on the motors and on the small wheels carrying the platform on the rails, which take off some of the load and partly changes the frictional into a rolling movement, so that it runs as if on ball bearings. The consumption of energy for a speed of 5 km. an hour varies from 250 kw. to 300 kw., this latter corresponding to a load of from 20,000 to 30,000 passengers.

SOME REMARKS UPON THE CAUSE AND NATURE OF THE ELECTRIC FORCE.

BY R. C. SHETTLE, M D.

In this paper facts and arguments with regard to the nature of the electric force and its mode of origin, will be briefly set forth in support of the hypothesis that matter was originally formed by the force of cohesion acting upon and condensing a primary stuff; that the residuum of that stuff (which did not undergo condensation into formed matter) constitutes the ether, and is the basis of the electric force. Mathematicians and physicists have based views and theories of the material universe upon their knowledge of matter in its various forms, and of force as the product of motion. Now, mathematical or physical assumptions should be based upon a careful study of all conditions under which matter exists; and inasmuch as mathematical modes of discussing the nature of matter have not included a recognition of the ether as a necessary concomitant, results of such discussions are liable to grave error. This is obvious if matter and ether are realised as coeval entities, the former being the result of condensation in combination with motion in a surviving ethereal medium, such motion generating force or energy.

In support of such view we have but to remember how the existence of the planet Neptune was deduced from the evident action and motion of some *then* unknown material body *upon* already known planets, and through intervening ether. We also fully realise and acknowledge that the spheroidal form of the earth is due to the velocity of its rotatory motion, whilst its material condition had a certain varying density. And we also regard the spherical or spheroidal shape of the magnetic and diamagnetic physical units of the present earth as due to their formation in obedience to the same all-pervading laws of motion. The question will, therefore, arise whether the present results of mathematical and physical enquiries should be accepted as final, or whether the origin of matter by condensation of a primary stuff, of which the existing and now acknowledged ether may be the highly attenuated residuum, is not worth consideration.

In the *Electrical Engineer* of July 27, 1899, I published a paper upon the formation of matter by condensation whilst undergoing rotation, and showed how magnetic and diamagnetic conditions would thus arise. In previous papers I have shown how, by a like process, biological phenomena would be maintained. In the following remarks I seek to explain the nature and origin of electric force; and the effect of calling attention to this mode of explanation may be similar to the effect produced in earlier days by the simple, full, and satisfactory explanation of familiar terrestrial phenomena: referring them to the earth's rotation and revolution around the sun rather than to the old notion (merely) of the sun's revolution around the earth. Before attempting to show how the phenomena of electricity are evolved, it will be well to define the main steps in the formation of matter by condensation of the original stuff, because, hypothetically, it is to the existence of a primary force known as cohesion, and a consequent attachment of ether to molecules thereby, that all natural phenomena can be traced. The general principles of the hypothesis are as follows: it is assumed that space was primarily occupied by a somewhat dense but perfect fluid of uniform density throughout, with absolute cohesive contact of parts or physical elements, and at complete rest. *Note*—Some degree of cohesion would be as essential to the existence of a perfect fluid as the stuff itself, because absolute contact of parts would be maintained by equilibrium of density ensuring equal stress in all directions. The cause of viscosity is thus explained. But cohesion, and *not* gravity, appears to be the proper name for this force of equilibrium of density, more especially from the, *at first*,

Digitized by Google

total absence of particular points or centres of greater density.

The theory herein advanced is based upon the conception of one primary stuff of uniform density, for it would seem that only such a medium could be transformed into a "universe," with its steady, continuous, precise motions, definite arrangement of parts, and regularity of action. Formed from this medium, every *material* atom, even the most minute, would manifest phenomena and distribute energy, whilst interference with the effect of these would imply heterogeneous composition or basic impurity. Nature teems with testimony to the accuracy of such a view, and with effects due solely to admixture of different kinds of matter in bodies subjected to precisely similar influences. But every such combination can be ultimately resolved into substances each with its own specific simplicity and purity, but subserving certain purposes and affecting general behaviour as a form of matter. Now, in the one assumed primary stuff it is evident that no centres or points varying in density could possibly exist as force accumulators or distributors, consequently primary *disturbances*, however strange it may appear, must have originated altogether apart from and external to the stuff itself.

It can readily be seen that disturbance of equilibrium in such original stuff would be the one great primary cause for the subsequent evolution of all natural phenomena. Thus (1) motion originated at any point, or points, in a compressible* (see footnote) fluid, would entail variation of density; (2) variation of density, under cohesion or viscosity, in proportion to its extent would create centres of attraction, by which some of the primary stuff would be radially withdrawn and centrally condensed, originating centres of gravity; (3) the density of each centre of gravity, and the physical properties of matter which resulted therefrom, would be in proportion to the quantity of stuff which had been condensed into any one unit; (4) in proportion to the volume of stuff condensed the residuum would be attenuated, and thus ether of low density resulted or remained; (5) it is obvious that the extent of the stress which each formed unit exercised through the surrounding space, and upon other units, as also upon the ether which pervaded space, must have been in proportion to the mass density of the formed units, and this stress results not only in the condensation of a layer of ether upon the surface of each atom, but in the attraction of surrounding units to form molecules and ultimately masses; all these attractions being effected through the agency of that force which is recognised as cohesion or viscosity, necessarily existent in the purest and most attenuated natural ether.

The cause of "force acting at a distance" is thus capable of being clearly explained: force especially observed (1) when intensified at magnetic poles, or (2) in the field of an electromagnet, when each form of matter under its influence takes a direction according with the form which it assumed when undergoing rotation and being manufactured under the influence of stress originated by its own mass density; and (3) in "universal gravitation," or that force or ethereal stress which regulates the motions of the largest masses of the material universe.

Passing on now to the mode in which upon the foregoing principles the phenomena of static electricity are produced, it will be well to consider somewhat closely the force of cohesion or viscosity of the ether, as exhibited by freshly and smoothly cut surfaces of lead, or polished plates of glass, whose union when placed together is so great as to allow the two pieces to be worked upon as one. Here are two instances illustrative of the mode in which the force is exhibited upon, and extends away from the surface of matter. The very great simplicity of the way in which induction electric machines generate static electricity, according to this hypothesis, will be realised, because the rotation of the glass plate or plates, as the case may be, determines the motion of the ether condensed on their surfaces, and by viscosity of the adjacent and more distant attenuated ether in the same direction. Thus the motion of the glass plates, the density of the glass being much greater than that of the atmospheric matter, draws the ether away from the atmosphere, its great natural reservoir; a process facilitated by strips of paper on the surface of the glass plates, because such strips, in proportion to their density, impart greater density to *definite* portions of the ether than that which pertained to it as generally diffused in the atmosphere. In other words, viscosity is increased with the increased density of the attracted ether. These strips of paper act as channels of supply of ether to the glass plates, just as rivulets feed large rivers, or capillaries the small veins; the plates yield up this ether to the metal points, as bodies of yet greater density, from which it is drawn off by the density of the larger reservoirs or prime conductors of the machine, where it is further condensed and accumulated until its tension overcomes the resistance of the surrounding medium. These machines also present good practical examples of the mode in which light is produced by electric force. Thus the force of cohesion, or ether viscosity, emanating from a molecule of glass on one plate extends in a line through the intermediate ethereal space to a molecule of glass on the other plate, each atmospheric molecule in the intervening space being held upon a definite axis by the lines of stress from both glass surfaces. Now, it is obvious that as soon as the glass plates move in opposite directions (and there is always relative if not absolute motion in the two directions), the lines of stress are twisted upon themselves, and light is the result of molecular attrition under the influence of more or less condensed ether, whilst these lines acting and reacting one upon the other, consequently rotate and cause friction of the molecules existing between them.

In dealing with static electricity, the synthetic formation of water is an illustration of the mode in which condensation is effected by sending charges of static electricity, or, in other words, charges of accumulated ether, through a mixture of the gases oxygen and hydrogen. In the process by which these elements are compressed and combined as water, it is recognised that when the gases are properly associated in a bell-glass jar, and a charge, or, more properly, charges of static electricity, prepared in the usual way, are sent through the mixture, the liquid is formed synthetically, because as soon as the static charges are brought into connection with the gaseous mixture, the condensed or above-mentioned accumulated ether in proportion to increased tension seizes upon the material elements and condenses them by two forces acting in *helical* directions from opposite points or centres of action. (*Note.*—The mode in which the electric force naturally acquires its helical form is attributable to the conjoint motions of the sun and the earth acting upon the intermediate ether in the way to which I have already directed attention, as occurring during the evolution of static electricity by the induction electric machine.) In the electrolytic cell we have the reverse of this. The metal plates, by their relative potentials exercised upon each other, draw the eogen or primary stuff which combines the molecules away from them; and so the water is again resolved into gases.

I therefore pass on to consider voltaic electricity, or that form of force obtained from the voltaic cell, and which Volta named "electromotive force," existing on the contact surfaces of two different substances. And having defined the mode in which this form of force is originated and converted into a state of tension upon Volta's hypothesis, it will be well to comment upon the objections to Volta's theory, as well as upon the suggested "alternative" or chemical source of origin.

Voltaic, or Galvanic, Electricity.—We have the following statements: "If a plate of zinc and a plate of copper dip side by side, without touching, in a vessel of water acidulated with sulphuric or hydrochloric acid, two pieces of copper wire attached one to each plate are found to differ in potential. If the wires are connected with the alternate pairs of quadrants of a quadrant electrometer, a deflection is produced indicating a difference of potentials of about one volt, the potential of the wire from the copper plate being the higher."*

* The compressibility of the ether is shown by its condensation in glass. See Dr. Oliver Lodge's "Modern Views of Electricity," p. 400.

* "Electricity and Magnetism." Joubert, Foster, and Atkinson. Section 96.

Digitized by Google

Volta's Theory of Electrification by Contact.—Volta, in order to explain the observed fact, "supposed that the surface of contact of two metals, or more generally of any two different substances, is the seat of a peculiar force, which he termed electromotive force, the effect of which is to transfer positive electricity across the surface in one direction and negative in the other, until the tendency of the two electricities to reunite balances the force which tends to separate them. He supposed the electromotive force in any given case to depend solely on the nature of the materials in contact, and not upon the size or shape of the bodies, or the extent of the surface of contact, or on their electric state."*

Objections to Volta's Theory.—"The most serious objection to Volta's theory is that it does not afford a satisfactory account of the source of the energy the production of which it implies. . . . The only source from which this energy could be derived, consistently with Volta's hypothesis, is the heat contained in the zinc and copper. It is true that the withdrawal of the quantity of heat required to furnish the quantity of energy in question, rather less than three-thousandths of an erg, would cause an utterly imperceptible fall of temperature in a compound bar of zinc and copper large enough to be used in the experiment, so that the suggested explanation cannot be rejected upon this ground. . . . But when a numerical comparison is made, it is found that the quantity of heat which thus disappears is inadequate to account for the difference of potentials developed in Volta's experiment. It is further found, when other pairs of metals are tried, that not only is the fall of temperature due to the passage of electricity across the separating surface generally insufficient to account for Volta's results, but that there is no recognisable relation between the magnitude of the change of temperature in the one set of experiments and the difference of potentials observed in the other set. *In fact, there appears to be a real difference of potentials between different metals in contact, arising in some way solely from their own properties, which enable them to transform thermal energy into electric energy, but this difference is, in general, much too small to account for the effects now under consideration, and it does not always agree with these even in direction.*"†

The Alternative, or Chemical, Theory.—Passing now to this theory, in which "we no longer look for the source of the required energy in the surface of contact of the two metals, we may enquire whether it is not possible for it to be furnished by chemical action taking place between one or both of the metals and the air or liquid with which they are in contact. It is well known . . . that chemical combination, or decomposition, is associated in a definite way with the transfer of electricity between the bodies taking part in the action, and that the occurrence of a fixed amount of chemical action involves the transfer of a fixed quantity of electricity. . . . The connection above alluded to between chemical action and transfer of electricity *naturally suggests the idea that a definite electric charge is uniformly associated with each atom of a chemical substance.*"‡ *Note.*—Chemical action is thus referred to electricity, but the question to be solved is the cause of the electricity.

Following the text of the discussion on this subject in "Electricity and Magnetism," Section 100, it will be found that the conclusion finally reached is that the electric force is in some manner intimately associated with the molecules, but yet outside them. Thus "a molecule of oxygen gas consists of two atoms *which are in some way held together, and the connecting force has been likened to, if not actually identified with, electrical attraction, a molecule of oxygen being represented by the symbols* $\overset{+}{O}\ \overset{-}{O}$."§

Consequently, the problem as to the nature of the force and the cause of its existence remains quite unsolved by either Volta's theory or by that of chemical action; because, while both recognise the *existence* of a force, neither attempts to define its primary cause, Volta's theory referring it to an *electromotive force* which resides on the contact surfaces of any two different substances, whilst chemical action refers the force to the difference of potentials between the positive and negative layers of matter, *but does not offer any suggestion why difference of potential should produce such effect.*

On the contrary, the hypothesis herein brought forward explains that both these theories are quite correct as to the existence of a force, its seat beween the units, and that one of its functions is to bind these units together in proportion to the potential of each. For when the two units are separated, the ether, which it must be remembered is attached to *each* of them, is strained. The E.M.F. developed depends not merely on the mechanical force applied in separating them, but on *the strength of attachment of the ether to each unit.* The theory also goes further, and traces the force back to the great primary form of physical force—viz., cohesion or viscosity—in which form it was coexistent and equally distributed with the primary stuff itself throughout that which we call space—in fact, it appears to have had its origin in the absolute contact of contiguous parts of the primary stuff, its first function seeming to have been to maintain equilibrium of this stuff, and so adapt it upon a very broad principle to the formation of every kind of matter required in or by the material universe. Thus when equilibrium was disturbed by external stress or power, cohesion became an active force, each centre of stress, in proportion to its intensity, attracting the stuff throughout a given radius by the modification which the force had undergone. It is obvious that the force did not cease to exist at the circumference of the formed material units, because each of these would drag upon the residual stuff only in a lesser degree—*i.e*, in proportion to the attenuation of the stuff and the cohesion and viscosity which still existed, and a certain quantity of this stuff, the quantity varying with the density or the potential of the unit, would be condensed and added upon the surface of each. Attenuation of the residuum would be further effected thereby, whilst the same force acting through this medium would cause the atoms to combine and form molecules and masses, the density of which would be also in proportion to the intensity of the force of cohesion, or the pull which the potential of each unit exercised.

This hypothesis, and the foregoing statement of facts, appear to afford justification for asserting that not only is the ulterior or secondary force of electricity thus completely explained, but that all natural phenomena throughout the three kingdoms of nature may be simply and wholly referred to modifications of the primary force, cohesion, in accordance with the nature and conditions of the matter with which that force is associated.

* "Electricity and Magnetism," Section 98.
† *Ibid*, Section 99. The italics are by the writer of this paper.
‡ *Ibid*, Section 100. The italics as above stated.
§ *Ibid*, Section 100. The italics as above stated.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 231.)

The following is the conclusion of Prof. Wedding's discourse upon arc lamps of the "Bremer" type, commenced in my last instalment of the Verband proceedings at Kiel:

"I also experimented with an alternating arc lamp of the Bremer type. Table VII. gives the measurements relative to this lamp, which consumed about 6·5 amperes at 39·3 volts terminal potential when unprotected by a globe:

TABLE VII.—Alternating-Current Arc Lamp without Globe. ⁓6·5 amperes × 39·3 volts.

Angle relative to the horizontal plane—Deg.	Intensity of light.
16·8	102
24	219
30	358
35	710
38·6	674
43	857
47·8	816
55	879
61	964
69	1,764
76	1,426
90	1,042

Digitized by Google

"From this data the curve in Fig. 7 is obtained. The lamp, however, on account of its rough construction, did not burn uniformly, and for a mean intensity of light, amounting to 512 candles, showed a specific consumption of about 0·5 of a watt, though this is certainly about a half only of the energy hitherto consumed for the same volume of light. Hence an advance upon present practice is also apparent here, and I believe that with a mechanically improved lamp, an efficiency approximating that of the continuous-current lamp already described can be obtained, so as to render the employment of alternating-current lamps possessing a relatively high specific consumption unnecessary.

"In taking the above measurements the special carbons were used only on one side of the lamp, as in the case of the continuous-current lamps. The carbons were placed in pairs, these pairs having an almost vertical position relative to each other so that three current paths might be distinguished. In one the current flowed from the top downwards, in the second from below upwards, in the third taking a horizontal direction between the two pairs of carbons at the arcing point. The latter path is movable as an arc, and is repulsed outwards by the other two paths according to a well-known observation by De la Rive. The arc is therefore deflected downwards in the form of a feathery flame. The greater the intensity of current employed the farther accordingly will the arc be projected.

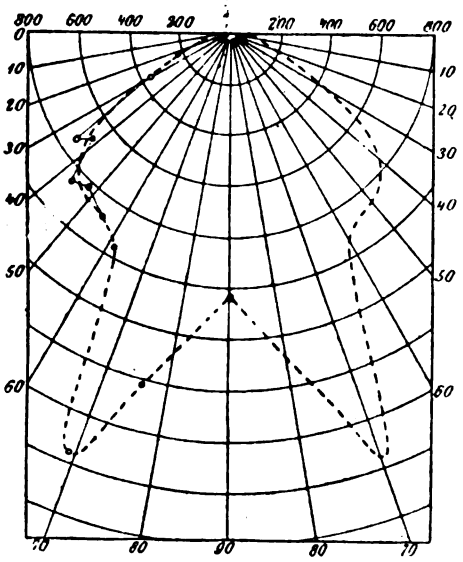


Fig. 7.

In arc lamps designed for low intensities the direct influence of the current is too weak, and in order to supplement this the magnetic field produced by two suitably-placed magnet poles is employed, the magnets being excited by a series coil connected in circuit with the lamp. Should the current become too great, the arc may be drawn inwards by the influence of a differential winding. This may become necessary, for instance, if the influence of the three current paths in a lamp taking a large current is alone too great, and the arc is consequently repulsed too strongly.

"For starting the arc a shunt electromagnet may be employed to bring the carbons into contact in the usual manner. Hence if the carbons constituting one pair or pole are suspended after the manner of a pendulum, the influence exerted by this electromagnet, which forms a shunt to the arc, may also be utilised to regulate the length of the arc should the consumption of carbon be ununiform. When the lamp is burning, the carbon feed is rendered continuous by the weight of the carbons supplemented by an auxiliary weight, and not intermittent. The bulky, costly, and extremely sensitive mechanism characteristic of the lamps now in vogue is entirely absent, and yet, according to the preliminary data at my disposal, the new lamp may be made to burn uniformly and steadily. At the express wish of the inventor, I must refrain from giving a more detailed description of the lamp's construction.

"In the case of the ordinary type of arc lamp the light rays proceeding from the arc constitute only a small percentage of the total light rays, whereas the much larger flame characteristic of the new lamp represents a far greater percentage of the total rays. An examination of the arc through a suitable medium makes this at once discernible. Light rays are not only projected downwards from the glowing points of the carbons, but also radiate into space from all sides of the arc. By the admixture with the carbon the resistance of the arc itself is so reduced that the tension across the lamp terminals, despite the larger arc, need not exceed that necessary for an ordinary arc lamp working with the same intensity of current. How far this statement applies when alternating currents are employed remains, however, to be seen.

"In order to utilise the available light to the maximum possible extent, a conical metal cylinder about 5cm. high is fixed above the ends of the carbons, whereby the heat developed in and between the carbons is converged. In this manner a high temperature is obtained, which results in a more gradual consumption of the carbon than would otherwise be the case. At present, however, the rate of the consumption of carbon in the new lamp is about double the ordinary rate, owing to the admixture already referred to. It should, however, be taken into consideration that the ratio of the cross-section of the carbons pertaining to the old system to that of the new is about as 3 : 1, so that the specific consumption of carbon in the new lamp need not necessarily be greater. The products of combustion, so far as these are not of the gaseous order, are deposited upon the inner surface of the cylinder in the form of a pure white fine powder. When the carbon has been compounded with calcium, the latter is found again in the form of a fine powder on the cylinder and upper cover of the lamp. Supposing that the calcium was decomposed and set free in the form of gas, this latter would inevitably attack the metal in connection with the upper half of the lamp or escape into space. But this is not the case. The calcium compound is minutely subdivided in the arc and its immediate vicinity, and probably present in a gaseous state, whence it deposits itself in a fine white powder.

"This deposit constitutes an excellent reflector, so that upon looking into the cylindrical converger the projection of the same appears as a brilliant and intensely illuminated disc. The great volume of light yielded is, therefore, initially distributed over a large surface. Hence the lamp does not possess the intensely piercing lustre common to the ordinary type, but when provided with a globe appears as a fairly uniformly illuminated disc. The formation of shadows is entirely absent in the new lamp. As the measurements and the curve in Fig. 2 show, a by no means inconsiderable volume of light is yielded up to an angle of 48deg. above the horizontal. For interior and street lighting this fact may be of importance, in so far that the side surfaces within the lamp's radius of action would be illuminated to a considerable height, the impression on the eye being thereby rendered more agreeable owing to the slight contrast between light and shadow.

"Photometric measurements do not always suffice; the æsthetic impression made by the light is sometimes the ruling factor. In virtue of the high percentage of calcium employed, the new light is very rich in red rays in contrast to the blue or violet light yielded by the lamps hitherto in vogue. Through the medium of a spectroscope, the bright, broad bands of yellow green and orange rays may be plainly distinguished. The resultant light does not, therefore, possess the cold, fallow tinge to which we have hitherto been accustomed, but a considerably warmer tinge, by which other colours—for instance, green—are much better defined. In my opinion, however, the colour in comparison with sunlight still leaves something to be desired; it still makes a piercing impression on the eye. This objection may, perhaps, be surmounted by incorporating other metallic salts, as in the case of the gas incandescent light, even at the danger of somewhat increasing the specific consumption. The inventor claims to have the colour of the light fully under control.

"It is a well-known fact that light possessing long wave-lengths will penetrate mist or fog better than light of shorter wave-lengths, in virtue of which a red ray is discernible for a greater distance than a violet ray of equal strength. I have, therefore, examined into the relative

Digitized by Google

penetrative powers of the light yielded respectively by the new and old types of arc lamps. A lamp of each type was tested with approximately the same intensity of current at an angle of 45deg. The test to ascertain the intensity of light yielded was conducted in each case once without, and a second time with, the inclusion of a cloud of steam. This steam cloud was produced by blowing-off a steam-boiler under conditions as equal as possible. There arose between the photometer and the respective lamp a dense cloud of steam about 1m. in thickness. The test could be made only in a very rough manner, since the blowing-off process did not always yield like results. A series of 10 tests gave values for the penetrativity of the light differing by no means inconsiderably. The results, however, showed clearly that the penetrative power of the new light rays through steam exceeded by 40 per cent. to 150 per cent. that of the ordinary arc light. Hence it is safe to assume that the penetrativity of the new light is 100 per cent. greater than that of the old. For signalling, light-house, and other purposes, the light may attain to some importance. But whether it will prove equally adaptable to the conditions of searchlight work remains for the future to determine. At any rate, no solution of the latter question is yet forthcoming."

(To be continued.)

MORE MIRACLES!

[BY OUR VERACIOUS INTERVIEWER]

"The latest startling announcement of the inventor Nikola Tesla is that he has discovered a perfect insulation for electricity. . . . The plan is by a chemical process to freeze a mixture of water and sawdust in a thin metal tube about the wire carrying the electric current. Tesla declares that electricity will in this way be transmitted from Niagara Falls to the Pacific coast, or through the ocean from New York to London, with no perceptible loss of power. He asserts that the invention will greatly cheapen electricity and cause a revolution in industrial affairs."—*Daily Mail*, Aug. 18, 1900.

Fired with the ambition of capturing yet another miracle, I betook myself in haste to the place where they flourish; in a word, to the residence of the discoverer whose motto is, "If it is but difficult, I have done it already; if it is impossible, I mean to do it." To my surprise I found him digging a hole in his back garden.

When he saw me, he courteously climbed out of the hole, which was already several feet deep, and asked me my business. On telling him that I traded in the miraculous, he looked pleased, and directed my attention to the excavation. "That hole," he said, "will shortly become the hub of the universe. From there will flow a stream of energy that will vitalise this old globe of ours. If you'll take——"

"Certainly," I replied; "a cocktail is my drink at this hour of the day."

My words appeared to disconcert the great discoverer for a moment, but he quickly recovered his equanimity, and ushered me into his laboratory—a weird room, lighted by strangely glowing tubes and bulbs. We drank in silence; but I could see, from the workings of the expressive countenance of the inventor, that his mind was active. When he spoke, I recognised that my quest had not been in vain.

"That hole," he continued presently, "must, before it is finished, penetrate below the roots of the hills, even to the fluid interior of the earth. The heat of that vast collection of molten matter, which we call lava, I mean to utilise as a source of energy. I then expect to upset our industries some. Niagara Falls? Pooh! Coalfields? They'll become mere curiosities."

When I promised to give publicity to this marvellous invention, the proud inventor shook me warmly by the hand. He even condescended to enter into details.

"The idea occurred to me three hours ago, and I have been working at it ever since. Prof. D——r, when I was in England in 1893, showed me some vacuum-coated glass vessels which heat was incapable of entering or leaving. You see my drift now? Glass tubes, each surrounded by a vacuum jacket, will proceed from the hole you have seen, and through them streams of molten lava will flow. The vacuum jacket will prevent any loss of heat, and thus energy can be transmitted from here to London in a manner before undreamed of. You run your lava into your boiler, and there's your steam at once. No ash! No smoke! No—er—anything!"

Here I murmured my admiration. When he resumed, I soon saw the magnitude of this invention. "Do you want to discover the North Pole? You merely direct a stream of molten lava toward it, and of itself it builds a causeway, and at the same times creates a warm and agreeable climate. As you know, I suggested some years ago that London should be entirely roofed in with one gigantic dome. The only objection ever raised to this project was that the smoke nuisance would be intensified. Smoke? Why, every grate will glow with molten lava, and the dome will become an accomplished fact. I shall even have small masses of molten lava enclosed in vacuum-jacketed vessels and sold as cigar lights.

"From these instances you may guess the varied purposes to which my invention would be put. I have applied for a patent in the United States; other countries must apply to me."

The cocktails had disappeared, and as no suggestion of replenishing them was given, I rose to bring my visit to a close.

"There seems to me to be one difficulty," I hesitatingly said "Suppose your vacuum-jacketed tubes should break?'

"Well, if you'll mention *that*, you'll mention anything," was the rejoinder. "If the tubes become broken, they must, of course, be mended."

I then left, in possession of my miracle, and lost in admiration of the ingenuity and resourcefulness of this our greatest inventor.

BRITISH ASSOCIATION.

The following is the provisional programme of papers to be read in Section G at the Bradford meeting of the British Association. It will be seen that valuable discussions should ensue. We are pleased to note that the arrangements of subjects on the various days is such that it will repay engineers who are unable to spend a week in Bradford to run down there for certain days. The section will be opened by a presidential address by Sir Alexander Binnie at 11.30 a.m. on Thursday, Sept. 6. At 2 p.m. on Thursday the following papers will be read: "Bradford Waterworks," by Mr. James Watson; and "The Disposal of House Refuse in Bradford," by Mr. John McTaggart.

On Friday, Sept. 7, the papers will be: "Resistance of Road Vehicles to Traction," by Prof. Hele Shaw, F.R.S.; "Recent Tramway Construction, with Special Reference to the Denerbe System," by Mr. W. H. H. Dawson; "The Coal and Iron Ore Fields of Shansi and Honan, and Railway Construction in China," by Mr. J. H. Glass; "The Use of Expanded Metal in Concrete," by Mr. A. T. Walmisley; and "Power Generation—Comparative Cost by the Steam-Engine, Water-Turbine, and Gas-Engine," by Mr. J. B. C. Kershaw.

On Saturday, Sept. 8, Prof. R. Beaumont will read a paper on "The Application of Photography to Textile Designing."

On Monday, Sept. 10, the report of the Small Screw-Gauge Committee will be read by Mr. W. A. Price, and the following papers: "Measurement of the Tractive Force, Resistance, and Acceleration of Trains," by Mr. A. Mallock; "The Liverpool and Manchester Electric Railway," by Sir W. H. Preece, F.R.S.; "The Design and Location of Electric Generating Stations," by Mr. A. H. Gibbings; "A Maximum Demand Meter," by Mr. T. Barker; "An Account of a New Form of Self-Registering Rain-Gauge," by Mr. J. W. Binnie; and "The Automobile for Electric Street Traction," by Mr. J. G. W. Aldridge.

On Tuesday, Sept. 11, the papers will be: "A New Form of Calorimeter for Measuring the Wetness of Steam," by Prof. J. Goodman; "The Internal Architecture of Steel," by Prof. Arnold; "Shop Buildings," by Mr. E E. Clark; and "Steam Raising and Smokeless Combustion," by Mr. H. R. Armitage.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	253	The Evolution of Switch Gears for High Pressure Alternating Currents	274
The Electrical Engineers' Conference in Paris	258	The Railway and the Telephone	277
Some Remarks upon the Cause and Nature of the Electric Force	265	Liverpool Tramways Tontine	277
The Verband Deutscher Elektrotechniker	267	Questions and Answers	278
More Miracles!	269	Contracts for Electrical Supplies	280
British Association	269	Traction Notes	282
The Paris Conference	270	Lighting Notes	283
Correspondence	271	Bristol Electricity Accounts	286
Paris Exhibition Awards	271	Provisional Patents	287
The Pearson Wing Trolley and Traveller	272	Specifications Accepted	288
Messrs. Davey, Paxman, and Company's Standard Ironworks, Colchester	272	Traffic Returns	288
		Companies' Stock and Share List	288

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

THE PARIS CONFERENCE.

When it was first proposed to hold an international conference of electrical engineers in Paris, a programme of the various subjects which ought to be discussed at this conference was drawn up by the French executive. We commented at the time on the utter absurdity of even suggesting that discussion was possible on only one-tenth of the number of subjects put down. In this case time has proved that our contention was correct, as at the conference last week practically only one subject was opened for discussion. This subject was "The Relative Advantages of Alternate and Continuous Current for a General Supply of Electricity, especially with regard to interference with other interests." As will be seen from the report by our special correspondent, electrical engineers from Great Britain and the United States, as well as French engineers, took part in the discussion on this important question, which has been discussed so frequently before. Without wishing to draw comparisons, we would express our opinion that the opening remarks of Mr. Ferranti started the discussion on the correct lines. We are sure that much more value would have been imparted to the discussion had other speakers discussed the matter from the same standpoint. In the struggle for existence in nature, all failures are destroyed without mercy, and in engineering progress the fittest only can survive. What has been done in the past in electric distribution of light and power, is in almost all countries an exceedingly small proportion of what has to be done in the future. Hence a system of supply which may have done exceedingly good work in the early days, may be quite incapable of extension to meet the enormous demands of the future. This was the standpoint taken by Mr. Ferranti, and it is from this point of view that a decision is wanted as to whether the continuous or alternating current system should be laid down in the future. For the transmission of power to a distance, the alternate-current system has proved itself the best; and the interest in the discussion was largely on the question of the distribution and supply of energy. It will be seen that several eminent engineers from the States do not consider the alternate-current motors capable of fulfilling the requirements of electric traction, or of giving the same results in rapid transit as can be obtained by the aid of continuous-current motors. Such engineers take an advanced view of the interference question, holding that interference by leakage currents to other conductors in the ground and to laboratory instruments should be borne by the public without demur, in consequence of the advantages conferred by the rapid system of communications. With this we can hardly agree, and think that the insulated return for electric railways is a necessity in large towns. Mr. Ferranti questions even then if it is possible to prevent electrolytic troubles, and this question can only be answered by practical experience on a large scale. The whole problem is an extensive one to be discussed at a convention, the members of which are practically on holiday, when the tendency is not

Digitized by Google

to give the deep forethought to one's remarks which the importance of the matter at issue demands. If the joint institutions were to state, say, three different cases of power transmission and distribution all on a large scale, with local conditions varying, we think that the vexed problem of continuous *versus* alternating currents could be practically solved by sending out to the experts of different nations the cases in question, and perusing the answers received as to which system each of these experts would recommend in each of the three cases. Even if a handsome fee were sent to each expert with the problems, the replies would be worth the expense, as the profession generally would benefit.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE NATURE OF ELECTRICITY.

SIR,—Kindly permit me to point out that near the end of my article on "Dr. Shettle's View of the Ultimate Nature of Electricity," published in your issue for Aug. 17, a rather unfortunate verbal error occurs. See line 17 of p. 233, column 1: the words "copper to zinc" should read "zinc to copper." The point at issue is that whereas in a Zn-Cu cell with acid, the current runs along the external circuit from Cu to Zn, with contact of two pieces of dry metal, electricity is transferred from *Zn to Cu*.

I believe this was correctly stated in my manuscript. As this slip vitiates the reasoning in this part of the paper, perhaps you would kindly correct in your next issue.—Yours, etc., SPENCER L. FLETCHER.

38, Lammas Park-road, Ealing, W., Aug. 18, 1900.

THE DAVY ENCLOSED ARC LAMP.

SIR,—The secretary of the Jandus Company in his letter published in your issue of the 17th inst. displays a touching solicitude for the Jandus licensees, but it seems to me that his anxiety might well have been limited to his own company. The extraordinary but unsuccessful efforts which Mr. Gillies is making to explain away in the Press the abandonment of the Jandus Company's action against me is a proof—if proof were needed—of the hopelessness of his company's attempt to justify their allegation of infringement. Inasmuch as his letter has been interpreted by some of my customers and friends as a threatening one, and as such is calculated to injure my business, I beg that you will let the facts speak for themselves.

While I can understand that the truth, that the Jandus Company have "wholly discontinued" their action against me, may be damaging to that company, I cannot possibly see where the injustice comes in. In the latter part of last year the Jandus Company commenced an action against me alleging infringement of certain of their letters patent, and claiming an injunction, damages, and delivery of the lamps made in infringement. My defence was that I had not infringed their letters patent. While the matter was before the High Court, the Jandus Company repeatedly applied for extensions of time, and apparently exhausted every possible legal method of postponing the date when the action could be set down for trial, and as they failed to set down the action for trial within the extended time allowed, an order was made dismissing the action, and in addition, on June 22, the Jandus Company served a notice (a copy of which I enclose) "wholly discontinuing the action." Prior to serving the notice of discontinuance, repeated efforts were made by or on behalf of the Jandus Company to induce me to accept a license for a merely nominal consideration, or on a basis of a "union of interests." I absolutely declined to do anything that would involve my accepting, either directly or indirectly, a license from the Jandus Company.

No proceedings in the nature of a test action or otherwise are at present pending against me; what the intentions of the Jandus Company may be in this respect I neither know nor care. The Jandus action against Messrs. Johnson and Phillips is in no sense parallel with their abortive action against me, for I never was, and never shall be, a licensee of the Jandus Company.—Yours, etc.,

London, E.C., Aug. 22, 1900. WILLIAM JAMES DAVY.

PARIS EXHIBITION AWARDS.

We notice the following awards obtained by British exhibitors at the Paris Exhibition:

GROUP 3.—APPLIANCES AND GENERAL PROCESSES RELATING TO LITERATURE, SCIENCE, AND ART.

CLASS XV. (Mathematical and Scientific Instruments).—"Hors Concours": Sir W. Abney, Messrs. C. V. Boys, Christie, Davidson, Dr. J. Mackenzie, J. Milne, Sir W. Roberts-Austen, J. J. Thomson, Thorpe, Hutton. Grand Prizes: Gas Referees of Board of Trade (collective exhibit of mathematical instruments made in the United Kingdom), Cambridge Scientific Instruments Company, Ross, Limited. Gold Medals: James Hicks, Mark Barr (Linotype Company), Watson and Son, Negretti and Zambra. Silver Medals: Legge and Co., Watson and Son (*? vide supra*).

Collaborators.—Gold Medals (unclassified as to country): James B. Macdowel and Hartman, of John A. Brashear; G. Fecker and W. E. Reed, of Warner and Swasey. Silver Medals (unclassified as to country): Smith; Oberlin, of the Ferracute Machine Company; John Wayne, Moser, of Cambridge; the Scientific Instrument Company; Alfred Higgins, of James J. Hicks; Pitman, Hill. Bronze Medals: Harry Janvier and William Ware, of the Ferracute Machine Company; Brice Gustav Watnecker, of Legge and Co.

GROUP 4.—MECHANICAL ENGINEERING.

CLASS XIX. (Steam-Engines). — "Hors Concours": Thwaite Bros. Grand Prizes: Parsons and Co., Willans and Robinson, Galloways. Gold Medals: Marshall, Sons, and Co., Ruston, Proctor, and Co., Ransome, Sims, and Co., Garrett and Sons. Silver Medals: Robey and Co., E. Green and Sons, G. and J. Weir, Patent Exhaust Steam Injector Company. Bronze Medals: James Proctor, Tangye, Limited, Deighton Patent Flue Tube Company.

Collaborators.—Bronze Medal: Lister Croft, of Deighton Patent Flue Tube Company.

CLASS XX. (Various Kinds of Engines).—Grand Prize: Crossley Bros. Gold Medals: Hornsby and Sons, Priestman Bros., Campbell Gas-Engine Company, National Gas-Engine Company, Tangye, Limited. Silver Medals: Ruston, Proctor, and Co., Dudbridge Ironworks, Limited, Robey and Co., Blackstone and Co., J. and F. Howard. Bronze Medals: Cundall and Sons, Dougill and Co., Duke and Ockenden.

Collaborators.—Gold Medals: W. J. Crossley and D. H. Irwin, of Crossley Bros. Silver Medals: George W. Taylor and William Linfoot, of Campbell Gas-Engine Company; W. Turner, E. Pierce, J. Cooke, and A. Hooker, of Crossley Bros.; Herbert Hatton, of Humpidge, Holborow, and Co.; William Wood, sen., William Wood, jun., of the National Gas-Engine Company. Bronze Medals: Albert Mallinson, Samuel Mitchell, Joseph Berry, John Robertshaw, William Yates, Chadwick Smith, Ousey Roberts, and John Jowett, of the Campbell Gas-Engine Company; J. Atkinson, W. Wilson, W. Mitchell, W. Schofield, and J. Carter, of Crossleys; W. Dougill, of Dougill and Co.; Albert White, Samuel Bennett, and Frank Apperly, of Humpidge, Holborow, and Co.

CLASS XXI. (General Machinery).—"Hors Concours": Thwaites Bros., Limited. Grand Prize: Merryweather and Sons. Silver Medals: Mather and Platt, Salter and Co., Wilson and Sons, Mossberg Roller Bearing Company, Stokalls and Sons, Maclaren. Bronze Medals: Dodge Manufacturing Company, Samuelson and Co., Roller Bearings Company.

CLASS XXII. (Machine Tools).—"Hors Concours": Thwaites Bros. Grand Prize: Smith and Coventry,

Digitized by Google

Mather and Platt. Silver Medal: Robey and Co. Bronze Medal: Belshaw and Co.

Collaborators.—Grand Prize: Edward Hopkinson.

GROUP 5.—ELECTRICITY.

CLASS XXIII. (Mechanical Production and Utilisation of Electricity).—Grand Prize: Siemens Bros. and Co. Gold Medals: C. A. Parsons and Co., the Scientific Instrument Company. Silver Medal: William Burton, of James Hicks and Co.

CLASS XXIV. (Electro-Chemistry). — Gold Medals: Electrical Power Storage Company, Chloride Electrical Storage Syndicate, Sherard Cowper-Coles. (?).

Collaborators.—Silver Medal: Herbert Butler, of the Electrical Power Storage Company.

CLASS XXV. (Electric Lighting).—Gold Medals: Benson and Co., Simplex Steel Conduit Company. Silver Medal: R. Beshaw and Co., city of Bath.

Collaborators.—Silver Medal: Lauder and Waterhouse, of the Simplex Steel Conduit Company.

CLASS XXVI. — Grand Prize: General Post Office. Silver Medal: Patent Nut and Bolt Company.

CLASS XXVII. (Telegraphy and Telephony).—Grand Prize: James White. Gold Medal: Crompton and Co. Silver Medal: James Hicks, Stockall, and Sons.

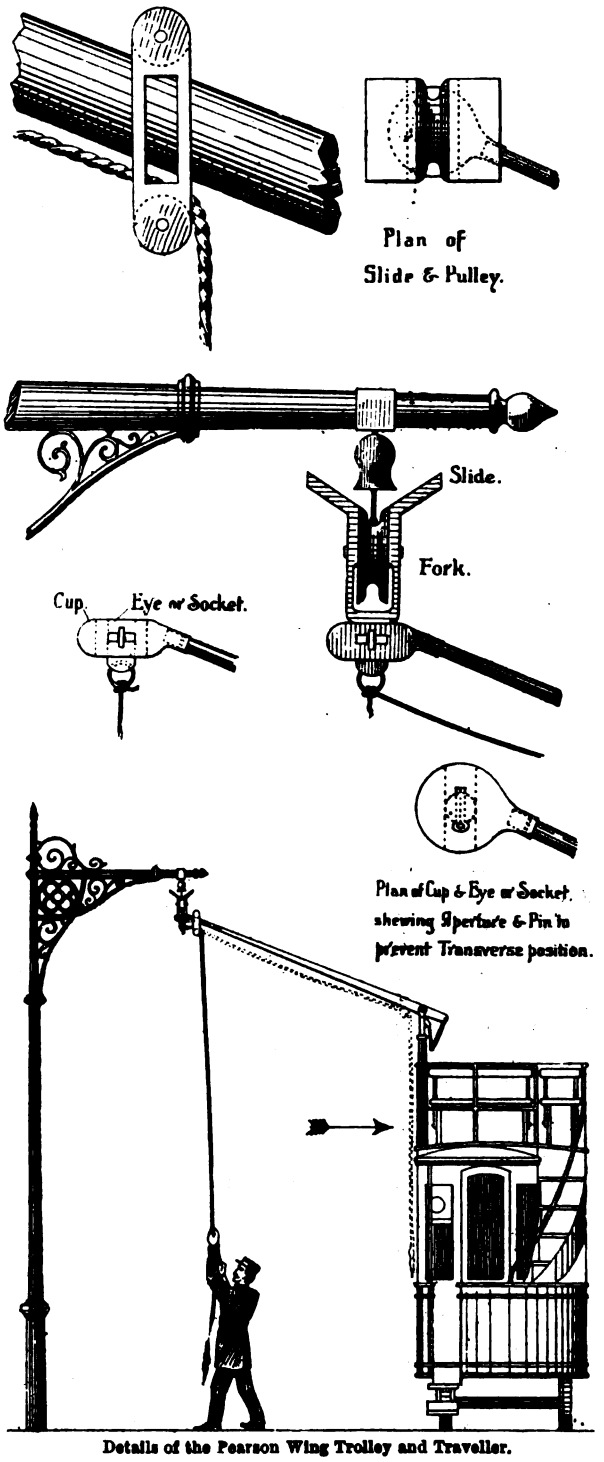
Collaborators.—Gold Medals: Kendall and Gent, Alfred Herbert, Ransome and Co, B. and S. Massey, George Richards and Co, Thomas Robinson and Son. Silver Medals: J. Rhodes and Sons, J. Holroyd and Co., H. W. Ward and Co., Brunton and Trier, Samuelson and Co., Wolseley Sheep-Shearing Machine Company, J. Bertram and Sons. Bronze Medals: United States Metallic Packing Company, Andrew and Co., Wolseley Sheep-Shearing Machine Company (? *vide supra*), Central Cyclone Company, Joseph Parkinson.

Collaborators.—Gold Medals: Oscar Harner, of Alfred Herbert; S. Henry Marl, of Ransome and Co. Bronze Medals: C. W. Jemas, of the Central Cyclone Company; H. Liebert, of J. Holroyd and Co.; John Barker, of Rhodes and Sons; Hughes Cunningham, of Samuelson and Co.; A. J. Thernelee, of H. W. Ward and Co.

THE PEARSON WING TROLLEY AND TRAVELLER.

We illustrate herewith two inventions of Mr. James T. Pearson, of Burnley, which are designed to remove difficulties connected with trolleys for electric tramways. The first of these, the wing trolley, is designed to make it more easy to get the trolley wheel on to the trolley wire, and also to make it more difficult for the wheel in question to leave the wire on the curves. The wing trolley is simply the ordinary trolley with wings (which need not project more than ¼in.), and a slot and pin penetrating the shank of the fork of the pulley, and, being parallel with the latter, allows it to swivel at curves, but prevents it getting across the wire by the ends coming in contact with the sides of the slot. On account of the extra width attained beyond that of the pulley by the "wings" forming a channel, the carman "lets go" the moment the latter is under the "trolley wire," and it engages instantaneously, without wasting time and patience in "dodging."

The other invention of Mr. Pearson's—called the "Traveller"—has for its object the prevention of accidents of the kind which have occurred in consequence of the rope from the trolley head hanging loose. The illustration explains how this is done by means of a traveller, which automatically keeps the rope confined at the bottom of the trolley pole when the rope is not in use. The traveller by means of which this is done only weighs a few ounces, and consists of two skeleton plates, comprising a frame for mounting rollers at the top and bottom. The rod forming the spindle of the rollers has a head at one end and a slot at the other to take a split pin, so that the "traveller" can be readily applied to any arm. When going to change the trolley from one feed wire to another, the carman takes hold of the end of the rope as it hangs down the side of the car and pulls it. The "traveller" then mounts the arm to the end, the trolley is instantaneously let go, and is "contacted" the moment it comes underneath the wire. The carman "lets go" the end of the rope, when the "traveller" descends by gravitating to the pillar of the arm if at the side of the car, or to a stop-piece or clip thereon if in the middle, drawing the rope up out of the way close to the underside of the arm, the end hanging down the side of the car. Simplicity and expedition are embraced in both of these details at a trifling cost, and it would seem that a saving of time would be effected by them.



Details of the Pearson Wing Trolley and Traveller.

MESSRS. DAVEY, PAXMAN, AND COMPANY'S STANDARD IRONWORKS, COLCHESTER.

On Thursday, the 16th inst, the Ipswich Engineering Society paid what proved to be a highly interesting and instructive visit to Messrs. Davey, Paxman, and Co.'s Standard Ironworks, Colchester. The visitors, to the number of about 60, were received at the works by Mr. James Paxman, C.E., J.P. (chairman of the company), who subsequently entertained them to tea. The inspection of

Digitized by Google

the works was conducted according to a prearranged plan, a copy of which was presented to each visitor.

Before describing what was seen, the history of the company may be briefly outlined. The firm of Davey, Paxman, and Co. was established in 1865 by Mr. James Paxman, in conjunction with the brothers Messrs. C. M. and H. M. Davey. Several years later Mr. T. J. Balls joined the firm. Premises were taken in the centre of Colchester, and a substantial business developed, the increase being so rapid, in fact, that land was purchased at the Hythe whereon to erect new works. The site occupies an area of about 15 acres, more than half of which is already covered with buildings. In 1876 Messrs. C. M. and H. M. Davey retired from the firm. In 1885 Mr. Balls also retired, the business devolving entirely upon Mr. James Paxman. Mr. William Paxman, who had been assisting his father for some years, was taken into the firm, and the business remained in the hands of Mr. James Paxman and his son, Mr. William Paxman, until the end of 1897, when it was turned into a private limited company for family reasons. The directors

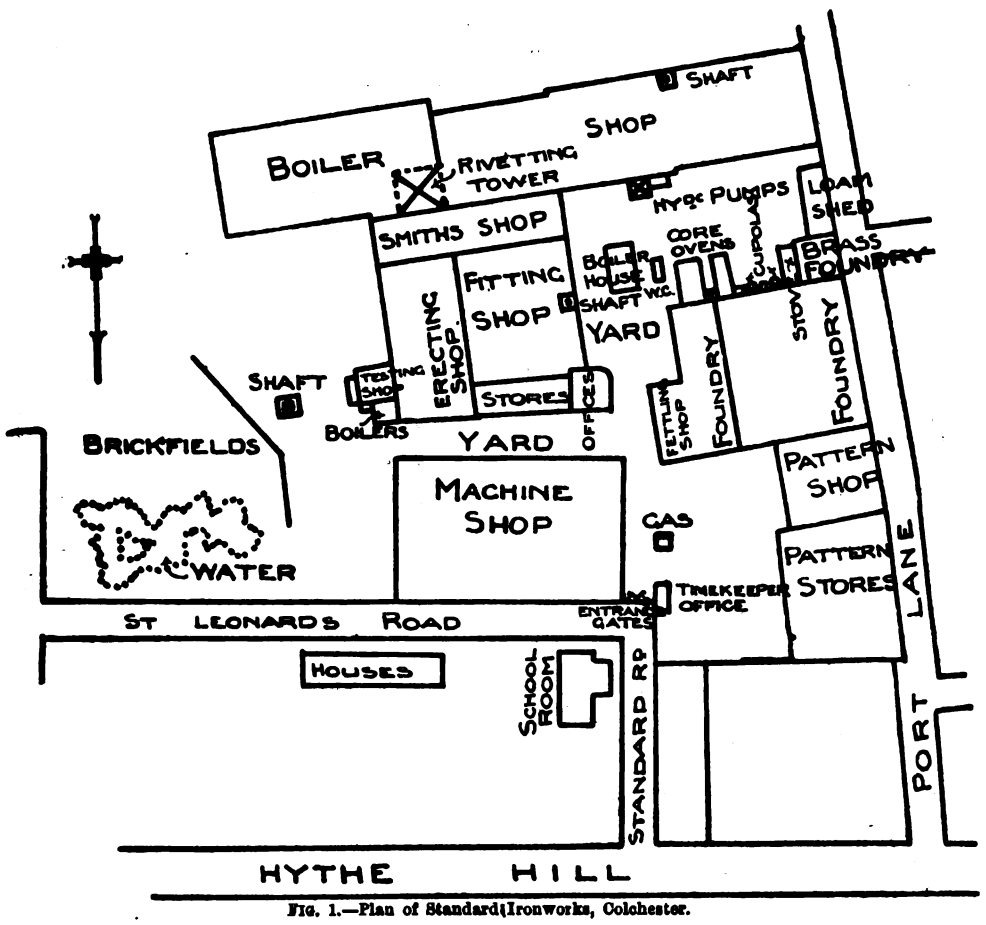


FIG. 1.—Plan of Standard Ironworks, Colchester.

of the company are Mr. James Paxman, C.E., J.P. (chairman), Mr. William Paxman, and Mr. Wilson Marriage, J.P. The secretary is Mr. W. Hedley King It is interesting to note that Mr. Paxman and his son hold the bulk of the shares, the remainder being held by members of the staff. The company devote practically all their attention to the manufacture of steam engines and boilers, air-compressing machinery, mining, and pumping plants, etc., a very large amount of work being done for foreign accounts.

Work was in full swing at the time of the inspection, about 900 men working overtime. The round of the works, which are shown in plan in Fig. 1, was commenced at the pattern stores, a fireproof building covering an area of 12,500 square feet. The patterns here represent 300 complete sets of engine patterns, from 2 h.p. to 1,500 h.p., as well as the other patterns used in the multifarious manufactures on which the firm are engaged. Every pattern is entered in a book of reference, giving the location of the pattern, and whether it is in the stores or in use, so that all patterns can be promptly found with the minimum of trouble. The pattern-making shop, which next claimed attention, consists of three bays, each 90ft. long and 30ft. wide, with a gallery at the further end. The customary labour-saving tools in use in this department are of modern type, and consist of circular saw, band saw, planing machine, lathes, etc., so as to reduce the cost of production of this class of work.

From the pattern shop a move was made to the iron-foundry, the older portion of which covers an area of about 20,000 square feet, divided into three bays, each 45ft. wide. A new extension has been added on the east side of the foundry, which is 140ft. long by 45ft. wide; and in addition, a fettling shop, 70ft. long by 30ft. wide, has been built. The foundry is fully equipped with lifting appliances, cupolas, core stoves, sand mixing and preparing machines, loam mills, etc. The travelling crane in the heavy bay is driven by a square shaft, and capable of lifting 20 tons. There are two core stoves on the south gable of the foundry, each 40ft. long by 20ft. wide, one of which is heated in the customary way with open fires, and the other on an improved down-draught principle. The hot gases are delivered in the top of the stove and the cooler gases are taken away by grated conduits running athwart the floor. This method prevents the cores being sweated when the core stove cools down, and is economical in the use of fuel, the correct laws of convection being duly observed therein. The system of mould drying employed in this department attracted special attention. This consists essentially of an induced draught delivered into covered green sand moulds, whereby dry moulds are obtained without the wasteful and inconvenient use of open fires. The cupolas at the far end of the foundry are capable of melting, as a maximum, 10 to 14 tons of pig iron per hour. At the south-west corner of this department is situated the brass-foundry, proceeding through which the visitors entered the power-house and boiler shop. The older portion of the latter is 400ft. long in two bays of 45ft. each, on to which extensions have been made, continuing the same width of bays for an additional 180ft., thus making the total length of the boiler shop 580ft. One end of the shop is devoted to store purposes and flanging. On the left-hand side, entering from this end, was noticed a "Colchester" compound engine, which furnishes the major portion of the

Digitized by Google

power for this department. There are two flanging furnaces in use and another in course of construction; also one flanging press, capable of taking a plate 8ft. 4in. wide and of exerting a maximum force of 120 tons. The larger press, recently erected, is 11ft. 4in. clear between the columns, and is capable of exerting a maximum force of 300 tons.

Proceeding in an easterly direction from the flanging department, the machine section of the boiler shop was entered. Here numerous fine tools were noticed economically performing a variety of operations in the preparation of the detailed parts of boilers. Amongst the special tools which claimed particular attention was a radial drill, fitted with an attachment for cutting out two holes at the same time in the tube-plates. Also a combined turning mill and boring machine, employed in turning up the flanged ends of boilers and cutting oval holes for man and mud holes. Continuing along the shop, a fine set of vertical rolls was observed, suitable for rolling large boiler shells of heavy scantlings; and beyond this a plate-edge planer, capable of dealing with plates 28ft. long at one setting. Adjacent to this is a multiple boiler shell-drilling machine, capable of drilling four holes at once indiscriminately on the longitudinal and circumferential seams, while opposite is a flue-drilling machine for drilling three holes at the same time in flue joints, arranged so that the pitch of rivets and radial position of the drills can be varied to suit the riveting for the different pressures. Further on, an interesting machine devoted to rolling out the Paxman patent flue joint, of which many thousands have been made, and are giving complete satisfaction, was seen. A considerable variety of pneumatic caulking, drilling, and tube expanding appliances were also noticed. Entering the new extension, the hammers for welding flues were examined. Behind the flue hammers is the hydraulic riveting section, arranged conveniently for dealing with all sizes of boilers. The cranes in this section are designed for loads of 5, 10, and 15 tons respectively. The rest of the new bays are devoted to riveting and finishing the boilers, of which many good examples were in evidence, notably four 9ft. 9in. diameter Paxman "Economic" boilers specially built for electrical power requirements. The cranes in this section are designed for loads of 10 and 25 tons respectively.

With regard to the "Economic" boiler it may be said that this for years has been one of the firm's principal specialities, and has been manufactured in large numbers for electricity supply stations and for many other purposes. It is of the Scotch dry-back type, with some valuable improvements patented and introduced by Mr. James Paxman, notably the arrangement of the two groups of return tubes, which are arranged so as to give the maximum heating surface, and at the same time to admit of complete internal inspection and scaling of the boiler without removal of any tubes or stays. In positions where economy of space is an object of importance—and this condition is practically always a feature of electricity supply stations—the "Economic" boiler has a great advantage. The tubes are cleaned and withdrawn from the front—that is, in the stoking space, so that the boilers can be placed against a dead wall. Further, the boiler has the well-known advantages of a large water capacity—viz., there is a large store of power contained in the form of heated water, of which a part is always available for sudden demands. The large surface at the water-level provides for the perfect disengagement of steam without danger of carrying entrained water with it, thus ensuring dry steam. This large water surface also provides against rapid fluctuations in the water-level, and, in fact, combined with the considerable variation in water-level which is admissible with this type of boiler, allows of great latitude in the supply of feed water and in the working conditions generally. The construction of this boiler provides for ample grate area, a large and very efficient combustion chamber, and ample heating surfaces, so that the very best evaporative efficiency is obtained. Fig. 2 shows the general appearance of the "Economic" boiler.

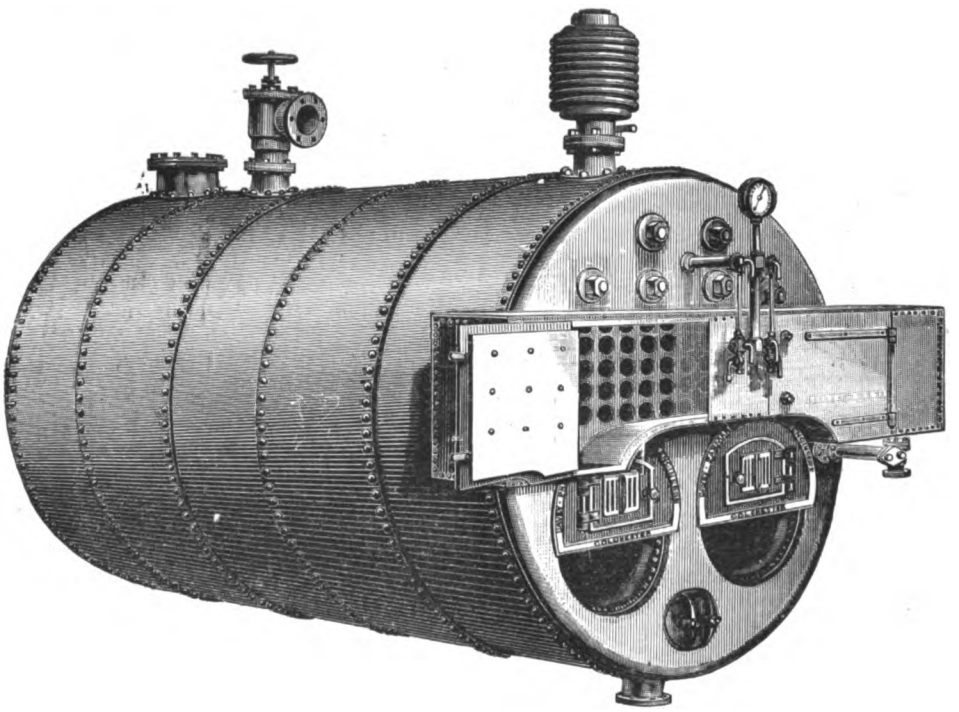


FIG. 2.—Elevation of Davey-Paxman's Economic Boiler.

To those who are not already familiar with the good qualities of this type of boiler, we strongly recommend inspection and enquiry.

(To be continued.)

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

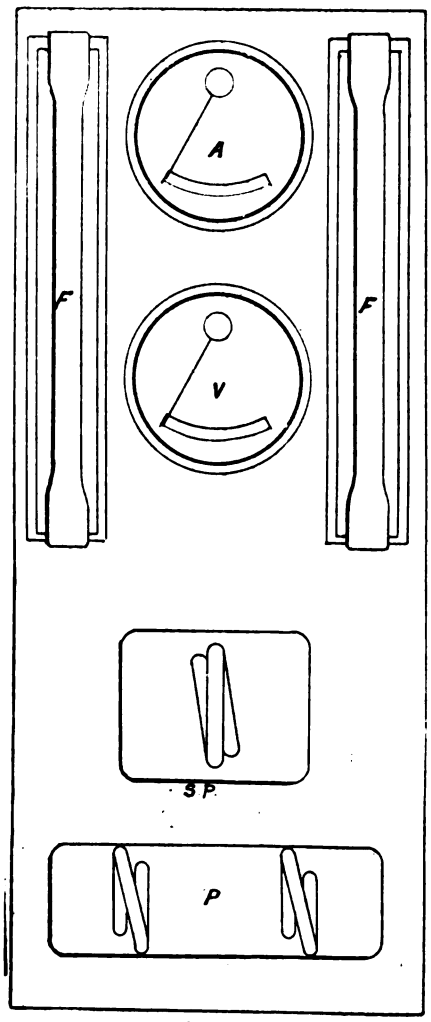
(Continued from page 229.)

CROMPTON.

A form of high-pressure panel constructed by Crompton and Co. is shown by Fig. 17, in which P is the main plug switch; F F, main fuses; A, primary ampere meter; V, machine voltmeter, and S P synchronising plug. The fittings are mounted on a slate slab which is fitted into a teak or mahogany framework. The plug switch is shown in detail by Fig. 18. It is of the double-pole type and arranged lengthwise, so that there is little prospect of the

Digitized by Google

machine being short-circuited by arcs drawing together when the plug is opened under current. The plugs are mounted on an ebonite base set in a wood foundation, and are provided with suitable handles. Contact is made with



IG. 17.—Crompton Panel.

the socket by means of a copper loop bolted to the plug, and the flexibility of this loop ensures a good connection between plug and socket. Should the copper become burned by sparking, it may be easily renewed. The plug is covered with ebonite for a considerable length, to prevent

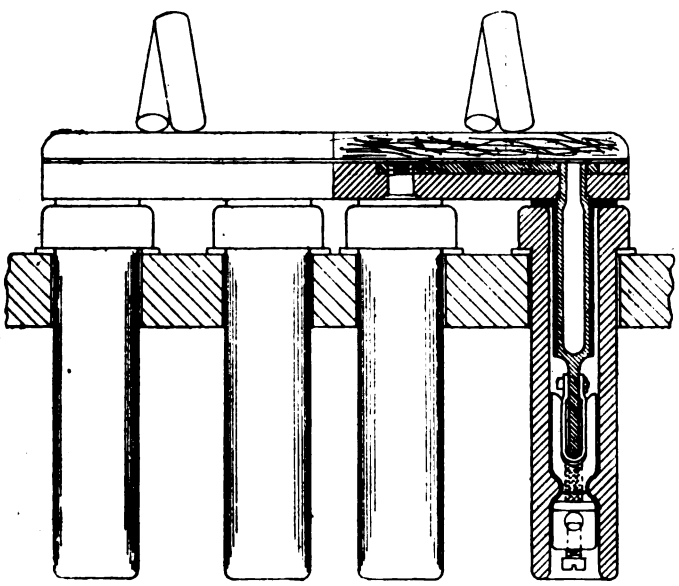


FIG. 18.—Crompton D.P. Plug Switch.

accidental contact when the switch is being withdrawn. The sockets are sunk deeply in stoneware tubes fastened to the slate by screw bolts, the cable connection at the back being well recessed, also, to render the back of the board as safe as possible. The fuse consists of two contacts placed at each end of a stoneware trough and coupled together by spring clips mounted in a porcelain bridge (Fig. 19). The fuse is drawn, or rather threaded, through holes in this bridge, so that the circuit might be opened without an arc forming between the terminals or clips. The shanks on the contacts are carried through holes in the slate having a large clearance, and bolted to porcelain washers, thus ensuring good insulation. The sweating sockets fastened to the shanks are covered with teak protectors, thus guarding the high-tension portions thoroughly. It will be seen that the above switch and fuse are provided with contacts, which may be renewed quite apart from the fittings attached to the board. This is a distinct advantage, and will be evident when a fuse, clip, or plug contact, through overheating or sparking, become damaged and need replacing.

In making up a complete board, the panels shown in Fig. 17 are grouped together in one framing, with dynamos and circuits on either side of a central synchronising panel.

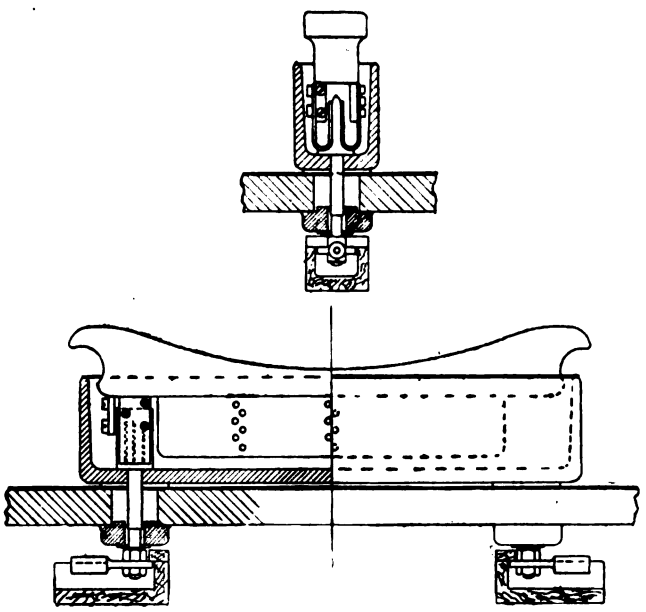


FIG 19.—Crompton H.P. Fuse.

Each alternator is provided with a double-pole plug, by which it could be connected to the synchronising panel, and at this panel it was coupled to the 'bus bars through a pair of light fuses. When the machine had been successfully synchronised, the main plug switch was closed. The exciter panel was placed below each machine panel, and contained a rheostat, ammeter, and fuses. In the centre of the board, beneath the synchronising panel, was arranged the main exciter panel, on which were mounted switches, fuses, voltmeter, and shunt resistances for running exciters in parallel.

Digitized by Google

In connection with this last arrangement, minimum current cut-outs were provided, and in case an exciter failed from any cause it was automatically disconnected. Messrs. Crompton have equipped several stations in this country with alternating-current apparatus.

Lowrie-Hall.

Messrs. Fowler and Sons, of Leeds, equipped many of the early electric lighting stations both with machinery and switch gears, which latter have had a very extended use. They constructed gears of the collected type, making a very neat arrangement of the board. Their main switch of the plug class is shown in Fig. 20, where both plug and sockets are represented.

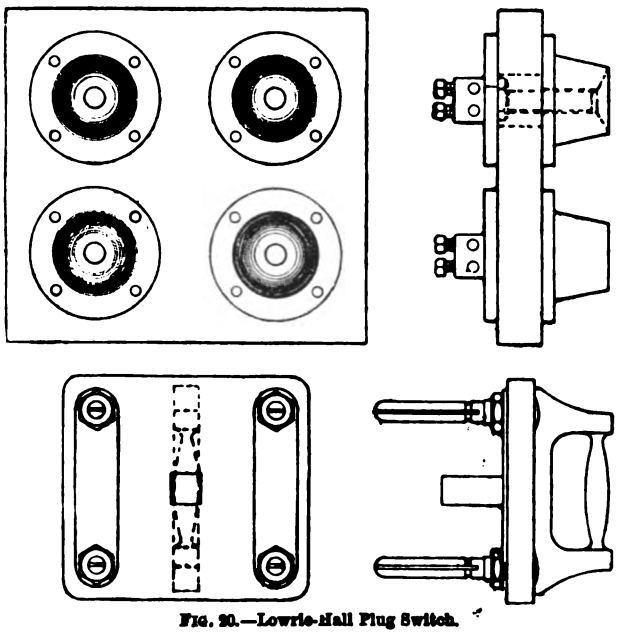


Fig. 20.—Lowrie-Hall Plug Switch.

The sockets are mounted in porcelain insulators, which are fixed to a slate slab of standard dimensions, so that other apparatus, when brought together to form a panel, will occupy the same width and height. Fixed into an ebonite slab are the plugs sawcut down their length to improve the contact, and each pair coupled together by a copper strip. A handle for the insertion of the plug and stop to prevent it going too far complete the switch. The sockets occupy the corners of a rectangle, so that the plug may not be put in the wrong way and short-circuit the two poles.

A main fuse of long break taking place in air is shown in Fig. 21. The contact sockets are fixed to porcelain insulators, very similar to those used in the plug switch, and they are sawn down the one side to allow the fuse plugs to be inserted. These plugs, which carry projections provided with screws for the fuse wires, are mounted in ebonite handles. When in position the fuse wire is recessed in a thick slate, and the arc produced by the blowing of the fuse tends to travel outwards and upwards. With this type the fuse could be renewed by short-circuiting the terminals at the back, but a more recent make has the fuse plugs fitted to an ebonite base with handle, the fuse wire being covered with asbestos. A short-circuiting plug is provided with this latest example to facilitate the renewal of the fuse. Fig. 22 illustrates a slate base fitted with plugs and instruments for synchronising the alternators. Each socket, which is of the concentric type, is connected to the secondary of a transformer whose primary is placed across the terminals of one machine—*i.e.*, each machine has its own synchronising transformer and socket. When two machines are to be paralleled the plugs are placed in the sockets corresponding to the alternator numbers, and as these sockets are connected to half the secondary of each transformer, the insertion of the plugs connects these secondaries in series with one another. The lamp and voltmeter are arranged to be in parallel with the two plugs, so that when co-phasal running of the alternator is attained the lamp burns steadily, and the voltmeter reads 100 volts (unless another pressure be desired).

The regulation of the exciting current is carried out by means of a circular rheostat mounted on a slate of similar width to the slabs on which the instruments above described are fixed. A wood framing is screwed to the back of the slate, with a porcelain base fastened to the end of the frame farthest from the slate. The resistance wires are arranged on this porcelain base, and are coupled to the rheostat stops direct without the intervention of cables. Should there be no room for these frames at the back of the board, they are placed in any convenient position and connected to the stops by cables. Messrs. Fowler also arrange these rheostats to form a table in front of the switchboard, providing the ammeters and field switches on the same arrangement, thus keeping the low-tension circuits apart from the main high-tension framing.

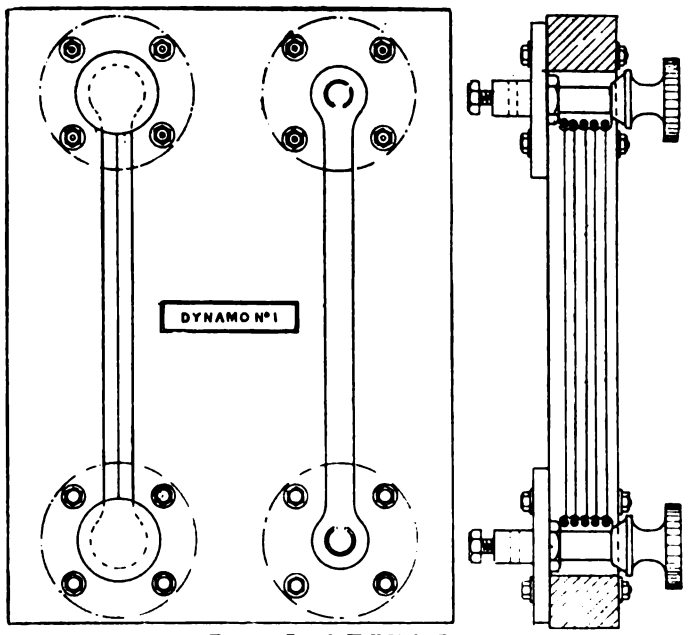


Fig. 21.—Lowrie-Hall Main Fuse.

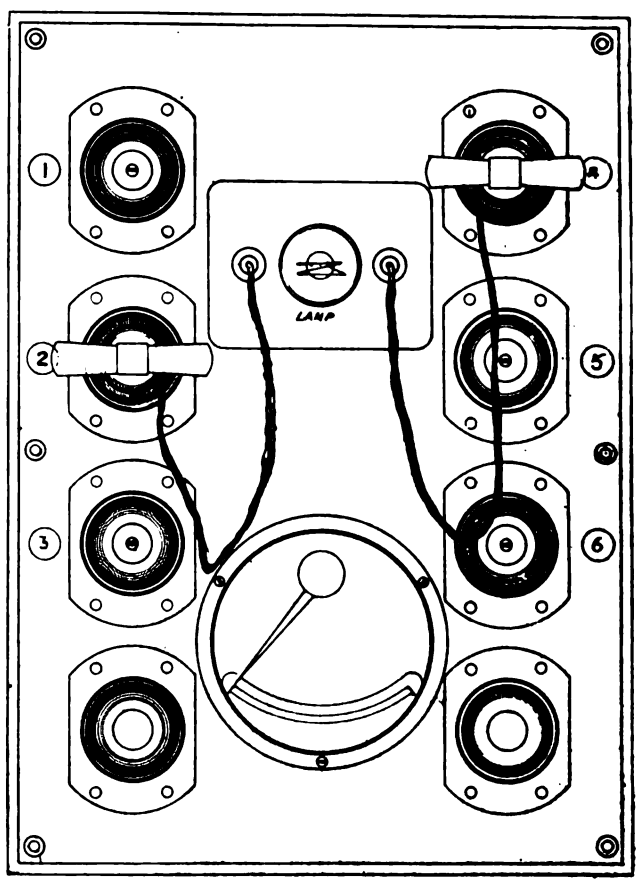


Fig. 22.—Lowrie-Hall Synchronising Base.

(To be continued.)

Digitized by Google

THE RAILWAY AND THE TELEPHONE.*

The substitution of the telephone for the Morse system in the intricate details of the manipulation of traffic has not been encouraged to any considerable degree, but sufficient progress has been made since the last meeting of this association to warrant the belief that the process of evolution has commenced, and that from this time forth the prejudices and uncertainties that have long obtained in opposition to the introduction of the telephone will gradually dispel themselves. I am quite confident that the more you investigate, the more you will be convinced of its availability for all the requirements of railway operations and astonished by its greater elasticity. This latter qualification insures, as a necessary sequence, the most important desideratum—greater safety. Complex situations can be met and determined immediately without the intervention of third parties, verbal negotiations between the various departments regarding the manipulation of traffic can be carried on with the facility and ease of ordinary conversation, though great distances intervene. To obtain these facilities and accomplish these results naturally involves expense, but the expense bears as little proportion to the results as does oil to the operation of the ponderous locomotive.

The telephone develops a new field and performs a new mission. It does not necessarily interfere with the telegraph only in so far as the telegraph falls behind in the race for superiority by failing to develop the new uses to which it might be put. As the situation appeals to me, the telegraph is fast relegating itself to the simple transmission of news, and positive and negative or confirmatory information, too important to be trusted to the slow-going mail service, and not sufficiently important to justify the employment of the telephone. A telephone communication is more or less a personal or private one, and does not involve a third person, and has advantages over any method of transmission. Distances, time, business considerations, and personal discomforts of travel are all eliminated.

It is frequently asserted and generally believed that the telephone is ill adapted as a substitute for Morse in the manipulation of railway traffic. As an old telegrapher, I had strongly held to this opinion, but with the knowledge of what has been done, and a more thorough consideration of the subject, I am a firm believer in the superiority of the telephone. Railway people are too apt to judge the possibilities of the telephone by the crude systems they instal and operate rather than by the standard of the system familiar to the telephone expert. As one of the superintendents frankly stated in his remarks before this association at a previous meeting, referring to certain experiments with regard to simultaneous telegraphy and telephony which he had been making in a desire to furnish satisfactory telephone service to his company, "I don't suppose inductive noises to them (railway employés) was any objection. I know our people would not for a moment tolerate any such noise as that on a telephone circuit, because they were accustomed to the long-distance service, and you know what that is."

Assuming that a railroad is equipped with a standard system, it is pretty safe to say that there is no part of the service but what can be handled more economically, more rapidly, and with greater safety by telephone. A large percentage, if not the entire transmission of service, would be performed by the practical railway operatives, men more familiar and more experienced in the operation of a railway than telegraph operators, many of whom are mere boys, preferably employed because of the small compensation the position justifies. In the use of the telephone every operator becomes, to all intents and purposes, a qualified operative, the switchman equally with the track foreman.

If you instal a system in the manner that obtains on the New York, New Haven, and Hartford road, your regard and opinion for the Morse system will dispel itself. The rapid introduction by railway companies of private branch exchanges is bringing you nearer and nearer to the very scheme of railway operation just alluded to. As these exchanges are established at one point and another the demand becomes more forcible to hitch them up tandem from one end of the line to the other, and the first thing you realise you are operating your system by telephone, and it becomes an indispensable feature. At the same time, you are woven into the great intercommunicating system.

The obstacle to the installation and expansion of this service is primarily its cost, but in considering this cost you should concede there is a factor of expense in the maintenance of wires and stations, established by long experience, below which telephone organisations in the business to stay cannot go. It costs more to ride than to walk, more to telephone than to telegraph, more to telegraph than to write—but weigh the difference! If your general manager had the peculiar and exclusive ability of making every official or employé subject to his control, hear his voice and command, without the interposition of third parties and without the detail of correspondence and red-tape, what would his services command in the railway market? The private branch exchange and its connecting links provide him with this qualification, and it is not reasonable to assert that the employment of these acquired talents moves the wheels of commerce with infinitely greater rapidity, less friction, and with wonderful economy of time? There is no red-tape involved in telephone transmission, greater privacy and secrecy is assured, but, above all, elasticity of operation is the predominating advantage in the railway service.

Ian McLaren, in expressing himself regarding America, exploits a line of reasoning worthy of your sober consideration. "No one, unless he leaves the country, or becomes a crank, can escape from this despotism of activity; he is a part of the regiment and must march with his fellows. No man goes slow if he has the chance of going fast, no man stops to talk if he can talk walking, no man goes in a trolley car if he can get a convenient steam car, and by-and-by no one will go in a steam car if he can be shot through a pneumatic tube. No one writes with his own hand if he can dictate to a stenographer, no one dictates if he can telegraph, no one telegraphs if he can telephone, and by-and-by, when the spirit of American invention has brought wireless telegraphy into thorough condition, a man will simply sit with his mouth at one hole and his ear at another and do business with the ends of the earth in a few seconds, which the same machine will copy and preserve in letter books. It is the American's regret that at present he can do nothing with his feet while he is listening at the telephone."

* Extracts in the *Railway and Engineering Review* from a paper prepared by Henry W. Pope, general manager, Bell Telephone Company, and read before the meeting of the Railway Telegraph Superintendents' Association, Detroit, Mich., June 20, 1900.

LIVERPOOL TRAMWAYS TONTINE.

The following report has been sent to us. It is of considerable interest to all men who join such societies. We have, however, to point out most emphatically that the question of solvency or insolvency does not seem to be really touched by the report of the inspector. The question of solvency of any friendly society is a question for actuaries, not for accountants, and many a society is insolvent whose books show a bank balance of hundreds and even thousands of pounds. Hence we should prefer to see an actuarial examination before whitewashing any friendly society's books:

The inspector appointed by the Registrar of Friendly Societies to examine into the affairs of the Liverpool United Tramway and Omnibus Employés' Friendly Society has presented the following report:

"There were present at the enquiry, which was held in Liverpool, the three applicants—viz., Messrs. John Fleming, John Dawson, and Frederick Coward; the secretary of the society, Mr. George M. Bednal; and one of the trustees, Mr. John O'Neill; and Robert Tilston, clerk to the auditors (Messrs. Harmood, Banner, and Son). The following strangers were, with the permission of both parties, also present—viz., Mr. F. Peacock, trade union secretary, representing the applicants, and himself a late member; Mr. Wright, solicitor, representing

Digitized by Google

the trustees; and Mr. Pierce, assistant town clerk, representing the Corporation. All the witnesses were examined under oath.

"The society was formed under the auspices of the late Liverpool Omnibus and Tramways Company, mainly with the idea of avoiding a threatened strike. The company made it a condition of employment that all their employés should join the society, and it was a rule of the society that none but employés of the said company could become members of the society. The tramways company used to make an annual donation of £200 to the funds of the society, but on the winding-up of the company consequent on the transfer of the properties to the Liverpool Corporation, the donation ceased. The Corporation wished to continue the donation, but had no powers under the Act, and have therefore been endeavouring since then to found another society of their own. They still deduct from the wages of each man his contribution to the society, and this action of theirs was the subject of a test case in the county court lately. The opposition to both society and Corporation, and also the application from which this inspection results, emanates from the secretary of the trades union, and it is evident that the action taken against the society is only an episode of the real fight on other issues between the Corporation and the trades union. As to the allegations:

"Sick Pay being Stopped without Notice.—It appears from the evidence that the payment of sick pay by the society was discontinued for three weeks during September last, but the only witness produced acknowledged receiving the full amount of arrears at the end of that time. No notice was given to members, but the society points out that notice is required to be given.

"That the Society is Practically Insolvent.—As to the alleged insolvency of the society, the society at the present time is quite solvent. At the end of the year they were solvent, and also at March 31 last, as shown in balance-sheets produced to me by the auditors. The only evidence of insolvency is contained in a resolution proposed at a special general meeting of the society at which the directors of the society declared it insolvent. As a matter of fact, being a tontine, it is periodically without a balance in hand after paying the dividend at Christmas.

"All the complainants asserted that the society was insolvent in 1899, but acknowledged having received a dividend at the end of that year, and expected one this year. They could none of them give any evidence of the society's insolvency except in the matter of the arrears of sick pay for three weeks during September last.

"To ascertain as to what purpose the funds of the society have been placed.—From the reports of the auditors, the books, and the evidence at the enquiry, I am convinced that the funds have been disbursed in accordance with the rules—*i.e.*, in paying the expenses of the society in sick pay and death claims, and dividends at the end of the year. The applicants made the assertion that 'contributions and levies are forced from men who are not members of the society.' This is true, but the officers of the society claim that it was done unwittingly on their part. It is a fact that some members have not passed the medical examination required by the rules, and there was at least one acknowledged case where the society returned subscriptions to a man.

"There was also put in evidence a decision of Judge Collier in the County Court of Liverpool ordering the Corporation to repay to the plaintiffs the sum of 5s. and costs, on the ground that they had been collected from him by a society which was not legally in existence. The judge argued that, as the society was limited to employés of a company now dissolved, there could be no society and no members. This case is now the subject of an appeal.

"Regarding the question of proper books being kept, the auditors in their evidence professed themselves quite satisfied. None of the applicants had ever required the books to be produced to him, but the secretary of the trades union, Mr. F. Peacock, asserted that he had once done so, but acknowledged that on being asked to come next day, as the books were at the residence of one of the officials, he had not pressed the demand, and had not asked again. My own opinion, derived from an inspection of the books and the evidence of the auditors' clerk, was that proper books were kept.

"To sum up, after going carefully into the papers and evidence, I do not consider the applicants to be justified in making these complaints and calling for this enquiry. The society's books are in better order than those of most friendly societies. I do not consider it badly managed, and the insolvency, if it can be called so, was of very short duration, and the allegation of membership being forced is a question of law, and is at present *sub judice*. . . . I recognised at the enquiry that the applicants were opposed by a very capable solicitor, and did all in my power to help them, cross-examining them so as to get at all their evidence, and doing what I could to place them in as favourable a position as their opponents.

"(Signed) E. S. GOULDING,
"Incorporated Accountant, Inspector."

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

301. In installations on board ships working with only one insulated wire, and using the ship as the return, which pole of the dynamo should be connected to the ship?—T. P.

302. How would you determine the proper size and lifting power of a travelling crane for an electric generating station?—J. A. S.

ANSWERS.

Question No. 293.—Is it possible to wind the shunt and series winding of a compound dynamo on separate formers in such wise that it shall be possible to remove either the shunt or series field winding without disturbing the other?

Best Answer to No. 293 (*awarded* 10*s.*).—The modern practice in compound-wound machines is to wind the series turns over the shunt. This method has been adopted for two reasons—viz, the usual small size of the shunt wire enables it to be easily brought through the series up to the terminal, while, especially in heavy-current dynamos, if the series be wound at the bottom, there would be great difficulty in bringing the end neatly up to the terminal, and the shunt wire would be greatly disarranged; and secondly, the series turns are very few in number, and in case of any breakdown it is easier to take off the few series turns to get to the shunt, than it would be to unwind the many shunt turns to get to the series if necessary.

From an electrical or magnetic point of view it is indifferent which is the outer. The magnetic effect is inversely proportional to the square of the mean distance the magnetising coil is from the iron core; hence with the shunt next to the iron the main magnetising coil is in its best place, whilst the compensating or series turns, on which depends the regulating of the voltage with varying loads, is in its worst position, being far removed from the iron. Change the position of the two windings and the disadvantages are simply reversed, not removed, the main coil being placed now at a distance from its work.

Consider a straight bar of iron 18in. in length. Suppose a coil of 1,000 turns 6in. long be wound and placed upon it, and a current of five amperes passed through it; the coil will now cause the bar to become an electromagnet of a certain strength, and this strength will not be altered in whatever position the magnetising coil be placed. The result is in nowise changed if the bar be bent into a U or horseshoe shape; the coil might then, equally, be placed on either limb or the yoke. Therefore, in a bipolar dynamo the shunt winding might be put into one coil and placed on one leg and the series winding on the other. There are two or three objections to this course, such as the unsymmetrical appearance of the machine, and also the fact that to accommodate the total number of turns which now must be put in one coil, the magnet leg must be made very much longer than is necessary when the turns are wound in two coils, or else the coil must be wound proportionally deeper. The objection to this latter course is serious, as not only is the cooling surface considerably diminished, but the amount of heat to be dissipated increases with the depth of winding, and also the mean distance of the coil from the iron core is increased. Although a bipolar machine has been taken for illustration, since a multipolar dynamo may be regarded as a series of bipolar ones, the above remarks will apply to any type. It will be seen that this method, while practicable, is not advisable.

Digitized by Google

Another method would be to wind both the series and shunt each on two formers, and fit one of each—it does not matter in which order—on each leg. The only objection to this course is the waste of valuable cooling space occupied by the double former. If, in place of withdrawing one winding entirely from the machine without disturbing the other, it is needful to arrange the parts so that either the series or shunt coils may be unwound without interfering with the other, there is a simple solution of the difficulty; one former for each leg is made, and the shunt is wound along a certain proportion of its length, and the series is made to fill up the residue. The diagrams show a simple method of winding the series when this consists

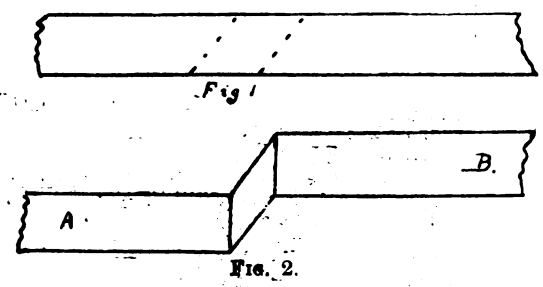


FIG. 2.

of a heavy strip. In order to prevent the unsightly appearance which would be caused by the connecting end of this thick material being taken to the bottom of the coil, halfway along the series strip it is bent along the dotted lines of Fig. 1 into the shape shown in Fig. 2. This is laid on the middle of the winding space, and the end marked A is wound in a right-hand direction, and B in a left-hand direction, which will cause the current to flow in the same direction through the coil; after the completion of the first layer, the two unfinished ends of the strip will be at the ends of the winding length, at the completion of the second they will meet at the centre, and so on. It will be advisable, in order to obtain a good appearance, to arrange the turns per layer in such a way that when the work is completed the ends are at their greatest distance apart. This is a method which has been adopted by more than one of the best dynamo builders. With this arrangement the cooling surface of the shunt is only slightly decreased, and compensation is afforded for this by the more open circulation of air, as the coil is not covered by the series, while if the mean distance of the coil is increased, that of the series is decreased, and they are both put on an equality in this respect.—M.

Answer to No. 293 *(awarded* 5*s.).*—Although in most compound-wound dynamos it is impossible to take, say, the shunt coil off the magnets without disturbing the series coil, it is possible to so wind them on separate formers that either coil may be removed without disturbing the arrangement of the other coil on its former. The compound winding may be arranged either as in Figs. 1 or 2, where A A = shunt coil, B B = series coil, C = core of dynamo. A A may be arranged inside B B in the first figure if required. For the first arrangement I have seen the following device on a small dynamo. A frame was made of sheet brass sweated together of the shape shown in the figure, to receive the shunt coil. When the coil was

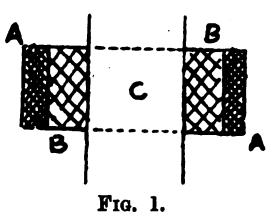


FIG. 1.

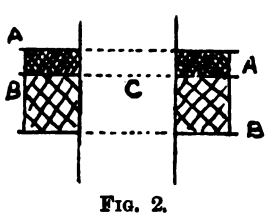


FIG. 2.

wound on the frame, additional L-shaped pieces were sweated to the outside corners, as shown at one corner by dotted lines. A similar frame without the outside corner pieces, of a size to slide over this shunt frame, was made for the series winding. The outside corner pieces of the shunt coil frame acted as guides for the series coil frame. Before the windings were placed on the frames, the latter were taped with Blackley tape, and the end flanges covered inside with pressspahn. The shunt coil was in this case placed inside the series, as the smaller size wire could be wound flatter than the large. It is, of course, necessary to unship both frames if the shunt winding is to be rewound.

There is a similar objection to arrangement Fig. 3—one coil must be shifted to get the other off. There is, however, the advantage that the mean perimeter of both the coils is the same, and so the electric circuit is reduced in length as much as possible in both coils. The arrangement simply consists of two coils ranged one above the other, mounted on ordinary formers. The cheeks of these are often of wood; in this case the top cheek is used to mount the gunmetal terminal blocks.

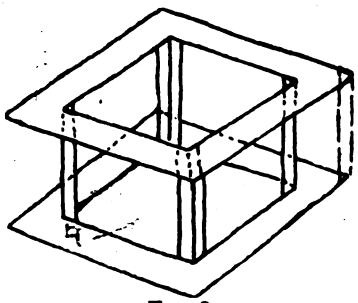


FIG. 3.

The Electric Construction Company have a very neat arrangement of coils in their continuous-current transformers, by means of which either series or shunt coil may be moved without touching the other coil. It consists of having two entirely separate magnets—one being series-wound, the other shunt-wound—ranged side by side along the armature's axis, and designed in due proportion to the series and shunt magnetic fluxes required. Any shifting of the centre of the magnetic field along the axial length due to relative variation of series and shunt currents is so slight as to be negligible.—J. A. S.

Answer to No. 293 *(awarded* 5*s.).*—Winding the shunt and series fields on formers, as suggested in the question, is by no means difficult. It is uncommon in practice, as any slight advantage that might be derived from so doing is more than counterbalanced by the increased expense involved. The writer has come across only one case in point—that of an experimental machine arranged for running under conditions of induction and compounding which could be varied at will, principally for demonstrating purposes. Fig. 1 shows the type of former used. The body of the bobbin was made by bending up a strip of galvanised sheet iron of 16 gauge into the form of a rectangle and riveting the ends together. The seam is arranged so that it falls in the centre of one of the sides, as shown at J. The flanges were also cut from the same sheet, angled and riveted to the body, as shown. The bobbin thus formed was then insulated and wound in the usual way. Fig. 2 shows windings in posi-

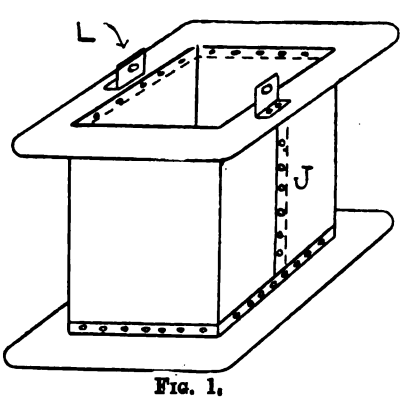


FIG. 1.

tion. The shunt bobbin, S, has been slipped over the magnet limb, and rests on two brass brackets, B. With this bobbin in position, a similar bobbin, on which the series winding has been placed, is slipped over the shunt bobbin and rests on the same brackets. The ends of the windings are brought out on to two terminal boards, T and T_1, one on the magnet limb and the other on the yoke piece. The bobbins are further secured to the limb by means of set screws and the lugs, L (Fig. 1). The machine in question was provided with several sets of

Digitized by Google

interchangeable field coils. To make use of these it was simply necessary to disconnect at the terminal boards, remove the yoke, and lift out whichever coil was to be changed. The machine was also provided with making-up

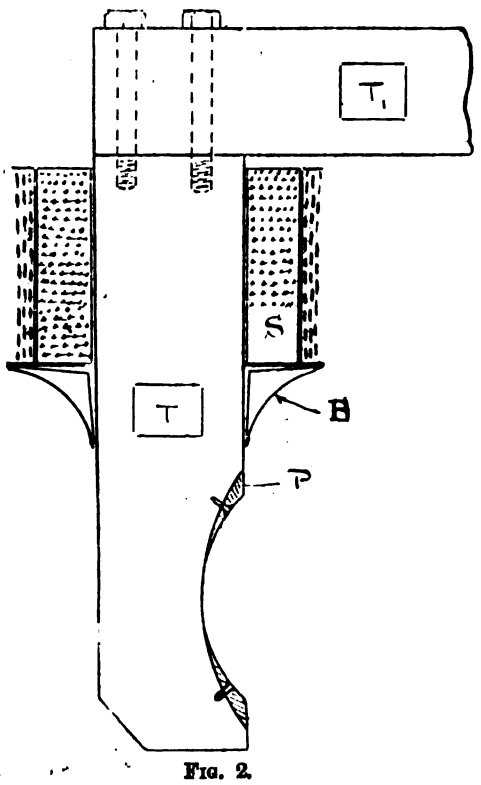
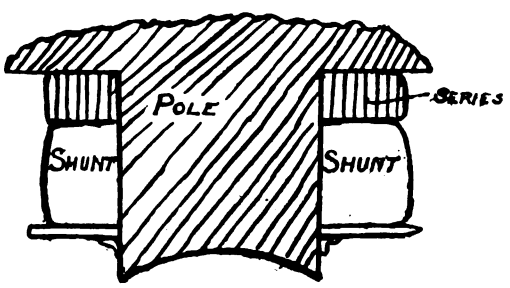


Fig. 2.

pieces, P (Fig. 2), for use with armatures of different diameters, which also formed part of the outfit, the yoke being so arranged that the distance between the magnet limbs could be varied to suit requirements.—P. S. T.

Answer to No. 293 (*awarded* 5*s.*).—A method of winding series and shunt so that each can be moved independently is shown in the figure. This method is adopted by Mavor and Coulson in their multipolar machines. The coils are not wound on formers, but are built up with tapes. When the coils are wound, they are wrapped over with tape and then varnished. This method is cheaper than using formers, and a brass plate holds the coils in position on the poles. The series winding consists of several layers of tape wound broadways, each layer being insulated. When wound, the series is put on first, then the shunt winding. This looks very neat on the machine. Of course,



it is possible to wind the series on a former and the shunt by means of tapes, as above, and then slip the series over the shunt. In either of the above cases the coils would have to be moved in case of accident to the series or shunt, but from the question it appears to indicate that an easy way of removing either shunt or series is required. A case occurs to mind where the series of a machine, wound in the ordinary way, shorted with the frame, and both shunt and series had to be rewound, but if the above had been adopted, this would have cost far less to repair.—F. M. Moody.

Question No. 294.—Is there any electrical device that will automatically keep the pressure constant with varying loads on battery regulating cells? If so, describe and illustrate same.

Best Answer to No. 294 (*awarded* 10*s.*).—A device for automatically keeping the pressure of a storage battery constant is shown in Fig. 1. The solenoid, A, has a coil of very high resistance, which is connected across the mains. The core, B, is drawn down into the solenoid against the resistance of spring, C. Connected to the solenoid, B, is an arm, D, which moves two wheels, K K1, which are keyed on to a spindle, E. These wheels are free to move in a horizontal position, but when revolving move the spindle, E, which by means of the thread and nut, F, move the contact, G, over the various contact blocks. Revolving power is transmitted to the wheels by means of a friction wheel, H, which is worked by a small motor.

Fig. 1.

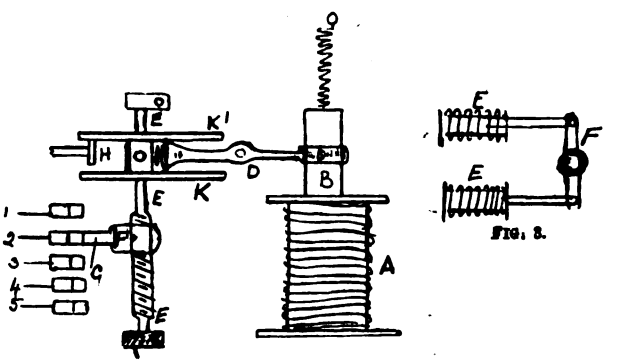


Fig. 3.

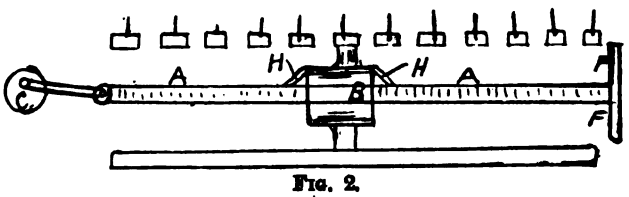


Fig. 2.

The principle upon which this apparatus works is as follows: The resistance of the coil, A, being constant, the magnetic pull on the core, B, depends upon the variations of the pressure. The solenoid, A, upon any variation attracts or allows the core to slip; this in turn moves the friction wheels against revolving pulley, H. By this means the contact block, F, is moved over the contacts, cutting out or putting in cells to keep the pressure constant. The apparatus in use at the County of London Electric Lighting Company's City-road station for the same purpose is of an interesting type, and requires a special switchboard. This board has two rows of charge and discharge blocks gripped on both sides by contact brushes, which grip long connecting bars. The brushes are carried on massive steel bars, and are free to slide along, thus varying the number of cells connected. The charge is set by hand, but the discharge is worked automatically in the following manner: Referring to diagram Fig. 2, the steel bar, A A, on which the discharge brush carrier, B, is fixed, is caused to oscillate to and fro by means of a crank, C, driven by a small motor. If the pressure should rise or fall, a delicately adjusted relay, consisting of a solenoid in series with an adjustable resistance connected across the mains, actuates a mercury switch, which causes a large current to flow through one or other of two solenoids, E E, causing a partial rotation of the bar, A A, by means of the arm, F. The bar, A, has two sets of notches, one on each side, and this partial rotation brings one or the other sets of notches into gear with the pawl, H, on the brush carrier, and the contact brush is carried rapidly forward or backward, until the normal pressure for which the relay is set is restored.—F. M. Moody.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ilford.—The Urban District Council invite offers for free wiring. Tenders by 29th inst.

Lincoln.—The Town Council invite tenders for wattmeters and demand meters. Tenders by Sept. 14.

Hamburg.—Two 30-ton electric cranes are required. Enquiries may be made at the Town Hall. Tenders by Sept. 10.

Preston.—Tenders are invited for the electric lighting of the Preston and County of Lancaster Royal Infirmary. Tenders by Sept. 1.

Digitized by Google

Hampstead.—The Vestry invite tenders for various plant for their central station, Lithos-road, Finchley-road. Tenders by Sept. 27.

Worksop.—The Urban District Council invite tenders for the erection of electricity supply works in Canal-road. Tenders by 27th inst.

Plumstead.—The Vestry invite tenders for the supply and erection of various plant and machinery for electricity works. Tenders by Sept. 19.

Worthing.—The Corporation invite tenders for the construction of a new electric generating station and alterations of buildings at the Corporation yard.

Stockport.—The Tramways Committee invite tenders for 20 double-deck tramcars, complete with electric equipment for overhead traction. Tenders by Aug. 31.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for conduits and holes for poles. Tenders by 31st inst. Details in our advertisement columns.

Oldham.—The Electric Light Committee invite tenders for the supply, delivery, and erection of boilers. Tenders by Sept. 11. Full details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of a 200-kw. steam dynamo for their electricity works. Tenders by Sept. 8. Details in our advertisement columns.

Southampton.—The Harbour Board invite tenders from crane builders for one 30cwt. portable electric wharf crane. Tenders by Sept. 10. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for the erection of a new boiler-house (all trades except ironfounder) at the generating station, Crown Point. Tenders by Sept. 3.

Middlesbrough.—The Electric Lighting Committee invite tenders for the wiring of the municipal electricity works. Tenders by Aug. 31. Full details in our advertisement columns.

Shipley (Yorks).—The Council invite tenders for steam and exhaust pipes, storage battery, switchboard and connections, and cables. Tenders by 27th inst. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for the supply and delivery and fixing of sundry pipes, feed-water heaters, etc., at the Corporation electricity works, Eldon-road, Cardiff. Tenders by Aug. 31.

Hammersmith.—The Vestry invite tenders for two single-phase alternate-current motors, coupled to two centrifugal pumps, with accessories. Tenders by Sept. 12. Full details in our advertisement columns.

Horton (Surrey).—The Asylums Committee of the London County Council invite tenders for the installation of boilers, engines, dynamos, etc., at the Horton Estate, Epsom, Surrey. Tenders by Sept. 22.

Greenock.—The Police Board invite tenders for traction plant as follows: water-tube boilers, two steam dynamos (high-speed enclosed engines), boosters, switchboard, steam and exhaust pipes, etc. Tenders by Sept. 10.

Hull.—The Electric Lighting Committee invite tenders for steam and water pipes, feed pump, water softener, etc., at their Sculcoates-lane generating station. Tenders by Sept. 27. Full details in our advertisement columns.

Southampton.—The Guardians invite tenders for the erection and completion of electrical plant and installation for the lighting of the new workhouse infirmary, Shirley Warren. Tenders by Sept. 11. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for a twelvemonth's supply of paper or fibre insulated lead-covered feeder, distributing and service cables, electricity meters, and house main fuse boxes. Tenders by 28th inst. Details in our advertisement columns.

Hackney.—The Electric Lighting Committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, public arc lamps, meters, travelling crane, and workshop equipment. Tenders by Sept. 12 Full particulars in our advertisement columns.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the following plant: lighting switchboard, traction switchboard, and balancing transformers at their new electricity works, Strawberry-road, Pendleton. Tenders by Sept. 3. Details in our advertisement columns.

Whitby.—The Council invite tenders for the following plant: two water tube boilers, pumps, condensers, pipes, etc., two steam dynamos, balancer, and boosters, switchboard and connections, battery, travelling crane, and cables, arc lamps, etc. Tenders by Sept. 3. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the supply, delivery, and erection of the whole of the plant and apparatus necessary to completely equip for electric traction their proposed power station at Vivash-road, Fratton-grove, Portsmouth. Tenders by Sept. 4. Details in our advertisement columns.

St. Petersburg.—The Posts and Telegraphs Department invite tenders for the working of the telephone systems in St. Petersburg, Moscow, Warsaw, Odessa, and Riga for 18 years from Nov. 1, 1901. Tenders by Aug. 28. All necessary particulars may be examined on personal application at the Imperial Russian Financial Agency, 107, Cromwell-road, London, S.W., on Mondays, Wednesdays, and Fridays, from 2 to 4 p.m.

Worthing.—The Corporation invite tenders for the supply and erection of the following plant: (1) three 96-kw. steam dynamos (vertical enclosed high-speed engines); (2) two boilers of the dry-back marine type, with fittings, etc.; (3) steam and exhaust, drain and other pipes, in engine and boiler house, pumps, condensing plant, etc.; (4) cast-iron manhole covers; (5) cast-iron arc lamp posts; (6) stoneware casings; (7) cable work; (8) arc lamps; (9) storage batteries; (11) balancing transformers and motor-generators; (12) economiser; (13) five-ton overhead engine-room travelling crane. Tenders by Sept. 3.

Fenton (Staffs).—Tenders are invited for works in connection with the construction of a single line of railway (2ft. 6in. gauge) from Waterhouses to Hulme End, Staffordshire (about eight miles two furlongs), and incidental works connected therewith, for the Leek and Manifold Valley Light Railway Company. Plans, specifications, bills of quantities, and forms of tender may be inspected at the offices of the company's engineer, Mr. Joseph Forsyth, Heron's Cross, Fenton, Staffs, on and after Aug. 4, and copies of same may be obtained from him. Sealed tenders must be sent to Mr. Edward Challinor, secretary, Leek, by Sept. 1.

RESULTS OF TENDERS.

Portsmouth.—An order for a 500-kw. alternator has been placed with Messrs. Parsons and Co. for the sum of £5,300.

Lowestoft.—The Electricity Committee have accepted the following tenders: Messrs. Hands, Limited, London, motors; Messrs. Geipel and Lange, Westminster, cut-outs.

Cardiff.—The Corporation have accepted the tender of the British Electric Transformer Manufacturing Company, Limited, Globe Works, Harrow-road, London, W., at £1,690, for the manufacture and delivery of 10 30-kw. transformers.

Dublin.—The Electricity Committee have recommended the acceptance of the following tenders: General Electric Company, Limited, London, compound engines, generators, etc., £33,061; Messrs. Holdsmith and Sons, Bradford, Lancashire boilers, £6 653; Messrs. Babcock and Wilcox, Limited, London, water-tube boilers, £5,278; Messrs. Holdsmith and Sons, fuel economisers, £1,060.

Bradford.—The Corporation have accepted the following tenders for the work required in extension of the electricity works, Valley-road: Humphreys and Moulson, 441, Little Horton-lane, Bradford, masons, excavators, and bricklayers; Wilkinson and Dawson, Bowland-street, Bradford, carpenters and joiners; B. Rhodes and Co., Limited, The Old Foundry, Bradford, smiths and iron-founders; Hill and Nelson, Edmund street, Bradford, slaters; Bradley, Kriscbke, and Co., Infirmary-street, Bradford, concretors and plasterers; S. Rushworth, Briggate, Shipley, near Bradford, plumber; Servent and Edmondson, Otley-road, Bradford, painters.

Barnes.—The Urban District Council have received the following tenders:

Condensing plant, pumps, oil filters and separators, feed, steam, and exhaust pipes, etc.

Cole, Marchent, and Morley, Bradford	£2,860
J. Simpson and Co., Pimlico	2,800
Aiton and Co., London	2,596
Alley and Maclellan, Glasgow	2,480
Babcock and Wilcox, London	2,239

Section F.—Overhead travelling crane.

J. Whitley and Co., Leeds	420
J. Carrick and Son, Edinburgh	265
Chatteris Engineering Works Company, Chatteris	264

Cardiff.—The Town Council have received the following tenders:

1,000 tons of rails and 40 tons of fishplates.

Compagnie Commerciale, Reunis	£10,720	0	0
Bolckow, Vaughan, and Co., Middlesbrough	10,610	0	0
Lorain Steel Company, Lorain, Ohio	9,970	0	0
W. Davis, Swansea	9 810	0	0
Barrow Hematite Steel Company, Barrow-in-Furness	9.712	0	0
Leeds Steelworks, Leeds	9,420	0	0
P. and W. McLellan, Glasgow	9,057	10	0
Dick, Kerr, and Co., London and Glasgow (accepted)	8,522	0	0
Société Anonyme Ougree, Brussels	8 370	0	0

Fishbolts and nuts (Ibbotson's patent).

Compagnie Commerciale	199	2	6
P. and W. McLellan	180	0	0
Dick, Kerr, and Co.	180	0	0
Wilkes, Limited, Darlaston	171	0	0
Ibbotson Bros., Sheffield (accepted)	170	2	0
Askham Bros. and Wilson, Sheffield	166	10	0
Patent Nut and Bolt Company, London Works, near Birmingham	148	10	0
Bayliss, Jones, and Bayliss, Wolverhampton	148	10	0

Sole-plates (Marshall's patent).

Wilkes, Limited	698	5	0
Dick, Kerr, and Co.	675	0	0
P. and W. McLellan	615	18	9
Askham Bros. and Wilson (accepted)	607	10	0
W. Davis	551	1	10
Patent Nut and Bolt Company	515	7	6
Bayliss, Jones, and Bayliss	508	14	6
Compagnie Commerciale	270	0	0

Points and crossings.

Compagnie Commerciale	614	0	0
Dick, Kerr, and Co.	398	10	0
Askham Bros. and Wilson (accepted)	355	0	0
P. and W. McLellan	341	12	9

Digitized by Google

Drain rails (Dawson's patent).			
Compagnie Commerciale	540	0	0
Dick, Kerr, and Co.	414	0	0
P. and W. McLellan	378	0	0
Askham Bros. and Wilson (accepted)	378	0	0
Tie-bars.			
Compagnie Commerciale	815	7	6
P. and W. McLellan	693	12	0
W. Davis (per ton)	16	2	6
Phœnix Bolt and Nut Company, Handsworth, Birmingham	620	0	0
Wilkes, Limited (per ton)	15	5	0
Horton and Son	585	0	0
Patent Nut and Bolt Company	578	18	9
Askham Bros. and Wilson	568	15	0
Dick, Kerr, and Co. (accepted)	565	15	6
Bayliss, Jones, and Bayliss	565	10	0
Copper bonds (Neptune).			
Dick, Kerr, and Co.	661	3	7
Felten and Guilleaume, Carlswerk, Cologne (accepted)	618	9	11
J. A. Roebling's Sons' Company, New Jersey, U.S.A.	540	12	9

BUSINESS NOTES.

TRACTION.

Birkdale.—The introduction of electric traction into Birkdale was virtually decided upon by the Council at the meeting on Tuesday night.

Portmadoc.—A special meeting of the Urban District Council will be held to meet representatives of the promoters of the proposed electric railway from Portmadoc to Beddgelert.

Royton.—The District Council are asking the Town Council of Oldham whether they are prepared to meet the District Council with regard to continuing their tramways to Royton.

Bradford.—The new branch of the electric tramways provided by the Corporation for the Lister Hills and Lidget Green district was practically completed last week, and a trial trip was run on Monday.

Croydon Tramways Co.—A meeting of the stockholders is to be held after the next ordinary general meeting for the purpose of passing the necessary resolutions for the winding-up of the Company.

Southport.—A scheme is on foot for connecting Liverpool Central (Low Level) with Huskisson (Cheshire Lines) by means of electric tube trains, much after the fashion of the now famous Central London Railway.

Burton-on-Trent.—A scheme is on foot for connecting Woodville with Burton-on-Trent *vid* Swadlincote and Newhall. The line is to be of standard gauge so as to allow of using the railway trucks at night time. The overhead system of electric traction is the system decided upon.

Sedgley and Netherton.—The electric equipment of these tramways has been inspected by Colonel Yorke, but the final Board of Trade inspection has yet to take place. It is expected that several weeks will elapse before the cars commence running for the use of the general public.

Halesowen.—The British Electric Traction Company are being censured for not having already extended their tramways from Old Hill and Cradley Heath to Halesowen, but we learn that it is very probable that in the near future the tramways will be extended, not only to Halesowen, but also to some of the outlying districts.

Maryport.—Messrs. Dick, Kerr, and Co. propose to obtain powers next session for constructing an electric tramway from Whitehaven to Maryport through Workington, providing the urban and rural authorities will support the project. Two representatives from each town are about to confer in the matter with the company.

South Shields.—Some dissatisfaction is expressed about the fact that the Board of Trade have sanctioned a further five years' lease of the trams. The Corporation's contention is that by waiting for a while they will gain experience, and eventually benefit by the working of the tramways by electric traction in the neighbouring boroughs.

Greenock.—At Tuesday's meeting of the Police Board the master of works and Mr. Nelson, electrical engineer, gave explanations upon the plans of the proposed reconstruction of the tramways within the burgh. It was agreed that after the full specification and detailed plans had been received and considered by the two officials there should be a further report to the committee.

Central London Railway.—Amongst the improvements now being made we note that electric communication is being established at some of the stations between the platforms and the booking halls, so that a signal may be made to the lift attendant indicating the approach of a train, this arrangement being needed to regulate the number of passengers who shall be allowed to descend to the platforms. The daily average of passengers on the railway has already reached a total of about 100,000.

Norwich.—The Newmarket-road tramway route was opened on Friday. On Saturday there were 38,660 passengers on the system, and on Sunday 32,285, nearly 6,000 more than on the previous Sunday. On Sunday evening a serious collision between two of the cars in St. Andrew's was only just averted, and on Monday afternoon there was a rather more serious accident near the same spot. It is stated that the brake failed to act, and the moving vehicle crashed into the rear of the stationary car with sufficient force to move the leading car off the metals.

Competition between Rail and 'Bus.—At the meeting of the London General Omnibus Company last week, Alderman Pound, the chairman, referring to the Central London Railway, observed that the effect would be quite temporary and could be met by "adapting the business to divergence of the traffic"—*i.e.*, by taking 'buses off some lines and putting them on others. The teeming population of London, he evidently thinks, is capable of absorbing the accommodation of the "2d. tube," the Underground, and the 'buses, and even then, perhaps, crying out for more.

Ayr.—Mr. Arthur F. Fuller has been asked to draw up a specification and carry out the work in connection with the overhead electric apparatus, with the exception of the designing of the posts, brackets, and section pillars, which is to be done by the town surveyor and furnished to the committee, the drawing up of the specifications for said items to be done by the electrical engineer. The town surveyor has also been instructed to draw up a general specification of the committee's requirements in regard to cars, and to invite tenders by advertisements for plans, specifications, and estimates for 10 cars with complete electrical equipment.

Sheffield.—The temporary shed which the Sheffield Tramways Committee have erected in Queen's-road for the accommodation of electric cars is now in use, and the reconstruction of the Heeley route is almost complete. The Highways Committee have already decided that Shoreham-street shall be paved with granite. The Tramways Committee are in favour of wood. The two committees are therefore in conflict on this matter, and the Council will have to make the final decision. The question of dry seats in wet weather is being debated. On Tuesday a start was made at the top of Hounsfield-road to complete the connection between this point and Broomhill, where already a short section has been laid.

Sunderland.—According to the *Newcastle Daily Chronicle*, another attempt was made to throw one of the Sunderland electric cars off the line on Saturday night. The circumstances were similar to those which marked the previous attempt, a fishplate being placed on the rails in Roker-avenue. An inspector, fortunately, saw the obstruction in time to stop the car reaching it. The Tramways Committee of the Corporation are highly satisfied with the success of the electric cars since they were opened. On Wednesday in last week they took £80 in fares, on Thursday £90, on Friday £55, and on Saturday £142. Saturday was a record day, for 30,000 passengers were carried on the whole system, 25,000 of them being on the electrical section. Including Sunday, the new cars had alone carried about 77,000 people.

Grimsby.—The Street Tramways Company have let their contract for the erection of the electric power station, in Pelham-road, Cleethorpes, in addition to having purchased new electric cars, at a cost of about £700 each. It is anticipated that by the time the season opens next year the cars at Grimsby and Cleethorpes—where the lines are to be extended as far as Brighton-street, at the south end of the promenade—will be running by electricity. The work of laying a double set of rails along Grimsby-road, suitable for electric traction, will be started in October. The station, which is to be acquired by the Urban District Council as soon as that body has the necessary power to purchase, will be so constructed as to permit of considerable extension, it being the Council's intention to build in conjunction with it the plant necessary for the purpose of street-lighting. It is the purpose of the Council to light by arc lamps the whole of the road along the tramway route, while negotiations with the Great Central Railway for the lighting of the Cliff gardens, pier, and promenade, by electricity are satisfactorily progressing, it being officially stated that the only question now to be considered is that of terms.

Aberdeen.—The Tramways Committee are recommending that the proposed new tramways and the extension of existing tramways be carried out in the following order: (1) the tramway from Castle-street to the bathing station first to be proceeded with and electrically equipped on the overhead trolley system, with span wires supported by side poles on the section between Castle-street and the east end of Constitution-street, and by centre poles on the remaining section eastwards to the bathing station; (2) the section of the existing tramway in Union-street, between St. Nicholas-street and Castle-street, to be electrically equipped on the overhead trolley system, with side poles and span wires; (3) the burgh surveyor to be authorised to invite tenders for the supply of 800 tons of steel rails and 10,000 tons of causeway setts, and the electrical engineer to invite tenders for the poles for the tramways to the bathing station, and for the section in Union-street (between St. Nicholas-street and Castle-street), and also for side poles for the King-street and Great Western-road sections. The electrical engineer and the superintendent of the tramways are about to report as to the type of car to be adopted, and the number to be ordered. They are asking the Westinghouse Electric Company for quotations of the cost of electrically equipping the tramway in Union street on the underground conduit system. The Council are about to make a trial of an automatic life-guard and dry-seat equipment—inventions that had favourably impressed a deputation who had visited the International Tramways and Light Railways Exhibition in London.

Moss Side (Manchester).—At the last meeting of the Moss Side Urban District Council the following terms, which had been arranged between the sub-committee and the Tramways Committee of the Manchester Corporation with regard to the electric

Digitized by Google

tramways in the Council's district, were agreed to: "(1) The Moss Side Council to grant to the Corporation a 21 years' lease of the tramways within the Moss Side district from the expiration of the lease to the Manchester Carriage Company; (2) the Corporation to undertake at their cost to reconstruct the tramways now owned by the Council, and to erect the overhead equipment thereof, and to repair and maintain the permanent way and overhead equipment during the lease, and to renew the rails during the last six years of the term, and to hand over the permanent way in good condition to the Council at the end of the lease, but the overhead equipment shall remain the property of the Corporation unless the Council determine to purchase it; (3) the rental for the lines now owned by the Moss Side Council to be at the rate of £400 per mile of single track per annum; (4) the line in Upper Chorlton-road, within the Moss Side district, now owned by the Manchester Carriage Company, shall be acquired by the Moss Side Council, and the lease of that line shall be on the same footing as leases of similar lines in other districts, which, shortly stated, is that the cost incurred by the Moss Side Council in acquiring and relaying the line according to the Manchester Corporation specification and otherwise shall be refunded by a series of annual payments during the term of the lease; (5) the lease of all the lines to terminate at the same time; (6) no advertisements to be allowed inside the cars.'

Leeds.—An electric car made a trial run over the Hunslet line on Monday. Councillor Smithson (chairman of the Tramways Committee), Alderman Lawson, Mr. Wharam (general manager), Mr. Jeken (assistant electrical engineer), Mr. Livesey (representing the Thomson-Houston Company), and Mr. Laing (of the firm of Messrs. R. W. Blackwell and Co., London, who erected the overhead wires), took part in the proceedings. At a subsequent meeting, Mr. Smithson reported that the Hunslet line was now ready for electric traction, and that the cars would commence running from Briggate to Thwaite-gate on Thursday morning (yesterday). The Tramways Committee on Wednesday decided to recommend the Council to seek powers under the proposed new Tramways Bill to construct the following lines: a tramway to connect the Kirkgate and New York-street tramway with the Vicar-lane and New Market-street section; a tramway branching out of the existing one at the junction of Victoria-road and Meadow-lane, thence along Victoria-road, School-close, and Bishopsgate-street, joining the existing tramway in Wellington-street; a tramway to connect the Infirmary-street tramway with the one in Wellington-street, by way of the short street in front of the Post Office; a tramway commencing at the junction of West-street and Kirkstall-road, thence along West-street and St. Paul's-street, and joining the Infirmary-street tramway at the junction of St. Paul's-street and Infirmary-street; a tramway from West-street to Wellington-street, by way of St. Philip's-street; a tramway commencing at the existing tramway at Chapeltown, and extending along the Harrogate-road to the junction of Street-lane, thence along Street-lane to join the existing tramway near the Canal Gardens at Roundhay. The above lines do not include the whole scheme of extensions which the committee have in view. They have, however, to consider the time at the disposal of the Corporation officials before the Bill has to be deposited in Parliament, and believe that it would not be possible to complete the necessary work in the way of the preparation of the plans, etc., for more extensions than those named. If it should be found necessary, from want of time, to leave out one of the proposed extensions, the line from Chapeltown to the Canal Gardens would be postponed until another Bill was promoted in Parliament.

Darlington.—Since the opening of the Stockton and Middlesbrough electric tramways the public of Darlington have been looking forward to the time when their present system of horse traction should be replaced by a system of electricity. Negotiations were opened with the Imperial Tramways Company, and an enquiry was held by the Light Railway Commissioners, at which the Corporation and the tramways company agreed as to the terms on which Darlington should be put in possession of 10 miles of electric tramways, at a cost of £120 000. The only point on which it seemed likely that there would be any difference of opinion was that of the supply of the current, the tramways company favouring a method by which the current should be transmitted from their existing works at Stockton, and the Corporation desiring to supply the motive power from their own generating station in Darlington. Prof. Kennedy was called in to advise and report as to the price he considered reasonable should be paid by the tramways company for such supply. The secretary to the Commissioners wrote to the Corporation enquiring whether any agreement had been come to, and he was informed that the company had agreed to take electrical energy from the Corporation. An interview was arranged between the secretary of the Commissioners and representatives of both the Corporation and the tramways company, at which it was stated that the Corporation would not have supported the application of the company at the enquiry before the Light Railway Commissioners in the manner they did had there been any suggestion that the company would seek a modification of the original scheme. The Corporation attached much importance to the arrangement to supply the company with electrical energy. The secretary to the Commissioners intimated that they would possibly grant an extension for the laying down of a considerable portion of the system. Another disputed point here arose as to the allocation of a sum of £5,000 which the company had agreed to contribute towards the cost of street widening. After the conference the company's representatives intimated that, though they were not prepared to do anything further towards street widening, they would hand over the provisional order, when obtained, to the Corporation, and dispose of the present tramway undertaking upon advantageous terms. Much correspondence ensued, and eventually the Corporation thereupon resolved that the Commissioners be informed that in the event of the company not being prepared to carry out the scheme, the Council would make application for a new order at an early date. The matter is thus at a deadlock, neither party showing any disposition to recede from the position taken up.

LIGHTING AND GENERAL.

Wrexham.—The work of laying the electric cables has been commenced.

Wimbledon.—It is reported that already an equivalent of 19,000 c.p. lamps has been applied for.

Worksop.—The Board of Trade have approved of the system proposed to be applied for the supply of electric energy.

Colchester.—The Standard Ironworks, which were visited by the Ipswich engineers last week, are lighted by electricity.

Blackpool.—The Corporation were fined last week 40s. for permitting a black smoke nuisance at the electricity works.

Glasgow.—The new tariff of charges, contained in the report published in our last issue, has been adopted by the Council.

Nantwich.—The Electric Lighting Sub-Committee of the Urban District Council are engaged in preparing a report *re* lighting.

Blairgowrie.—The London Electric Company have offered to send a representative to discuss the electric lighting of the town.

Ballymena.—Mr. McCarthy's lighting scheme, which is now being discussed by the Urban District Council, is estimated to cost £6,000.

Derby.—Mr. W. A. Ducat has held an enquiry into the application of the Borough Council to borrow £730 for a condenser in connection with the electric lighting.

Napier Motor Co.—This Company has been registered with a capital of £100, the object being to carry on the business of electrical and mechanical engineers, etc.

Telephone Services.—A conference of authorities within the Salford exchange area of the National Telephone Company is to be held at the Salford Town Hall on Sept. 12.

Newton-in-Makerfield.—The Council object to, and will oppose, if necessary, the proposed application of the South Lancashire Electric Supply Company, Limited, for a provisional order.

London Gazette.—The last day for receiving proofs in the estate of H. Sewell, Clifton-place, Shipley, Yorks, is Sept. 5. Mr. J. A. Binns, official receiver, 31, Manor-row, Bradford, is trustee.

Brighouse.—The North British Electrical Supply Company have decided to cancel their application for powers to supply electrical energy for public and private purposes in Brighouse.

Hampton Wick.—An interview has been arranged between the Lighting Committee and the representative of the Twickenham and Teddington Electricity Supply Company on the subject of the supply of current.

Barnstaple.—The Electric Lighting Act empowering the Council to light the district by electricity having received the Royal assent, the Council are about to engage an expert electrical engineer to advise them.

Leeds.—The Lighting Committee will recommend the Town Council, at its next meeting, to abolish the charge for meters used in connection with the supply of electricity from Oct. 1. It is not proposed to make any alteration in the price.

Oban.—The Town Council have decided to apply in the ensuing session to the Board of Trade for a provisional order to supply electrical energy for public and private purposes within the burgh. A committee will be appointed shortly.

China Cables.—The Eastern Extension and Great Northern Telegraph Companies' submarine cable between Chefoo and Taku is now open for traffic, and arrangements have been made for the early laying of a cable between Chefoo and Shanghai.

Ilford.—The Urban District Council intend to contribute £350 towards the cost of laying the telegraph wires underground, from the bank in the Broadway to Green-lanes, the postal authorities having agreed to make the alteration on that condition.

Bexhill.—At the last meeting of the Urban District Council it was said that the question of free wiring would have to be faced in the future, as the progress of electric lighting was retarded because landlords provided gas fittings in their houses free of charge.

Dover.—At the meeting of the Town Council last week, the Surveyor reported on the notice of the Dover Electricity Supply Company to extend their mains to Victoria Park. He recommended that they should be laid in the road, as cellars projected under the footway.

Rathmines.—We are informed that at the request of the Lord-Lieutenant of Ireland, who is at present confined to his bed, the Electric Lighting Committee have postponed the opening ceremony from the 24th inst. to Friday, Aug. 31, when the arrangements will be carried out as originally proposed.

Ebbw Vale.—The District Council are taking steps to carry out their previous resolution to apply for a provisional order for power to supply the district with electric lighting. The Council's opposition to the South Wales Electrical Power Distribution Bill has resulted in very advantageous concessions.

Hotel Cecil, London.—In consequence of the building of the north block the electrical installation is being largely extended under the superintendence of the chief engineer, Mr. W. A. Poynton, A.I.E.E., and a fifth 75-kw. turbo-dynamo has been ordered from Messrs. C. A. Parsons and Co.

Digitized by Google

Rogers and Gowlett, Limited.—This Company has been registered with a capital of £10,000, the object being to acquire the business carried on by Rogers Bros. at Watford, and to carry on the business of ironmongers, electricians, etc.

Mordey-Fricker Electricity Meter Co.—This Company has been registered with a capital of £20 000, the object being to acquire the inventions of W. M. Mordey and G. C. Fricker relating to improvements in electricity meters, and to carry on the business of electric meter manufacturers, electricians, etc.

Paris Exhibition.—We learn that besides the awards mentioned in our list, the Parsons Marine Steam Turbine Company have obtained the grand prize in Class 33 for materials and plant used in the mercantile marine, and gold medal in Class 118 for naval construction. Those classes we have not noticed.

Carlisle.—The Public Lighting Committee of the Town Council have accepted a proposal by the tramways company to attach lights to four centre poles in Church-street and nine in Lowther-street, and referred the question of lighting the remainder of the centre poles in the streets of the city to a sub-committee.

Aberdeen.—The Corporation tramways traffic returns for the week ending 18th inst. were £876. 5s. 8d,, as compared with that ending Aug. 18, 1899, of £704. 14s. 8d., showing an increase of £171. 19s. The total receipts for the half-year were £8,614. 10s. 3d., and those for the corresponding period, 1899, £7,585. 19s. 10d.

Tunbridge Wells.—At a recent meeting of the Electric Lighting Committee, it was stated that the committee are not going to undertake any extension of public lighting until the new plant is working, but that they would make special arrangement for the illumination of the Pantiles at the concerts for the opening of the new bandstand.

Boness.—The Police Commissioners have agreed to meet a representative of the North British Electrical Supply Company, South Shields, with regard to that company's intended application to the Board of Trade for authority to supply electrical energy for public or private purposes within the jurisdiction of the Commissioners.

Walsall.—The total number of consumers supplied with electric light on July 31 last was 167. The total units generated at the station during the month of July was 19,550. The total output from the main generators was 18 424 units. The total units from the transformers was 14,083. The total units registered on the meters was 13,235.

Brecon.—At the quarterly meeting of the Town Council the Mayor (Colonel Morgan) announced that he had obtained a provisional order for the electric lighting of Brecon, and was prepared to present a copy of it to the Council. A hearty vote of thanks was accorded the Mayor for his generosity in obtaining the order, at a cost to himself of £500.

Greenock.—The Police Board on Tuesday adopted the following motion: "The Board approve of the scale of charges proposed by the electrical engineer, except that the minimum charge for power and lighting combined be 4½d. and 1½d., and that the charge for power only be at the rate of 4d. and 1½d. on the Brighton system, the scale of charges to be subject to revision by the Board."

Stock Exchange.—The Stock Exchange Committee have appointed Aug. 29 as a special settling day for Calcutta Electric Supply Corporation's further issue of 10,000 shares of £5 each, 10s. paid, Nos. 20,001 to 30 000, and have ordered National Telephone Company's further issue of 100,000 ordinary shares of £5 each, fully paid, Nos. 490,001 to 590,000 to be quoted in the official list.

Aberdeen.—At a recent meeting of the Gas and Electric Lighting Committee of the Town Council the question of the erection of the proposed new electric lighting station was under consideration. The committee decided to endeavour to obtain the whole of the Millburn street site for the erection of the electric lighting station, rather than that both Millburn-street and Dee Village-road should be broken up.

Buxton.—At a recent meeting of the Electricity Committee of the Urban District Council, Mr. Jenkins explained the result of his visit to Messrs. Mather and Platt's works, and of his conference with Messrs. R. Hornsby and Sons in reference to the machine stokers, and said Messrs. Crompton would adjust the cut-outs of the arc lamps. The cables for Burlington-road will be proceeded with next week.

Hull.—From the statement of receipts and expenditure of the Municipal Corporation and Urban Sanitary Authority from April 1, 1899, to March 31, 1900, just published, we note that the capital expenditure on the electricity works during the year amounted to £38,843. 9s. 11d., the income was £19,290. 12s. 7d., the expenditure came to £17,366. 9s. 3d., leaving £1,924. 3s. 4d. to be placed to the reserve fund.

Vote Recorder.—Mr. Howe is showing at 332, Strand an ingenious contrivance by means of which votes are printed by levers pulled by the voters. The tedious and so often incorrect process of counting is entirely avoided, and elaborate and apparently efficient means of secrecy are provided. Members of municipal bodies will be interested in this view, which is to remain open for some time.

The City (London).—The Finance Committee of the City of London Union are considering a specification of Mr. Collins, 62, Broad-street, for an electric installation and ventilation at the Board offices. The amount is £533. 10s., £250 of which is for the installation. It includes two ventilating fans, at an estimated cost of £70, to be placed in the windows over the entrance doors. The illumination of the whole building would require 300 lights.

Andes Development Co.—This Company has been registered with a capital of £100,000, the object being to adopt and carry into effect an agreement expressed to be made between the Peruvian Corporation, Limited, and a second agreement made with the Central Railway of Peru, Limited, for the acquisition of railways, tramways, telegraph and telephone systems, etc.

West Riding.—With regard to the notifications from electrical syndicates received by a number of urban councils in the West Riding of intention to apply for powers to supply electric light in the various districts, the *Yorkshire Post* says there is a feeling in some quarters that the authorities should themselves have this power in their own hands, and we understand that a joint meeting of the councils is being arranged to consider the whole question.

Theft of Wire.—At Govan Police Court on Friday, before Bailie Anthony, Arch. Walker, electrician, 16, Garscube-lane, Glasgow, was charged with having stolen 7lb. of lead-covered electric cable from the new Municipal Buildings, Govan. Accused was working at the buildings when he appropriated the wire, stating, when called to account, that he was entitled to take it. He pleaded guilty, and was fined £1. 10s., with the option of 21 days in prison.

Kingstown.—The Urban District Council at an adjourned meeting last week adopted the interim report of the Electric Lighting Committee, which recommended the Council to oppose the application of Messrs. Porte, Sykes, and Co., should it be made to the Board of Trade, asking for a provisional order to light Kingstown by electricity. The Council propose to apply for a loan for the purpose of providing the installation under their own order.

British Motor Traction Co.—This Company has been registered with a capital of £1,000,000, the objects being to adopt agreements made between the British Motor Company, Limited, and this Company; between the British Motor Company, Limited, and H. J. Lawson and this Company, between the British Motor Company, Limited, and J. Harris and this Company; and between the British Motor Traction Company, Limited, and S. F. Edge and the present Company, and generally to carry on the business of electricians, etc.

Blackrock.—At the next meeting of the Urban District Council the following motion is to be discussed: "That any scheme for electric lighting within Blackrock urban district be undertaken by this Council and not by outsiders, and that a conference be held with the Kingstown Urban District Council to ascertain what action they have decided upon for the lighting by them of their district, and also to discuss with them the feasibility or otherwise of a joint scheme of electric lighting for the two urban districts of Kingstown and Blackrock."

Scarborough.—Some correspondence has passed between the Scarborough Electric Supply Company and the Corporation as to the terms of purchase of the undertaking. The company at first objected to referring the terms of purchase to arbitration, and suggested that negotiations should proceed on the basis of the present and future profits of the undertaking, and that a small committee be appointed to discuss the matter. A deputation has now been appointed by the Town Council to meet a deputation of the electric supply company.

Consett.—The Urban District Council are considering the question of lighting the district with electricity. At a special meeting on Monday a deputation on behalf of the Northern Counties Electrical Supply Company asked the Council's consent to a provisional order from the Board of Trade to lay down plant, with the object of supplying the district with electricity for lighting and other purposes. The chairman was adverse to the Council giving away its rights, but favoured the idea of the Council supplying its own electricity. The subject was ultimately referred to the Gas Committee to consider the matter in detail and report to the next ordinary meeting of the Council.

Appointments Vacant.—The Corporation of Eccles invite applications for the appointment of borough electrical engineer at a commencing salary of £200 per annum.—The Borough of South Shields require two shift engineers (£104 per annum).—The Dundee Town Council have a vacancy for improver (commencing salary, £52 per annum). Full particulars of these vacancies appear in our advertisement columns.—The Tramways Committee of Darwen require the services of a working foreman to take charge of the electrical equipment of the cars and overhead equipment under the electrical engineer. Applications, endorsed "Tramway Foreman," with testimonials or references, to be sent to Mr. W. P. Halliwell, town clerk, Darwen, by noon on 29th inst.

Chester.—Lieutenant-Colonel A. C. Smith, R.E., held an enquiry on Wednesday into the application made by the Chester Corporation for sanction to borrow £35,000 for the purpose of extending electric lighting in the city. The Town Clerk explained that the loan was for new machinery, extension of the station, engine-house, and anticipated requirements for extension of the mains and providing service for lamps. So far the undertaking had proved an unqualified success, and out of the revenue the Council had been able to pay off all preliminary expenses, which were not included in the previous loan. They had placed to the reserve fund a sum of £2,465 1s. 1d., and reduced their original price of 6d. per unit to 4½d., and in addition to that the committee were clearing a considerable discount to large consumers. During the last three years 355,957 units, 473,656 units, and 617,792 units respectively had been sold. The public lamps had increased from 83 to 361: 165 of these are arc lamps. It was not absolutely settled, but most probably they would be able to work the trams (which the Corporation propose to take over) by electric traction, and the Corporation would be able to generate the electric energy at the present station.

Digitized by Google

Soothill Nether.—At a meeting of the District Council the opinion was expressed that the electric light would be more expensive than gas. The question was also raised as to whether the British Electric Traction Company, and the Northern Counties' Electricity Supply Company, Newcastle-on-Tyne, would supply electricity for illuminating purposes or whether they only provided electricity for traction purposes. It was agreed to write to the Thornhill Council asking whether the companies named supplied electricity for lighting purposes.

Stockport.—The Theatre Royal has just been fitted with electric light upon the three-wire system. Owing to the fact that the voltage of the Corporation supply is too high for stage work, a special rotary transformer has been provided for the stage lighting, which transforms the electric current from 230 to 75 volts. There is a gamut of three colours—white, red, and green. The lighting throughout has been done by Messrs. Robert Dawson and Sons, of Stalybridge, to the specifications of Messrs. Bamford and Halstead, consulting electrical engineers, of Manchester.

Arbroath.—The Gas Corporation have had under consideration an application from a manufacturing firm in the town to be allowed to carry an electric wire from their works to their private residence. The Corporation are considering the advisability of introducing the electric light themselves, and it was remarked that this application raised the question as to whether overhead or underground wires should be allowed to be laid in connection with the streets of the borough, or whether private parties should be allowed to cut up the streets. The question is now before the Electric Committee for report.

Friern Barnet.—The District Council have decided to obtain a provisional order authorising them to light the district by electricity. The scheme is yet in embryo, and the suggestion at present is to schedule only the two main roads in the district, Station-road and Friern Barnet-road, for immediate lighting, and to add other roads as occasion and opportunity arise. This plan would give a very small area to start with, so small that the cost—initial and working—could not, in our opinion, be justified by the return. The Council have declined to go in with Tottenham for a joint scheme.

Halifax.—The accounts of the Corporation electricity works for the year ended March 31 show that the expansion of this department has exceeded expectation. The output has been more than doubled, the number of units sold being 1,371,333, as compared with 628,759 in the previous year. The lamps connected number 45,403, as against 32 020; the gross revenue was £16 069, as against £8,957—an increase of £7,112. The gross profits amounted to £9,001, as compared with £4 565 last year—an increase of £4,436. The average price obtained per unit, after deducting discounts, is 2·77d., as against 3·33d. last year. It is reported that the electrical engineer (Mr. Street) has had an offer from a Lancashire borough of £500 a year.

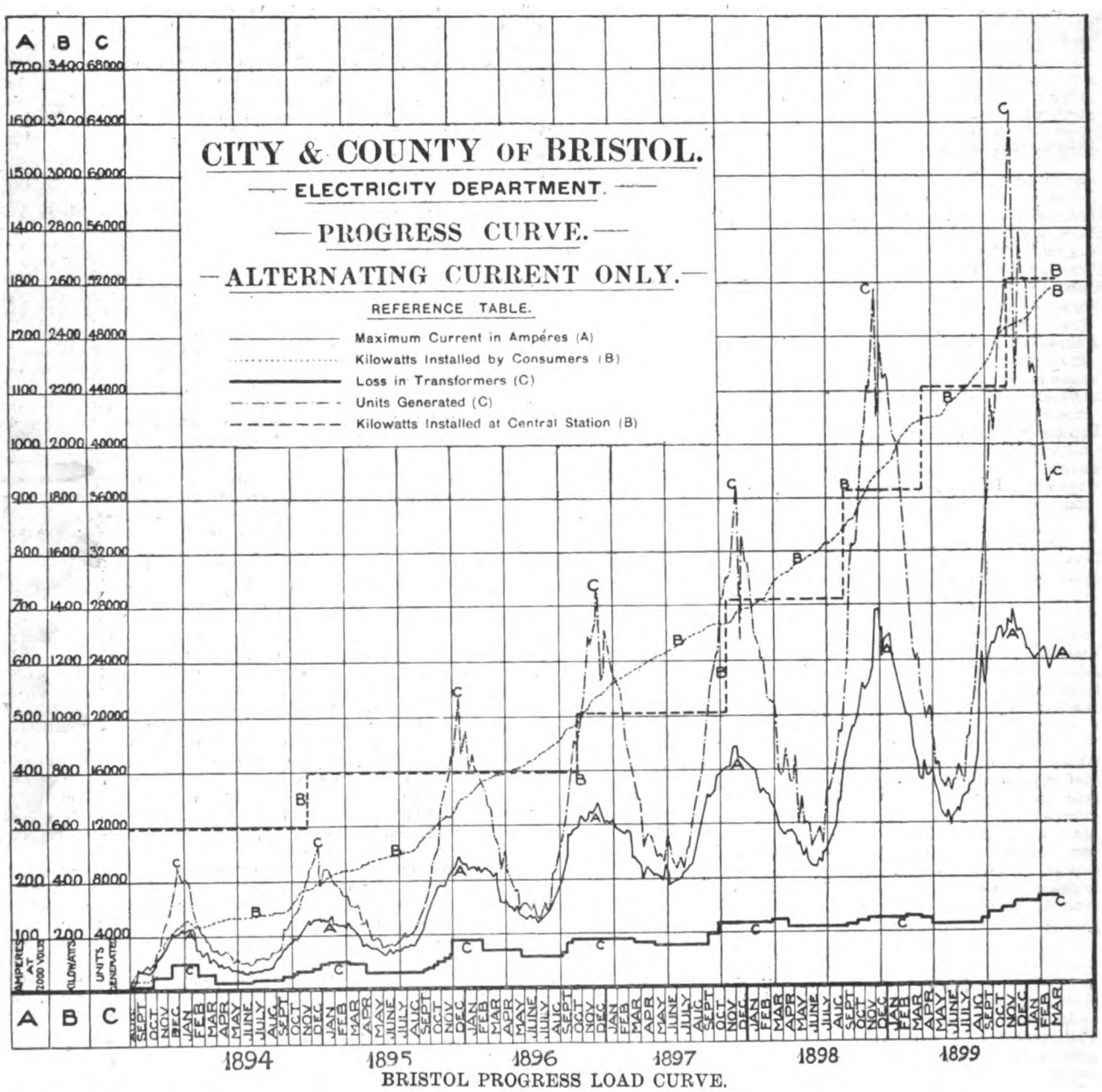
Llanelly.—There is now nothing in the way of the scheme for providing Llanelly with a system of electric light and traction going forward. There has been some delay owing to the inability of the British Insulated Wire Company to arrive at a settlement with the proprietors of the existing tramways. This week terms have been agreed upon between the two companies by which the British Insulated Wire Company will purchase the undertaking of the Llanelly Tramways Company. The scheme is a very elaborate one, and will entail a cost of close upon £100,000, all of which is to be provided by the company. It is proposed to establish a system of electric cars not only for the town, but also to the outlying districts of Pwll, Felinfoel, and Llwynhendy. In addition, there will be a complete installation of electric light, thus bringing Llanelly into line with the largest towns in the country.

Sydenham Explosion.—The following account of the inquest appeared in the *Daily Chronicle*: "The deputy-coroner for West Kent, who had the assistance of Mr. J. Owner, factory inspector, resumed at Lewisham the inquest on the bodies of Frederick Elliston, 33, and William Philbrook, 19, who met their deaths in a boiler explosion on the premises of the Crystal Palace District Electric Supply Company on the 25th of last month. Evidence was given by Mr. Walter Phillips, electrical engineer to the company. He said that every year until this year the boiler had been thoroughly examined. The reason why it was not done this year was because the company were busy and could not let the boiler be idle, as the examining process took over a week. Since the explosion witness had examined the fragments of the boiler and found a flaw. In his opinion, that flaw was the cause of the explosion. After further evidence had been taken the jury returned the following verdict: That the deceased men died suddenly from injuries caused by an explosion of a boiler due to its defective condition, which might have been discovered had the boiler been thoroughly examined, as it ought to have been, between April of last year and the date of the explosion.

Blackburn.—A Local Government Board enquiry was held on Friday into an application of the Corporation to borrow £190,000 for electricity extension purposes, including lighting and power. The present scheme will carry the Corporation on for four or five years, when they will still have land available at their proposed new works for an even larger scheme. The Town Clerk explained that it was originally proposed to ask for £220,073 for the purpose of electricity extensions, but that amount had been reduced to £189,699. The electricity works adjoined the No. 1 gasworks, which were very old, and had become too small to meet the needs of the town. The Corporation had purchased land in another part of the town for new gasworks, and when these were completed the whole of No. 1 gasworks would be devoted to electricity purposes. The site had been valued at £30,000. Mr. Lacey, consulting electrical engineer, commenting upon a number of the points of the scheme, said part of the scheme would meet the requirements of the borough for the next four or five years, and the borrowing powers now sought would cover the expenditure for that period. The electricity extension included lighting and power, whilst after the present portion of the scheme had been carried out there would be land available for further extensions for another 15 or 20 years.

Battersea.—The people, with a big "P", had a field day at Battersea on Saturday last, when the chairman of the Vestry, Mr. Mathews, J.P., laid the foundation stone of the electric light station at Lombard-road. Mr. Willis, the chairman of the Lighting Committee, who presided, in a few clear words gave a description of the scheme. He said that out of the 13 miles of mains proposed to be laid 11 miles had already been laid, and the committee expected the building to be ready by November next, and to be able to supply current by May, 1901. They also intended to supply private lighting at the rate of 5¾d. per unit on the free-wiring system. Great stress was laid on the fact that all the work was being carried out under the direct employment system. As a matter of fact the buildings are being erected by the Works Department of the Vestry, from the designs of Mr. C. Stanley Peach, F.R.I.B.A., of 28, Victoria-street, Westminster, S.W., under the surveyor (Mr. J. T. Pilditch) and the general foreman (Mr. L. J. Howell). From notes by Alexander B. W. Kennedy, LL.D., F.R.S., the consulting electrical engineer, we gather that the Battersea central electric light station has been designed so that when it is complete it may contain about 14,000 h.p. in boilers, engines, dynamos, etc. In the first instance, however, it is proposed to build only a portion of the station, and in this portion plant is to be placed to the amount of about 1,500 h.p., which, if all working at once, is sufficient to supply current for about 25,000 lamps of 8 c.p. alight, besides 240 arc lamps in the streets. Allowing, however, for the necessary reserves, it is intended that this plant should supply current for about 17,000 lamps of 8 c.p. alight (or about 45,000 lamps wired), besides the street-lighting. The boilers which are now being placed in the station are of the Babcock tubular type, and will work at a steam pressure of 200lb. per square inch. They supply steam at this pressure to the engines, which are of the triple expansion type, and are intended to work with condensation. Each engine drives one dynamo direct without intermediate gearing. The engines are being made by Messrs. Willans and Robinson, Limited, of Rugby, and the dynamos by Messrs. Mather and Platt, of Manchester. A large battery made by the Hart Accumulator Company, of Stratford, having a capacity of 1,000 ampere-hours, will be placed in the station to assist in the regulation, and also as a means of supply during hours of light load. The current generated by the dynamos is to be distributed throughout Battersea at a pressure of 460 volts, the mains being arranged on a three-wire system, so that the lamps work at 230 volts. The current is of the continuous type, so as to be directly suitable for power as well as for lighting. The mains are being laid at once of a section sufficient to supply current to a total of about 60,000 lamps wired. The distributing mains are laid throughout in troughs filled solid with bitumen. The trunk or feeder mains are chiefly laid on the same system, and partly also as concentric armoured cable. The whole of the main-laying is in the hands of the Callender's Cable and Construction Company, Limited, of Erith, but the work of opening and reinstating the highways is being done by the Vestry's own workmen. There are at present being placed in the streets 240 arc lamps, which are to be supplied 10 in series from the outer mains of the distributing system. These lamps are placed in the streets at about 65 yards apart, and carried on special posts, so that the height of the lamp above the ground is about 23ft. The tenders accepted for all the engines and appliances, and the whole system of mains, amount to £57,800. Then Mr. Mathews took hold of the silver trowel presented to him by Prof. Kennedy, the consulting engineer of the Vestry, and launched out in statistics. We were pleased to hear that all municipal electric lighting undertakings paid well, with one exception, and had no idea that the current sold in Edinburgh at 3¾d. per unit cost only 1½d. But Mr. Mathews said so. It is true Prof. Kennedy afterwards explained that another 1½d. or so would have to be added to this 1½d. on account of amortisation charges. But Mr. Mathews's great point was that municipalities made enormous profits out of electric light undertakings, while no company did half as well. Therefore, consumers ought to deal only with the former. It did not strike us as particularly good logic—but let that pass. Where we got our first shock was when we heard the proclamation, "In the name of the people of Battersea, I declare this stone well and truly laid." To one familiar with similar proceedings this savoured very much of 1793, red caps, disestablishment of the deity, etc. Mr. Mathews was followed by Mr. Burns, the present member of Parliament for the district, who let forth a violent diatribe against all and every opponent of municipal trading. These opponents consisted either of ignorant or of interested persons; well-informed and disinterested persons like himself, so he said, knew that it was the best thing for the people, and he dared both Houses of Parliament to interfere with the municipal authorities in that respect. Mr. Burns, as might be expected from a particularly well-informed and a particularly disinterested person, then had a deal to say about company-mongers who scooped in the profits, ignorant local scribes who ought to be at the treadmill, etc. This was interlarded with some statistics which were quietly brushed aside in subsequent speeches by Mr. W. Manser and Prof. Kennedy. What Mr. Burns did not tell his audience was that the "company-monger" and the company shareholder, who is generally also a

Digitized by Google



BRISTOL PROGRESS LOAD CURVE.

ratepayer, risks his own money, while the vestrymen openly gamble with the credit or the purse of the ratepayer. Furthermore, a company has not the same amortieation charges to meet, and should, therefore, be able to supply cheaper light. It is true that these charges cease after 25 or 30 years, when we are dead, and when the machinery is either useless or superseded. So there is more than one side to the question; and vote-catching, patronage, and nepotism for the leaders, and the Government stroke for their clients might be mentioned as appertaining to that so much advocated by some particularly well-informed and partially disinterested persons. Mr. Manser said that the Moderates in the Vestry had opposed the idea on the ground that thereby every ratepayer was made, whether he wished or not, a shareholder in a trading enterprise, to which, naturally, some risk was attached. They, however, had given in after the wish of the people had been ascertained. Mr. C. Stanley Peach, F.R.I.B.A., the architect, gave some particulars of the buildings now in course of erection. They are situated at the junction of Lombard-road and Holman-road, the frontage to the former being 186ft., and to the latter 64ft. 3in., and comprise the offices connected with the central station, an engine-room 90ft. by 71ft., a boiler-house 123ft. by 64ft., coal store 80ft. by 64ft., battery-room 63ft. by 20ft., and ample stores for mains department and meter-testing room. The chimney is octagonal in shape, measuring 25ft. 6in. by 25ft. 6in. at the base, and 13ft. 6in. by 13ft. 6in. at the top, and when finished will be 194ft. high above the ground. The foundation is 28ft. below the street level. The total height of the shaft from bottom of foundation to top of cap is therefore 222ft. The walls, externally, will be faced with picked stock bricks with blue brick strings and dressings, and the interior of the walls will be faced with blue bricks, with white and brown glazed bricks in those rooms in which cleanliness and light are of importance. Above the office portion of the buildings apartments are provided for the engineer in charge of the station, and also for some of the staff. The buildings, which will cost about £50,000, will contain all the latest improvements, and in the part now being built provision is made for erecting from time to time additional machinery and plant as the demand for current increases.

Then some more speeches followed, the band of the 4th V.B. East Surrey Regiment (by kind permission of Lieut.-Colonel T. Tully, commanding), under the direction of Mr. A. R Spriggs, played a few more selections of popular music while the people perambulated around the newly-laid stone, and then betook themselves into the refreshment tents, where ample food and drink was provided, and even tables and chairs to enable them to enjoy the same in peace and comfort. In fact, everything, from the substantial scaffoldings, the large marquees, the band, down to the programme with its coat-of-arms, was on the most lavish scale—probably in anticipation of the future profits of the undertaking.

BRISTOL ELECTRICITY ACCOUNTS.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£6,230	10	6			
Oil, waste, water, and engine-room stores	511	4	8			
Wages at generating station	2,190	9	1			
Repairs and maintenance	1,090	3	10			
				10,022	8	1
Distribution of Electricity.						
Wages to linesmen, etc.	547	13	10			
Repairs, etc., of mains	138	5	4			
Repairs, etc., of transformers, etc.	133	16	3			
Repairs, etc., of apparatus at distributing stations	500	4	0			
Sundries	22	5	2			
				1,342	4	7
Public Lamps.						
Attending and repairs	1,056	6	11			
Carbons and renewals of lamps	333	14	8			
Sundries	21	19	0			
				1,442	0	7

Digitized by Google

Rents, Rates, and Taxes.			
Rents payable	447 5 0		
Rates and taxes	1,319 10 7		
		1,766 15 7	
Management Expenses.			
Salaries—Engineer's department	1 186 11 10		
Secretary and clerical staff	809 3 2		
Stationery and printing	179 6 11		
General establishment charges	464 13 6		
		2,639 15 5	
Law expenses		304 18 5	
Special Charges.			
Insurance and guarantee premiums	179 5 11		
Canvassing for new customers	2 16 6		
Interest on deposits by customers	6 8 0		
Compensation for damages	3 0 2		
Testing machinery, mains, etc.	44 1 0		
Gratuity to wife of H. Mayne (reservist)	6 12 0		
Gratuity to wife of W. Coleman (deceased)	26 0 0		
Expenses *re* accident to H. J. Arnel	2 3 0		
Expenses *re* Queen's visit illuminations	6 8 4		
Expenses *re* negotiations for sites for new station	59 2 10		
Salary, etc., of electric inspector appointed by the Court of Summary Jurisdiction	108 0 7		
		443 18 4	
Total expenditure		17,962 1 0	
Carried to net revenue account		13,755 13 2	
		£31,717 14 2	

Cr.	£ s. d.
Sale of current per meter, less discounts	23 193 16 7
Rental of meters	1,118 2 11
Rental of motors, less depreciation	19 5 3
Less bad debts	24 17 2
	24,306 7 7
Public lighting, £5,630. 10s. 2d.; attendance and carbons for same, £1,442. 0s. 7d.	7,072 10 9
Incidents	4 8 6
Improvers' premiums	171 10 0
Sale of incandescent lamps	86 14 5
Fees for insulation tests	10 10 0
Surplus lands—rents receivable	33 7 4
Charging batteries	9 4 3
Work on consumers' premises	11 18 3
Profit on sales of material	11 3 1
	£31,717 14 2

General Balance-Sheet.

Dr. Liabilities.	£ s. d.
Capital account—amount received	228 730 0 0
Sundry creditors	9,565 3 11
Deposits by customers as security	257 0 0
Balance at credit of net revenue account	3,062 3 9
Ditto redemption account	1,190 0 0
Ditto reserve fund account	5,000 0 0
Ditto depreciation account	2,024 17 7
Ditto suspense account	283 15 11
Amount overdrawn at bank, £14,064. 0s. 11d.; less cash in hand, £793. 17s. 5d.	13,270 3 6
	£263,383 4 8

Cr. Assets.	£ s. d.
Capital account—amount expended for works	252,588 7 2
Stores on hand: coal, £342. 18s.; oils, waste, etc., £36. 0s. 6d.; general, £527. 15s. 6d.	906 14 0
Sundry debtors for current, £8,019. 12s. 10d.; other debtors, £1,868. 10s. 8d.	9,888 3 6
	£263,383 4 8

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		2,384,464
Quantity sold	Public lamps 481,841	1,812,511
	Private consumers by meter 1,330,670	
Quantity used on works		571,953
Total quantity accounted for		2,384,464
Total maximum supply demanded (kilowatts)		1,676
Total maximum possible demand (kilowatts)		2,733

Number of public lamps, 308 arc and three incandescent.

PROVISIONAL PATENTS, 1900.

August 13.

14449. Improvements relating to double-pole, three-way, and similar electrical switches. Ernest Edward Bartlett, 10, St. George's-crescent, Liverpool.

14450. Improvements relating to electrical controlling and regulating switches. Ernest Edward Bartlett, 10, St. George's-crescent, Liverpool.

14458. Improvements in telegraphic relays. Charles Edwin Wilson, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14463. Improvements in apparatus for electrolysis. Paul Schoop, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14488. A method of electrically reversing the direction of elevators driven by electricity. Reginald Haddan, 18, Buckingham-street, Strand, London. (A. Stigler, Italy.)

August 14.

14495. Improvements in or connected with automatically opened switches. Thomas Hesketh, Belvedere, Cheriton-road, Folkestone.

14506. Improvements in and relating to dynamo-electric machinery. Alfred George Brookes, 55, Chancery-lane, London. (Charles Leonard Cotton, United States.) (Complete specification.)

14550. Improvements relating to the insulation of electric conductors. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Nikola Tesla, United States.) (Complete specification.)

14552. Improvements in conduits for electric conductors, water, or the like. Hosea Tugby, 47, Lincoln's-inn-fields, London.

14557. Improvements in or relating to conduits for electric conductors. John James Bate, 6, Lord-street, Liverpool.

14558. Improvements relating to the transmission and receiving of telegraphic signals. Georg Friedrich Rudolf Blochmann, 45, Southampton-buildings, Chancery-lane, London.

14568. Improvements in toll-collecting machines for telephones. Reginald Haddan, 18, Buckingham-street, Strand, London. (The American Toll Telephone Company, United States.) (Complete specification.)

14582. Improvements in and connected with electric furnaces. Rámon Chavarria-Contardo, 55, Chancery-lane, London. (Complete specification.)

August 15.

14608. Improvements in electricity meters. Sydney Holmwood Holden and Chamberlain and Hookham, Limited, 4, New Bartholomew-street, Birmingham.

14633. An improved system of electric lighting and apparatus or devices therefor. Pierre Lapertot, Gilbert Villard, and Laurent Pignaud, 6, Lord-street, Liverpool.

14637. Improvements in and connected with apparatus for punching strips of paper and like material suitable for use in telegraphic transmitters and for like purposes, the same being particularly adapted for the preparation of telegraphic messages for automatic transmission over single or duplexed circuits, which may be received in Morse or other telegraphic codes or type-printed characters arranged in page form. William Lloyd Wise, 46, Lincoln's-inn-fields, London (Charles Luman Buckingham, United States.) (Complete specification.)

August 16.

14684. Improvements in or connected with incandescent electric lamps. Herbert Edmund Moul, 8, Hythe-road, Willesden Junction, London.

14691. Improvements connected with electric primary batteries for traction purpose. Samuel William Maquay and Theodore Gervase Chambers, 55, Chancery-lane, London.

14704. Improvements in transmitters for electrical waves or the like apparatus. Carl Gustaf Georg Braunerhjelm, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 26, 1900, being date of application in Sweden.)

14712. Improvements in apparatus for recording, reproducing, and transmitting sounds. George Edward Gouraud and Horace Leonard Short, Clun House, Surrey-street, Strand, London.

14715. Improvements in and relating to thermo-electric apparatus. William Edward Evans, 27, Chancery-lane, London. (La Société Ginestes et Cie., France.)

14723. Improvements in magnetic cut-out apparatus. Leonard Andrews, 46, Lincoln's-inn-fields, London.

August 17.

14743. Improvements in electric cut-outs and the like. Herbert Fitzroy Clayton, Union Works, Huddersfield. (Complete specification.)

14759. Improvements in electric traction. Edward Henry Tyler and Arnold Greaves Hansard, 15, Kirkstall-road, Streatham Hill, London.

14794. Improvements in apparatus for use in wireless telegraphy. Thomas James Bowlker, 37, Chancery-lane, London.

August 18.

14841. Improvements in means and apparatus for telegraphing and controlling various mechanisms from a distance without wire or other like connections. James Tarbotton Armstrong and Axel Orling, 40, Vartry-road, South Tottenham, London.

Digitized by Google

14798. An attachment to ceiling roses for raising and lowering central-hole weights or fixing electrical fittings. Robert Walter Braham, 54, Farringdon-road, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Sept. 8.

1899.

16569. Accumulator electrodes. Katz.

16926. Electric measuring and indicating apparatus. Darwin, Griffiths, and Whetham.

17504. Means and apparatus for recording the deflections of pointers, magnetic needles, coils, and the like, and the fluctuations of electric currents, and for utilising such deflections or fluctuations to actuate or control various other mechanisms or apparatus. Goddin.

17593. Transmission dynamometers or torque indicators. Morgan.

18365. Central battery telephone exchange systems. Aitken.

18443. Amalgamation and coating of metals or alloys of metals with metals or alloys of metals by the aid of electricity and apparatus therefor. Frederick Foss (executor of the late Frederick Hall Snyder).

20544. Electric bell. Bowman.

20751. Device for steering electrically-driven motorcars. Andreas.

21720. Switches for electric light. Bell and Berry.

22182. Electric cables. Buchanan.

23182. Contact breakers especially applicable to induction coils. Weissmann and Wydts. (Date applied for under International Convention, April 25, 1899.)

23561. Vacuum-tube lighting. Wise. (Moore Electrical Company.)

1900.

246. Automatic electric switches or cut-outs. Headley.

2929. Electrolysers. Chapman and Batt.

5755. Manufacture of electrical insulating material. Jung, Brecher, and Kittel.

6479. Electric accumulator plate. Ribbe.

7166. Electric railways on a surface-contact system. Murphy.

9110. Contact-pieces for transmitting the current from the fixed base to the revolving or swinging top of electric searchlight projectors. Paul. (Paul.)

11026. Cord grips for electric light fittings. Lundberg and Lundberg.

11272. Means of and apparatus for preventing the premature starting of electric motors or the like used in connection with electric lifts. Hofbauer.

11429. Electromagnet of high attractive force. Vogelsang and Lindenstruth.

11659. Electric cut-out plug. Haase and Röder.

11797. Regulating devices for alternating electric current circuits. British Thomson-Houston Company, Limited. (Thomson.)

11915. Trolleys for electric railways or tramways. Tomb.

11991. Rheostats for electric motors. British Thomson-Houston Company, Limited. (Hall.)

12971. Electric switches. Bruce.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Aug. 11	804	767	+ 37	7,738	6,881
Birmingham Tramways Co.	,, 18	4,475	4,175	+ 300	142,311	135,084 *c*
Blackburn Corp'rat'n	—	—	—	—	—	—
Blackpool Corporatn.	,, 16	1 801	1,357	+ 444	15,888	12,464
Blackpool-Fleetwood	,, 18	1,973	1,919	+ 54	9,760	9,900
Bradford City Trams	,, 19	516	497	+ 19	10,019	8,222
Bristol Tramways Co.	,, 17	3,605	3,485	+ 120	—	—
Central London Ry.	,, 18	4,579	—	—	13,944 *e*	—
City & South London	,, 19	1,534	1,080	+ 454	10,535	6,769
Cork E. T. and L. Co.	,, 16	576	533	+ 43	13,288	11,997 *c*
Dover Tramways ...	,, 18	354	322	+ 32	6,510	6,141
Dublin U.T., elec. cars	,, 17	4,320	1,316	+3,004	—	—
Dublin S.D. Electric	,, 17	1,361	1,157	+ 204	—	—
Glasgow Corporation	,, 18	9,788	9,212	+ 576	—	—
Halifax Corporation	,, 19	1,036	804	+ 232	15,091	12,251
Hull Corporat'n E.S.	—	—	—	—	— *a*	— *d*
Liverpool Corporat'n	,, 11 *b*	8,779	9,072	- 293	241,154	214,371
Liverpool Overhead	,, 19	1,818	1,695	+ 123	12,193 *c*	11,762
Sheffield Corporation	,, 19	2,640	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *d* Since July 5. *e* From July 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11½-12½
—— 40,001-100,000	—	—	10½-11
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 1/16-6 3/16
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-⅞
—— 6 per cent. Cum. Pref., 1-50,000	1	—	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	108-113
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	13-14
—— 5 per cent. Pref.	5	—	5¼-5⅝
Crompton and Co.	8	—	8¼-4½
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	8	—	1¾-2⅛ xd
—— 5 per cent. Debentures	5	—	3¾-4¼ xd
—— 4 per cent. Deb. Stock, Red	100	—	91-93
—— 5 per cent, Second Deb. Stk., Prov. Crts. 70 p.ct. pd.	—	..	68 72
Electric Construction	2	—	1⅞-2⅛
—— 7 per cent. Cumulative Pref.	2	..	2⅞-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	85-89
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10¼-11⅛
—— 5 per cent. Cum. Pref.	5	..	5¼-5⅝
Williams and Robinson, Ordinary, 1-80,000	5	..	10¼-11⅛
—— 6 per cent. Cum. Pref., 80,001-60,000	5	—	6¼-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-
Bournemouth and Poole, Ordinary	10	..	11¼-12½
—— 4½ per cent. Cum. Pref.	10	..	9¼-10¼ xd
Brompton and Kensington, Ordinary	5	—	7-8 xd
—— 7 per cent. Preference	5	—	8¼-9¼ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6-6½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5-5½ xd
Chelsea Electricity Supply	5	—	6¾-7¾
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	7¼-8¼
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	123-128
County of London and Brush Provincial, Ordinary	10	—	8¼-9¼ xd
—— 6 per cent. Cum. Pref.	10	—	11-12 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¼-5
—— 4½ per cent. First Mort. Deb.	100	—	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¼-10¼
London Electric, Ordinary	3	—	1-1⅛
—— 6 per cent. Pref.	5	—	3¼-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	96-100
Metropolitan, Ordinary	10	—	14-15 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-98
Notting Hill Electric Lighting	10	—	14¼-15½
Oriental, 1879	1	—	1-1⅛
—— £5 Shares	5	—	7¼-7⅝
—— £4½ Shares, New	4½	..	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	..	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8-9
Westminster, Ordinary	5	—	12-13 xd
—— 80,001-109,437	2½	—	8¼-9½
Electric Railways.—			
Central London, Ordinary	10	—	10-10½
—— Pref. Half-Shares	5	—	5 5¼
—— ,, deferred	5	—	5-5¼
City and South London, Consolidated Ordinary	100	—	55-58 xd
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	—	138-143 xd
—— ,, ,, ,, '96	100	—	130-136 xd
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	90 93
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	17-18
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10¼-10⅝
British Electric Traction, Ordinary	10	..	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13 xd
—— 5 per cent. Perpetual Debenture Stock	100	—	123-126
—— ,, ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¼-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	—	103-106
—— Prov. Cert., all paid	—	..	96-99
Isle of Man Electric Power, 5 per cent. Pref., 1-10,000	5	..	5¼-6¼
Kidderminster and District Lighting and Traction, Pref.	10	..	9¼-10¼
New General Traction, Ordinary	5	—	2¼-2¾
—— 6 per cent. Cum. Pref.	5	—	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-19
—— 5 per cent. Cum. Pref.	10	..	10¼-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½ xd
Telephones.—			
National Telephone, Ordinary	5	—	4⅝-4⅞
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	4¼-5¼
—— 3½ per cent. Deb. Stock, Red.	100	—	97-100
Oriental Telephone and Electric Company	1	—	¾-1⅛

Digitized by Google

NOTES.

South-Western Polytechnic.—We are informed that Mr. William Henry Eccles, B.Sc., and Mr. Charles Frederick Smith, Whitworth scholar, have been respectively appointed to the posts of senior demonstrator of physics and senior demonstrator of electrical engineering at the South-Western Polytechnic, Chelsea.

Electrical Treatment.—It is gravely announced by the *Scientific American* that an ostrich in the Cincinnati Zoological Gardens is undergoing treatment by electricity for paralysis. Under this treatment the bird has been able to swing first one leg and then the other. We trust that a continuation of the treatment will not induce the ostrich to attempt the hazardous procedure of swinging both legs at the same time.

The Associated Chambers of Commerce.—The gathering of the representatives of the Associated Chambers of Commerce in Paris will commence on Sept. 5, and will in this way clash with the meeting of the British Association at Bradford. It is hoped that nearly 500 representatives will proceed to France, where a series of festivities and a little business has been arranged. In the notes in the daily Press great stress is laid on the wonderful dinner which is to take place.

American Institute of Electrical Engineers.—We have received a copy of the June and July number of the *Transactions* of the American Institute of Electrical Engineers. The volume contains an illustrated paper by Dr. F. A. C. Perrine on "The Use of Aluminium Wire and Some Constants for Transmission Lines," and the discussion in New York and Chicago of the paper by Mr. Sachs on "The Evolution of Safe and Accurate Fuse Protective Devices."

Destruction of Aluminium Works.—We are sorry to note that during a tornado recently, the Pittsburgh Reduction Company's aluminium works were almost entirely destroyed. The loss amounts to some £20,000, and the works must be closed for a very considerable period. The engineer of the works was caught by the falling walls and was very seriously injured. The company's works were situated on the banks of the Alleghany River, and covered a space of some 10 acres.

Calcutta Trams.—We are pleased to note that Messrs. Dick, Kerr, and Co. have secured yet another contract in India—namely, that for the electrical equipment of the Calcutta tramways for the sum of £70,000. The Bill for these Calcutta tramways has passed through the Bengal Legislative Council, and the company's tramway engineer has been in Calcutta for some time. These things, taken together, seem to point to the early construction of the tramways, and a speedy disappearance of the horse from the tramway tracks.

Personal.—Mr. Dunn, the superintendent of telegraphs of the Caledonian Railway for the past 33 years, has, we learn, intimated his resignation to the directors of the company. Mr. Dunn's retirement takes effect at the end of October. He has had a long connection with telegraphy, and is one of the oldest telegraph officers in the United Kingdom, and one of the few original members of the Institution of Electrical Engineers. He was also president of the conference of the Railway Telegraph Superintendents and Engineers in 1889.

Indian Electricity.—It is somewhat disappointing to learn that the report which Mr. J. W. Meares was some time since commissioned to prepare as to the feasibility of a scheme of electric lighting by water power for Simla will not be presented for a considerable time yet. One gathers from information received as to the district that a really useful scheme is quite possible. It is also interesting to learn that the Viceregal Lodge at Simla has had an electric installation placed in it, the plant consisting of three Siemens-Willans direct-coupled sets, with also a battery of Tudor accumulators.

Paris Congresses. — Our contemporary *La Mois Scientifique et Industriel* is distinguishing itself in its report of the congresses being held in the Paris Exhibition. Thus in the second part of the volume, which has just reached us, we find a number of valuable abstracts of the communications read before the Physical Congress at the beginning of the present month. These abstracts are quite as, if not more, useful to the scientific man as the full papers, which would be too cumbersome if collected together. The rest of our notes in this issue referring to the congress are translated and condensed from the above contemporary.

The Occlusion of Gases.—Prof. J. L. Howe in his address to the American Association for the Advancement of Science discussed the present knowledge of the phenomena of the occlusion of gases by metals. It is curious that, while the fact that platinum absorbed hydrogen and that it would cause the ignition of the stream of that gas was discovered in 1823, little is known at the present time of the way in which this occlusion takes place. The author showed that other members of the eighth group of metals had similar properties to a certain degree, and lamented that more was not known of the phenomena in question. Prof. Howe had no new facts to add to his historical *résumé*.

A Valuable Patent.—It is interesting to learn that the German Government has just paid some £100,000 to the Strowger Automatic Telephone Exchange of Chicago for the patents and rights to manufacture and use the automatic switch which the company owned. The deal has not taken place without due consideration by the Germans, as a trial was made of it in the earlier part of the year, and £30,000 was paid at that time. The contract at that time was for a 200-instrument exchange to be used by the Government for six months, and if considered satisfactory at the end of that time a further £10,000 was to be paid. The installation, as well as another which was fitted later, has proved a success, and payment has been made as above recorded.

The Progress of Pyrometry.—Mr. C. Barus presented a report to the International Congress of Physics on the 6th inst. on the above subject. In it he reviewed the various systems of measuring high temperatures, such as the alteration it caused to liquids and solids. The use of measurements based on this principle is on the increase. Other methods, such as the determination of temperature by melting points, by ebullition, and by the specific heat of metals, were described; as was also a gas thermometer, which he also states gives very good results. The most accurate method, however, is that devised by Messrs. Callender and Griffiths for ascertaining temperature by means of the variation of the resistance of a platinum wire. The method is well known to our readers, and we are pleased to see the value of it adopted by the International Congress.

The Nernst Lamp.—The Nernst lamps have at last made an appearance in the Paris Exhibition, but, as with the Marconi telegraph at the British Association at Dover last year, they have been left in charge of an untechnical man. This procedure, of course, has an advantage from the owners' point of view, in that they wish to give the public a good idea of the system, but no technical details concerning the same. The lamps on view gave a good

Digitized by Google

light, just as those sent to England some 18 months ago and exhibited by Mr. Swinburne did. The visitor to the Exhibition is, however, given no chance of ascertaining what current they take, and has to believe the statement of the untechnical attendant as to the watts per candle-power. Thus, while the exhibit is exceedingly interesting in experiments on the lighting up of these lamps, it gives no indication that a commercial stage has been reached in the manufacture of them.

Tramway Obstruction.—The electric tramways at Sunderland have now been running for a fortnight or so, and have been subjected to the usual obstruction from idiots in the roadway. Unfortunately, one of the obstructors who might have caused a serious accident has not yet been discovered, although a considerable reward has been offered for information which would lead to his detection. The obstruction referred to was the placing of a heavy railway chair across one of the metals, which might have wrecked an electric car. We are pleased to see that the more usual cases of obstruction are being brought before the police court, and that heavy fines are being imposed against those drivers who refuse to draw to one side to allow the tramcars to pass. A few fines such as have been inflicted will soon convince the owners of the cars that they have not the sole right to the roadway, nor can they obstruct the general public, as they seem to think they may do.

The Marconi Telegraph.—It is stated by the daily Press that the Marconi system of telegraphy is to be extensively used on board the ships of the British navy, in consequence of the fact that it proved more successful than a rival system against which it was tried. The exact purpose for which the navy are to use the system is not stated in the daily Press, nor is mention made of the number of equipments which will be required. We trust that the news is authentic, and that it will console the company for the harsh treatment which they claim to be receiving from the Postmaster-General. The directors, after puffing the system for years as the Marconi wireless telegraph, naturally feel it extremely hard that the Government should look upon it as a system of telegraphing at all. An agitation is being organised by the Dover Chamber of Commerce to get the signalling arrangements between the East Goodwin lightship and the shore reinstated.

Bruges Harbour Construction.—It is stated that in the great works which are now going on in order to make Bruges a good port electricity plays an important part, all the machinery and apparatus being operated by its aid. The electrical plant is driven by energy supplied from a central station containing three Willans compound engines of 500 h.p., driving three dynamos at 500 volts. Some 30 motors are used in connection with the various machines, amongst which are brickmaking machines, band and circular saws, pile drivers, cranes, pumps, etc. The application of electricity is not, however, only temporary, as when the works are finished the rolling lock gates and revolving bridges are also to be worked by motors. The brickmaking machines have a daily capacity of from 160,000 to 200,000, and each is operated independently by a motor. Very heavy work is also carried on in the boiler shop, and the motors in this case have been found to be invaluable.

The Specific Heat of Water.—Prof. C. H. Griffiths reported to the Physical Congress on the above subject. In his report he reviews the work which has been done in determining accurately the value of the specific heat of water and its variation with temperature. He concludes from various determinations that the following is a fair statement of present-day knowledge: If one takes as the thermal unit the quantity of heat required to raise 1 grm. of water from 15deg. to 16deg. C. as measured on the scale of a hydrogen thermometer, then the calorific capacity which should be admitted for 1 grm. of water, as an international basis, should be $4\,187 \times 10^7$. He also concluded that the new experiments which should be accepted for the variation of the specific heat of water should be represented by the curves resulting from the researches of Barnes. He considered that the specific heat of water between 0deg. and 100deg. C. might be considered as equal to the value defined above.

Electric Motors v. Gas-Engines.—We learn from a Sheffield paper that dear coal is conducing to the increase in the number of gas-engines, and that the orders for these small gas-engines to replace steam-engines are at the present time very numerous. In view of the fact that nearly all the gas companies are increasing their rates, we would suggest that those people who intend changing over should approach their Corporation electricity supply department before entering into contracts for gas-engines. We know that in certain of the large towns the electric lighting committees have not yet reduced their tariffs for the energy for use in motors to the point they should do, but in the majority of our large towns electric motors on the public mains will be found more convenient, more economical, and, in most cases, cheaper than gas-engines. The space required is very much less, and, as regards noise and nuisance, a gas-engine will not be tolerated where once a motor has been tried.

Telephone Opposition in Glasgow.—The National Telephone Company evidently intend to make a keen fight for the telephone business in Glasgow against the Corporation exchanges. They are for this reason introducing improvements and new features. One of the improvements is naturally the complete metallic circuit, which, of course, has to be carried overhead, and which, it is said, will be in full working order in a few months time. Of course, we do not know whether the few months' will expire before or after the real competition commences. Another feature being introduced is the use of a single connection for two subscribers. This cheapens the cost of the service, but with it one subscriber only can use the line at one time. It is proposed that as many as eight individuals should be placed on the one wire, in which case it would only cost £3 per subscriber per annum. In the notice which appears in the local papers no mention is made of the fact that one of the eight subscribers could monopolise the wire at an important time and prevent the other seven from speaking.

Electric Tramways and Asphalte Pavements.—Various attempts have been made in Germany to devise a means whereby the destructive influence exerted by the passage of heavy electric tramcars upon asphalte pavements may be counteracted. Hitherto these endeavours have been without definite result, but much has been said lately in praise of a system which is shortly to be subjected to a practical test in Berlin. Contrary to ordinary practice, in which the tramrails are laid immediately upon a foundation of concrete, further resting in direct contact with the superimposed asphalte, the new method consists in laying the rails upon a bed of coarse gravel, and running a line of hardwood blocks along either side. Experience has taught that ordinary pavements, with gravel and stone foundations in place of concrete, offer the greatest resistance to the influence of electric cars. It is assumed that the gravel or stone allows the rails more play, which is advantageous, in that, despite great care in their manufacture, it is impossible to ensure exact uniformity with the gauge of the cars. The new method is also relied upon to reduce the noise caused by the cars running over the lines.

Digitized by Google

Air Storage.—It is stated in a communication by Messrs. Desgrey and Balthazard to the French Académie des Sciences that they have discovered a means of renewing air indefinitely. They propose to use the invention in divers' helmets. The process consists merely in the use of sodium bioxide, which they state has been found to possess the property of absorbing carbonic acid gas in a vitiated atmosphere, and throwing off its oxygen in exchange. Laboratory experiments have been tried with mice, which continued to live under a glass containing a fragment of moistened sodium bioxide, while under similar conditions, without the latter substance, they died by asphyxia. A diving helmet has also been devised of aluminium, coated with sodium bioxide, which enabled the wearer to remain for several hours in an atmosphere which he could not otherwise have breathed. We are inclined to believe that the discoverers of this remarkable property in sodium bioxide have somewhat hastily jumped at conclusions, and are afraid that the diver who took a few hours under water on the strength of this discovery would never dive again.

Electric Tree Felling.—We gather from the *Electrical World* that a large elm tree 42in. in diameter was recently cut down at Jacksonville, Illinois, by means of an electrically-heated wire. This tree, which proved to be slightly too large for a cross-cut saw which was available, was handed over to the electrician of a large public institution in the neighbourhood. He used for the purpose a 20ft. length of $^{7}/_{16}$ iron wire, but removed three strands of the wire in order to increase the resistance in circuit. This strand, then consisting of four wires, was heated up to a dull red in the sunlight, and naturally became considerably hotter when in the crevice in the tree. The strand was slowly drawn backwards and forwards through the tree in order to remove the soft charcoal formed, and also to admit air to complete combustion. The current used varied from 120 to 135 amperes, the voltage of the dynamo varying from 80 to 115. It took two hours and ten minutes to cut down the tree, which had the diameter above mentioned, and the operation was watched with great interest by a number of the inhabitants. It will be interesting to know how much quicker the work would have been done if the same voltage had been used to drive an electric motor geared on to a saw.

Portsmouth Telephones.—The sub-committee of the Portsmouth Corporation which is dealing with the telephone question, has received a report from Mr. A. R. Bennett that, if subscribers can only to be attracted in sufficient numbers, a municipal system could be established which would be efficient and remunerative at much cheaper rates than are charged by the National Telephone Company. Two schemes were proposed in the report—one for 1,200 lines to the exchange and one for 2,000. The cost for the smaller scheme, with 300 spare wires, would be £26,000, and Mr. Bennett estimates that the standing charges would be met when 500 subscribers had been obtained. A charge of £5. 17s. 6d. is suggested for an unrestricted service, or, as an alternative, £3. 10s. per annum with ½d. per call in addition. Another alternative would be £2. 10s. per year and 1d. per call. The Finance Committee, before recommending the town to undertake the work, desire to know how many people would become subscribers, and are asking to spend £150 on circulars and canvassing. Surely there can be no doubt that 500 subscribers could be obtained in a town like Portsmouth for connection with a telephone system with such low rates as mentioned above, and hence the cost of the canvass must be unnecessary.

Guard Wires.—The reporters of the accident which occurred at Vincennes on Monday have not, we are afraid, a clear knowledge to enable them to distinguish between telephone, telegraph, and tramway wires. The accident occurred through a balloon when ascending from Vincennes coming in contact with some overhead wires. A short-circuit ensued, which started an arc and ignited the fabric of the balloon. A large crowd was watching the balloon races, and immediately stampeded, owing to the fear that an explosion would take place. In the rush a considerable amount of damage was done, and women and children were injured. We are not told what happened to the aeronaut, who had the presence of mind to open the escape valve, but this did not prevent an explosion taking place, which set fire to the adjoining houses. We presume that if these balloon races are to be encouraged on this side of the Channel, we shall have the Board of Trade making rules to protect aeronauts from such catastrophes, and the cost of protecting them from trolley wires will have to be borne by the tramway authorities. From the description of the accident we almost fancy that in the case of Vincennes the electric light or trolley wire was cross-connected to the telephone wires. In any case, we are told that the telephones were not in working order the next day.

Guide-Books.—With the development of travel the red-backed guide-book is a sure indication by which strangers in a district can be detected. Apart from the advantages gained from railways, the extension of cyclist touring has also done much to open up new districts to the general public, and a whole series of cyclists' guide-books are now to be obtained for all civilised countries. A new type of guide-book has, however, recently been brought out in the States, which, it is stated by the *Electrical World*, will serve thousands where the cyclists' guide-books served hundreds. The new departure in question is a trolley guide-book, which covers New England and Washington. The idea is due to a lady, by name Katherine Abbott. Our contemporary adds that "according to Coleridge, the road the human being travels winds round the cornfield and the hill of vines, but according to Katherine Abbott, if you only stick to the route of the trolley car you can also see far more of the historic and romantic spots than were even contemplated in the philosophy of the old grand tour. This is not only true of Boston and of Washington, but of New York and Chicago, and will soon be true, we hope, of all the great cities of the Old World. There are plenty of guide-books, but those which are most needed for the future must follow the street car lines.

The Royal Insurance Company.—We have received from the above company a supplement to their rules for electrical installations in such cases where special safeguards have to be observed owing to particular surroundings. We must do the company the credit of saying that these rules appear to us to be reasonable in every case. Thus in breweries, distilleries, cold stores, and ice factories special stress is laid on keeping the wires free from joints and running the same on the true distribution system, by which all connections are made in distributing boxes. The company also advise the use of tell-tale earthed lamps on the switchboard, which will give a visible warning of leakages on either conductor as they occur. With drapery warehouses, etc., the risk of fire from faulty arc lamp resistance is provided against. We note that the company propose to put pressure on electrical engineers to conform to the rules of the associated fire offices by insisting on an extra charge if this is not done. We are not quite sure, however, that the associated fire offices are right when they insist on the absolute enclosure of all motors used in factories. In the circular sent to us it states that no ventilation is permitted into such mill or factory, but only

Digitized by Google

by pipe into the outside air. This means that the enclosed type of motor must be made considerably larger than it otherwise would be, and there are a number of cases where this precaution is not necessary, even in a textile factory, for which the rules are evidently meant. The air in the mill is not liable to spontaneous combustion or explosion, as it so often is in coal mines.

Electric Lighting Extensions.—There are certain areas in all our large towns in which building operations are proceeding rapidly, and in which the houses being erected are of such a class that their inhabitants are practically sure to be consumers of electrical energy. Central-station engineers working electric lighting undertakings in such areas are now able to obtain large increases of their load, if they only approach the builders of such houses in the right spirit. These builders, as a rule, are only too pleased to add any attraction to the houses which will make them sell more easily. Amongst these attractions is the statement that the houses are wired for electric lighting, and that the supply can be obtained immediately the purchaser takes possession. If this is done, it will be found that no gas-pipes will be put in, and hence the undertakers are sure of consumers in practically every house. This renders the laying of the mains a profitable outlay from the first, and also makes the calculation of the size of conductors easy, as the load can be predicted with almost mathematical accuracy. We know of certain blocks of buildings in the London district which are so wired, and are sure it will repay all central-station engineers to keep themselves well in touch with the building operations going on in their areas. It is absurd to allow at this date new houses of a good class to be erected and to be supplied with gas, because electric lighting mains are not laid near them. If gas is once used, the changing over to electric lighting is bound to be delayed on the score of cost and the vexed question of decorations being disturbed.

The International Electrical Congress.—The opening of the International Electrical Congress took place on Saturday, Aug. 18. Mr. Mougeot, French Under-Secretary of State for Post and Telegraphs, presided, and after a brilliant speech declared the congress open. The election of the president and vice-presidents was then proceeded with. Prof. Mascart had been elected president, and on his proposition Lord Kelvin was proclaimed hon. president. The vice-presidents were then elected as follows: Messrs. Moissan, H. Fontaine, and Gariel, of France; Messrs. Kohlrausch and Dorn, of Germany; Prof. Eric Gérard, of Belgium; Messrs. Carl Hering and Kennelly, of the United States; Sir W. Preece and Prof. J. Perry, of Great Britain; Prof. Jullig, of Austria; Mr. De Fodor, of Hungary; Prof. Colombo, of Italy; Mr. Chatelain, of Russia; and Dr. Turrettini, of Switzerland. Mr. M. P. Janet was nominated general secretary. Then followed the dividing up of the sections. The congress appointed the president of each section, and left it to him to appoint his own staff. The presidents of the sections are as follows: Section 1, dealing with scientific applications and measuring instruments, Prof. Violle; Section 2, Messrs. Hillairet and H. Fontaine (this section was divided into two sub-sections, one dealing with the production of electrical energy, its transformation, transmission and distribution, and electric traction, and the other dealing with electric lighting); Section 3, dealing with electro-chemistry, Prof. H. Moissan; Section 4, dealing with telegraphy, telephony, and their various applications, Mr. Wunschendorff; and Section 5, dealing with electro-physiology, Dr. d'Arsonval.

Rapid Communication.—We are now so used to telegraphic communication that any interruption in the same is looked upon as a personal hardship by every reader of a daily paper. In no instance has this interruption been more felt than in the campaign in China. All the time telegraphic communication was maintained between the sea coast and Pekin, European nations knew within a few hours the verdict of their representatives in that city as to the probability of the spread of the Boxer rising. Immediately this wire was interrupted, we were thrown back 50 years in our means of obtaining communication. Rumours of all kinds then became transmitted to Europe, and, as is always the case, the untrue news vastly exceeded in volume any items to which credence could be given. This state of affairs reminds us of what our forefathers had to submit to in times of war, when it took weeks instead of minutes for the news of victory or defeat to reach London. We trust that the uncertainty of the last few months in obtaining news from the representatives of Britain and of other nations in Pekin, will remind all concerned of the disastrous state of affairs which would result from a war with this country in which cable communication with our Colonies was interrupted. This reminder should be quite sufficient to lead to the establishment of all-British cables to our various Colonies and dependencies. In the laying of these cables great care should be taken that the routes should not be known to any outside the Government, so that the work of interrupting them would be rendered difficult. It would, of course, be rather difficult to keep the general lines absolutely secret, but it would be well worth a considerable extra expense to prevent the position of the cable being known within 100 miles, even if it became necessary to dispatch bogus cable ships or even to lay lengths of dummy cable.

The British Association.—The Bradford meeting of the British Association, although it does not open until Wednesday next, seems, from all appearances, to merit success. Thus the local committees have organised early, and from certain hints we gather that they have taken steps to avoid the great defects of the Dover meeting. It will be remembered that at Dover the accommodation was limited, and that speculative individuals secured this limited accommodation with the idea of making large profits out of the members attending the meeting. The natural outcome was that the members did not pay the price demanded, and the meeting suffered for lack of attendance. At Bradford the local committee have even organised the hotel accommodation, with, we trust, advantageous results. The reception rooms, which are situated at the grammar school, will be opened on Monday next from 2 p.m. to 6 p.m., and on the succeeding weekdays from 8 a.m. to 6 p.m. On Sunday, Sept. 9, the rooms will be open from 9 to 10.30 in the morning and 2 to 5 in the afternoon. Most of the clubs in Bradford will keep open house to the members of the association, while the Bradford, the Ilkley, and Ravenscliffe golf clubs will do likewise. The social functions of the meeting are the following: On Thursday, Sept. 6, a conversazione by the Mayor and Mayoress in the St. George's Hall, preceded by a reception by the local committee in the municipal technical college from 3.30 to 6 p.m. On Friday the local committee have organised a smoking concert. In the next week, on the Tuesday, the Mayor and Corporation give a soirée in St. George's Hall, and there will be a full-dress concert in the same place the next evening. The garden parties and excursions are too numerous to mention in our columns. A representative list of works in the district is given as being open for inspection, amongst which are the Corporation electricity works, where Mr. R. A. Chattock will be pleased to welcome visitors. The destructor works of the Corporation will also be open for inspection, under the supervision of Mr.

Digitized by Google

McTaggart, the engineer. We gave in our last issue a list of the papers to be read in Section B, from which it will be seen that the business side of the meeting is in good hands.

Electric Waves.—The following is an abstract of a paper read by Messrs. Blondlot and Gutton before the International Congress of Physics and Electricity at Paris this month. The subject of the paper is the rate of diffusion of electric waves. In the paper the authors give particulars of various experiments which they did to determine this rate. After the attempts of Hertz and Lecher, Mr. Blondlot has found the rate of diffusion. The length of the waves of a sounder is connected with its tune of vibration and with its velocity by the equation $\lambda = V T$. The length of the wave, λ, he determined experimentally by placing the sounder between two wires, along which he diffused the waves, and by measuring the width of the wave at the bottom. The period, T, he obtained from Lord Kelvin's equation, $T = 2\pi\sqrt{L C}$; the capacity is measured and the self-induction calculated. In continuation, Mr. Blondlot has measured the rate of diffusion of an electrical impulse of short duration by a method which is independent of theory. He measures the time taken for it to travel along a copper wire of great length. Experiments conducted on a different principle have been made in America, first by Messrs. Trowbridge and Diane, and then by Mr. Clarence Saunders. These scientists measured the length of the wave of electric oscillations which travelled along two parallel copper wires, and obtained the corresponding period by photographing the reflection of the spark in a revolving mirror. The equation $\lambda = V T$ gives the velocity. Finally, Mr. MacLean has measured the rate of diffusion of the waves in air. He measured the length of the waves given off by an exciter and reflected back by a metallic mirror, and then determined the period by photographing an oscillating spark. The figures given by these three different experiments agree very well, and are similar to the figures for measuring the velocity of light or the coefficient of transformation of the units.

Electro-Synthesis—The following is an abstract of a paper by Mr. O. Dony-Hénault which appeared in the *Zeitschrift fuer Elektrochemie*. The abstract appears in *Science Abstracts* for August, and reads as follows: "In the electro-synthesis of organic compounds two classes of reactions are to be distinguished—those in which the compound is formed by the inter-action of the ions, as in the formation of ethane by the electrolysis of acetic acid, and those in which the liberated ions act on a non-electrolyte in the vicinity of one of the electrodes, as in the reduction of nitrobenzene to aniline. This paper is the first of a series in which it is proposed to study reactions of the second class more systematically than has hitherto been done. Stress is laid on the importance of ascertaining the exact experimental conditions favourable to each synthesis, and the E.M.F. at the working electrode is considered to be of more value than the current density as a measure of the chemical action of the ions. Every organic compound capable of entering into reaction with the liberated ions acts as a depolariser, and the requisite condition for the decrease of potential is that the reaction shall take place with loss of free energy. Thus the electrolytic decomposition point for chlorine ions in normal hydrochloric acid is 1·31 volts (compared with hydrogen), whilst in the presence of phenol the required E.M.F. is reduced to 0·9 volt. Accordingly, as some preliminary experiments have already indicated, the quantitative conversion of phenol into one or more chlorine derivatives should be made possible by careful regulation of the E.M.F. Similar observations apply to the preparation of bromine derivatives of phenol. A series of experiments, described in detail in the paper, has been carried out on the electrolysis of dilute sulphuric acid in the presence of methyl and ethyl alcohols. The results show that by keeping the anode potential between 1·3 and 1·66 volts throughout the electrolysis a quantitative conversion of ethyl alcohol into aldehyde is effected; with higher potentials the yield of aldehyde diminishes, and acetic acid and ethyl hydrogen sulphate are formed. In the case of methyl alcohol the author confirms Renard's observation that formaldehyde is not produced, the primary oxidation product being probably methylal. The paper concludes with some remarks on the analogy between chemical and electrochemical modes of oxidation, and it is shown that the limited oxidation of alcohol to aldehyde can be effected chemically by means of cupric oxide or lead peroxide in alkaline solution."

Illumination.—Dr. Louis Bell still continues his series of articles on the elements of illumination in the *Electrical World*. In his eighth article he deals with the distribution of lights for interior illumination, and with the actual illumination in candle-power per square foot which it is necessary to obtain. The author gives formulæ for these principles, introducing the factor for the effect of diffused light from the ceiling or walls. He points out that the diffusion does not materially change with the position of the lamps in the room. In other words, a change in the position of the lamps makes but a small difference in the intensity of the illumination. In fact, in an ordinary room the moving of the lights from their usual height up to the ceiling does not seriously affect the illumination if the walls and ceiling are of good diffusing media. Of course, if the walls are dark, such a change makes a considerable difference. In this case Dr. Bell suggests that reflectors should be placed behind the lamps if they are placed near the ceiling. But the reflecting media must be placed so that they do not give the appearance of beams giving definite bright areas. In order to avoid this, ground or frosted bulbs should be used. The author concludes that about 1 c.p. for three square feet of floor surface should be provided, which is equivalent to providing one 16-c.p. lamp for about every 50 square feet. This is certainly quite sufficient, and from our actual experience we should say that it is more than is required in many cases. The author compares the standards adopted by other experts, such as Uppenborn, who advocates 1 c.p. per 3·6 square feet; Piazzoli, who advocates 1 c.p. per 3·5 square feet; and Fontane, who suggests 1 c.p. for every seven square feet. For ordinary domestic lighting Dr. Bell considers that a good plan is to give a diffused illumination of, say, 0·5 candle-foot for the whole of the room, together with a working illumination of from 1 to 1·5 candle-feet in addition for any parts requiring special lighting. The most important rule for domestic lighting is, in his opinion, never to use an incandescent or other brilliant light unshaded. Either ground or frosted bulbs should be used, or opal shades or holophane globes. Ornamental shades of coloured glass or fabrics are useful for harmonising with the surroundings, but, of course, they are rather wasteful of the light. In conclusion of the eighth article, Dr. Bell gives the number of lamps he would use in the various rooms of a house, and also the square feet area per candle-power in these rooms. These are as follows: the square feet per candle-power in the hall 4·7, in the library 3·1, in the reception-room 7, music-room 3, dining-room 2·7, billiard-room 2·3, bedrooms 7, dressing-rooms 4·7, servants' rooms 9·4, and in the bath-rooms 5,

Digitized by Google

SUNDERLAND TRAMWAYS.

The first section of the Sunderland tramways to be worked electrically was opened for traffic on the 15th inst., after having been tested by the Board of Trade and Local Government Board inspectors. As will be remembered, the whole of this tramway work has been placed in the hands of Mr. J. F. C. Snell, borough electrical engineer, who has had to design all the equipment and the overhead construction. It is worthy of note that the work of reconstruction has been very quickly proceeded with. In fact, the Corporation of Sunderland only received sanction to their Tramway Act last year, so that little over 12 months has elapsed since the sanction was given, and yet the first section of the tramways is now running electrically. The actual work of reconstruction was only commenced on Nov. 1 last year. The line now open consists of the Christchurch and Roker road, which is a total route of four miles and one furlong of single track. Twelve miles of track are, however, being constructed for electrical working, while under the Act the Corporation are empowered to provide 23 miles of track.

The gauge adopted in Sunderland is 4ft. 8½in., which allows of very easy running. The lines in question were previously equipped for horse traction, and it was stipulated in the contract for reconstructing the track that the work must be carried out without interfering in any way with the tramway service. The new rails, which are of considerably heavier section than the previous ones, weigh 96lb. per yard. They are of the girder type, 7in. in depth, and were supplied by the contractor in 30ft. lengths. The fishplates weigh 64lb. per pair, and a sole-plate is laid under each joint, securely bolted to the under flange of the rails. This tends to prevent the rails sinking into the concrete at the joint owing to a slight yield in the fishplates. These rails are laid on a 6in. bed of concrete. Some very good special work has been done at the crossings by the contractors. The space between the rails is in some places filled in with creosoted wood blocks, while in other places Aberdeen and Norwegian granite setts are used to make up the roadway. The contractors for the reconstruction of the track were Messrs. Dick, Kerr, and Co.

The overhead equipment was supplied under and directed by the British Thomson-Houston Company. Fig. 1 shows the meeting of two tramcars on a section of the road equipped on the central pole construction. Fig. 2 is a view taken at a point at which the central pole construction merges into a span-wire construction, while Fig. 3 is a typical example of the side-pole type of overhead work. At the base of the column in Fig. 3 will be seen a section switch pillar. These are placed at every half-mile along the route, so that the trolley wires are split up into half-mile sections for convenience in isolating faults. Care has been taken throughout to give a flexible suspension to the trolley wires, which has the additional advantage of giving double insulation. The diameter of the trolley wire used at Sunderland is ·325in., and it is supported at an average height of 21ft. from the ground. The whole of the overhead accessories and materials are made of gunmetal, except, of course, where insulation is required. The feeders supplying the tramways were supplied by the Callender's Cable and Construction Company, Limited, and are drawn into Sykes's earthenware conduits, which were laid along the roads in the clear while the tracks were being reconstructed. There are four feeders provided for the present contract of 12 miles of track. One of these commences with ¼in. in section, and divides up into two ends, each ·122 to a square inch. The other feeders are ·2 of a square inch in sectional area, reducing at their ends to ·122 square inch. Great care has been taken by Mr. Snell in the design of the return circuit for the current; thus the whole of the rails are carefully bonded together and the tracks are bonded opposite every pole. There are clear way bonds also placed half-way between each pair of poles. Besides the conductivity thus given in the track for the return current, Mr. Snell has also provided two negative feeders, which are connected to different parts of the system and go back to negative boosters in the station. These negative boosters are capable of dealing with a current of 250 amperes, and can give a voltage of 30 volts. The excitation in the usual way is provided by the feeder current going through a series cell; but a second method of excitation by means of a shunt coil is provided, so that the boosters can be worked even if the feeder connected to the series turns is not

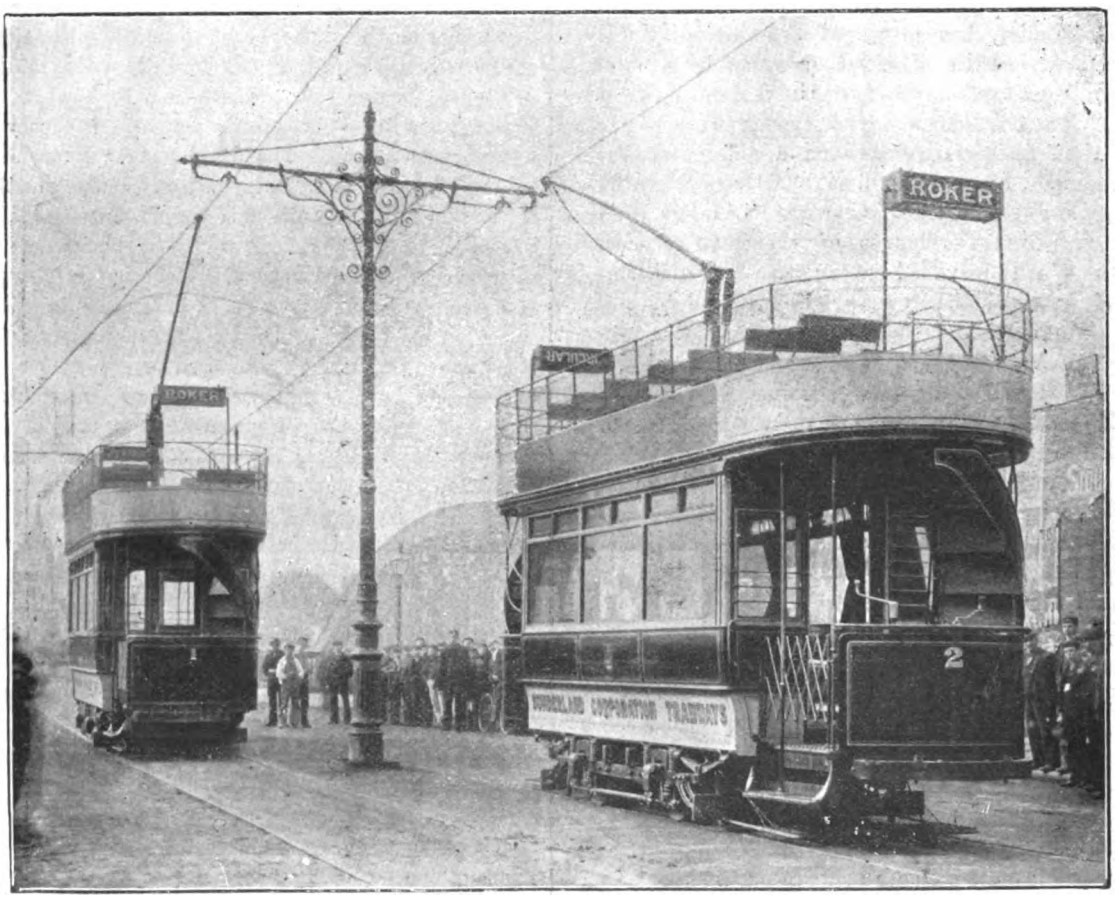


FIG. 1.—The Sunderland Electric Tramways.

Digitized by Google

being used. We understand that Mr. Snell has based his calculations on a drop of voltage between any two points on the return circuit of 3½ volts—*i.e.*, one-half that allowed by the Board of Trade as a maximum. This will provide margin for contingencies, such as loose bonds, etc. These negative boosters have not yet been put to work.

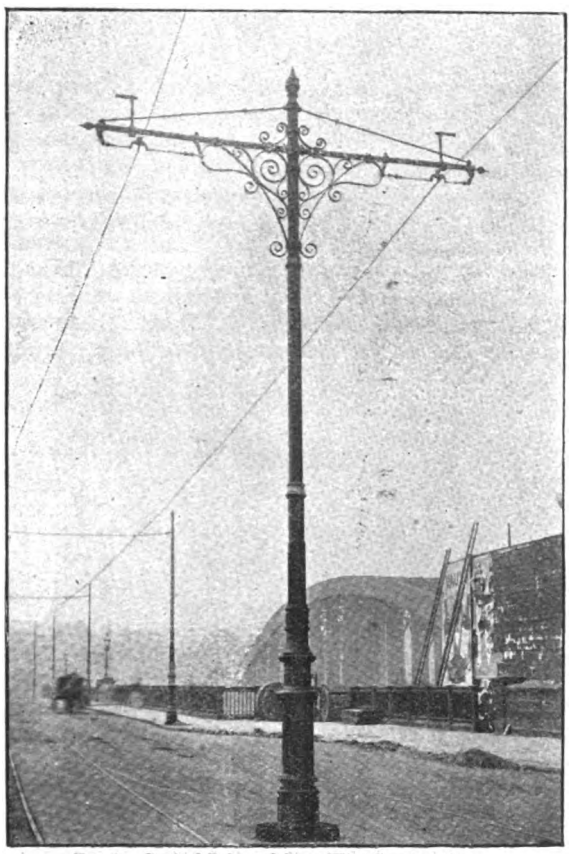


FIG 2.—Central Pole and Span-Wire Construction.

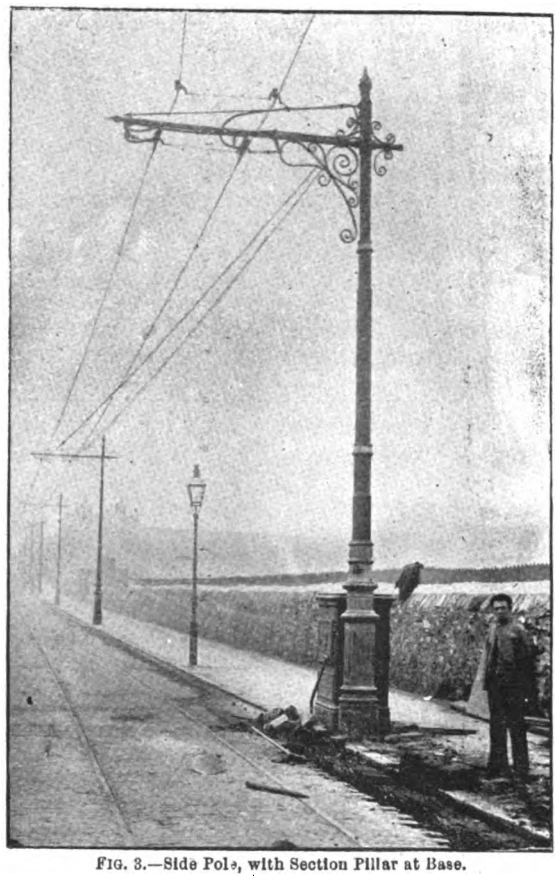


FIG. 3.—Side Pole, with Section Pillar at Base.

The first instalment of cars consists of 12 double-deck single-truck cars, of the type which is shown in our illustration (Fig. 1). These are equipped with Walker motors and controllers, and have three distinct brakes—*i.e.*, a standard air-brake, an electric emergency brake, and a hand-brake. These cars are able to seat 56 persons, of which 22 are carried inside and 34 outside. The staircases at either end of the car are made with the reverse spiral to that which is usual, which gives much greater safety to passengers ascending them. It will be seen from the illustration that there is no break in the guard rail running round the upper deck of the car, as is too often the case with the older types. Besides these, there are to be supplied six double-bogie cars, which are to be mounted on maximum traction cars, and are capable of carrying 70 passengers. Besides there are to be used eight single-deck cars, only seating 30 passengers, which will be employed on the Tatham-street route, where a bridge prevents the use of a double-deck car. In fact, the height available is only 13ft. 6in., and the road cannot be lowered. At present the principal car-shed is at the Wheatsheaf, where 50 cars will be able to be accommodated. The designs, however, are for a new shed and repairing shops on the south side of the river, which will hold 60 cars. These new sheds will be on the Hilton-road route.

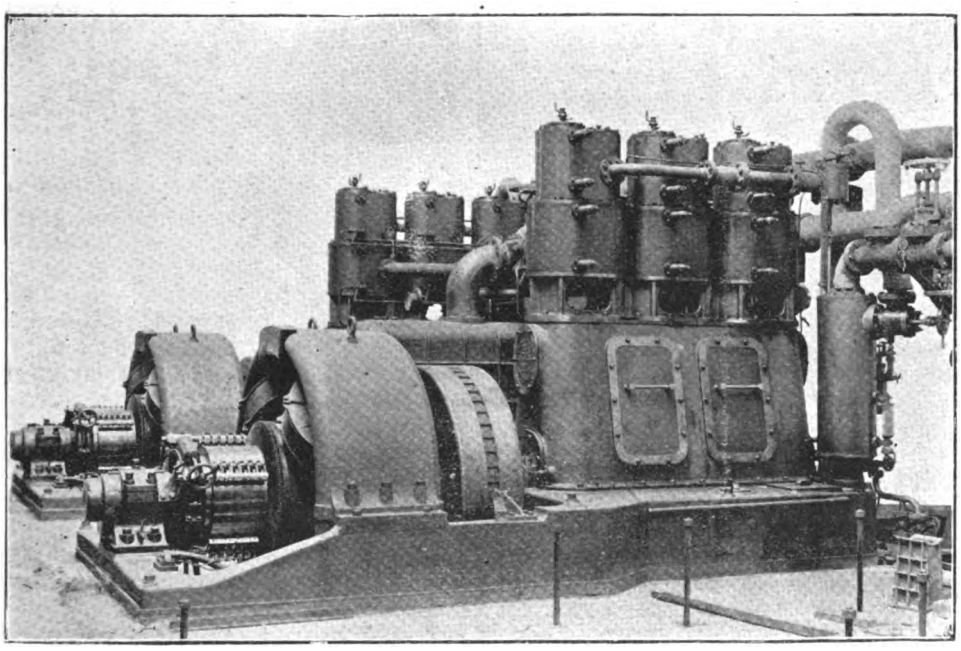


FIG. 4.—View of Two of the Traction Generating Sets.

The energy for these tramways is taken from the Dunning-street lighting station of the Corporation, where three steam generators of 450 h.p. are being installed for

Digitized by Google

tramway work. Fig. 4 is a view of two of three generating sets, which consist of Bellis's three-crank compound engines direct coupled to four-pole dynamos, made by the Sunderland Forge Company. The switchboard (Fig. 5) was manufactured and supplied by Messrs. Moon, Lochlin, and Co. The engines take their steam from Galloway boilers, which are also used for lighting, and which will be seen in Fig. 6. Messrs. E. Green and Son's economisers are used in the flue from these boilers. The exhaust steam from the engines passes into Wheeler surface condensers, an independent condenser being provided for each pair of engines. In connection with the condenser is used a Barnard cooling tower, in which an up draught is maintained by means of an electric fan, supplied by the Sunderland Forge Company. In order to provide for emergency loads, induced-draught fans are provided in the main flues. This induced-draught apparatus delivers its exhaust into an auxiliary steel chimney. This apparatus was supplied by Messrs. Dutilh Smith, McMillan, and Co. In the near future mechanical stokers and a coal-conveying plant are to be added. We understand that the load on the station for light is increasing so rapidly that a new power-house is shortly to be erected in the town, from which both light and power can be supplied.

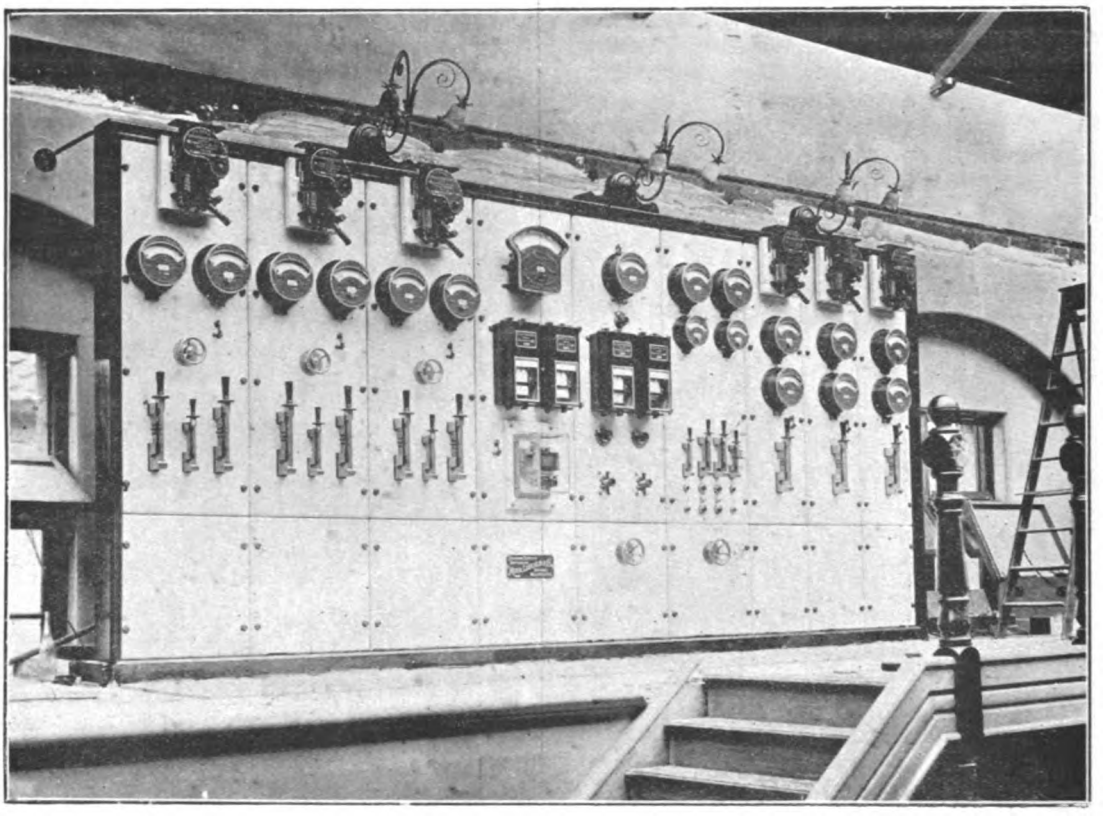


FIG. 5.—The Sunderland Traction Switchboard.

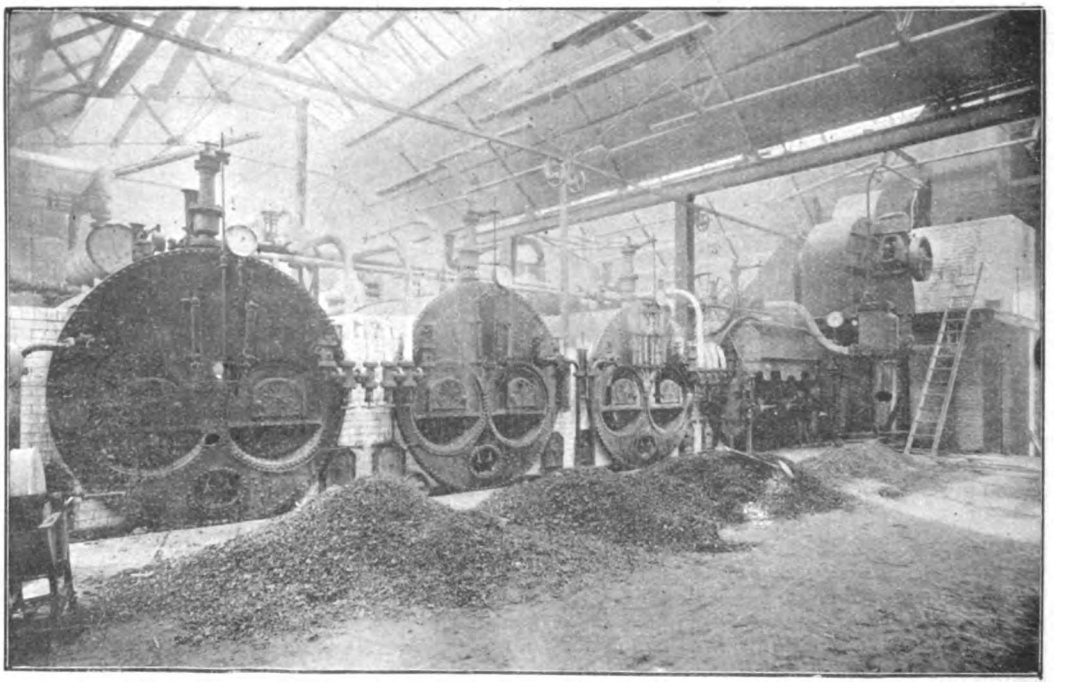


FIG. 6.—View in the Boiler-House.

On the occasion of the opening ceremony on the 15th inst. a lunch was given in the town hall by Mr. Councillor Trewhitt, chairman of the Tramway Committee. After the lunch "The Success of the Tramways" was proposed by Mr. Hopkins, C.E., and was responded to by Mr. Trewhitt, who gave a history of the undertaking and how it was taken up by the Corporation. The usual visits had been paid to other towns, including some on the Continent.

Digitized by Google

The specifications had all been prepared by their own borough electrical engineer, Mr. Snell, together with their borough surveyor.

After lunch and speechmaking was over, a number of ladies joined the party, which boarded the cars drawn up opposite the town hall. An opening run was then made to Christ Church, after which a complete journey to Roker was made. Sunderland, as is perhaps well known, lies on both banks of the Wear, and comprises large shipbuilding yards, docks, and coal staithes. Roker is a pleasant seaside suburb of Sunderland, north of the river, and a favourite resort of the townspeople in the summer time. This has caused the section of the tramways which joins Roker to Sunderland to be first equipped with electric traction.

After examining the electric tramways at Sunderland one of the things that strikes us most is that there are so many kinds of overhead equipments. Thus, Fawcett-street, which is the finest street, has been equipped for the most part with rosettes and span wires, but it seems a pity that rosettes could not have been used in the case of the whole of Fawcett-street, but it is understood that the quality of the property would not allow of this. In other streets two single poles carrying a span wire are used, notably on the bridge crossing the Wear. In others a short bracket pole is used, one on each side of the street, in others a long bracket pole on one side of the street,

MR. J. F. C. SNELL, BOROUGH ELECTRICAL ENGINEER, SUNDERLAND.

while in others centre poles are used. Evidently the Sunderland Corporation do not mind having a considerable number of poles in the streets, as besides the poles for the overhead equipment, there are the poles for the electric lighting, as the lighting is not done from the tramway poles.

The permanent-way work and the overhead equipment, which was all done by Messrs. Dick, Kerr, and Co., strikes one as having been done in an exceptionally sound and substantial manner, and owing to the fact that there are few curves, the overhead work cannot be said to offend the eye of even the most fastidious person, and strikes one as considerably neater than that which one has seen in some other towns. We should certainly advise corporations to visit Sunderland, and see how little obstruction is caused by this system when well carried out.

The work must have been carried out very expeditiously by the contractors, whose resident engineer was Mr. Hay, who we did not notice as being present at the opening. We understand that the overtime and all-night work which this class of work often necessitates had made it necessary for him to take a holiday, which the completion of the work enabled him to do.

We understand that the chairman (Mr. Trewhitt) is very largely responsible for inducing the Corporation to go in for electric traction, and he is to be congratulated on having engineered the scheme through the Council in the successful manner he has done. Similar congratulations are due to Mr. Snell for such of the first portion of the extensive scheme of electric traction he has designed. The photographs from which our illustrations were prepared were taken by Mr. J. W. French.

TAUNTON ELECTRICITY WORKS.

The official inauguration of the extensions to the electric lighting plant at Taunton and the remodelling of the station was referred to in our recent issue. The present time seems to us to be a suitable one at which to review briefly the history of the electric lighting undertaking at Taunton. At the same time particulars of the economies which have been effected by discarding the old plant and laying down new will be of interest to all, and particularly to those unfortunate central-station engineers who are expected to make good returns with obsolete plant.

Taunton claims to be the first town in England to establish street-lighting by electricity on a permanent basis. It was in 1886 that Mr. H. G. Massingham introduced the electric light for his own and adjoining premises in Taunton. This led to a desire on the part of the townsmen to have a general system of lighting, and after considerable opposition and a three months' trial of arc lighting in the parade the Town Council granted Mr. Massingham's company a contract for street-lighting. The

THE MAYOR OF TAUNTON.

arc lighting in this instance was carried out on the Thomson-Houston system by means of series lamps supplied by open-coil arc lighters with spherical armatures. At the same time an alternating-current plant was laid down which gave a supply for incandescent lighting for private houses and shops by means of transformers placed in the consumers' houses. Of course, the capital obtained by this company was not large. On the other hand, the price of electrical machinery was high, and the efficiency of the same was exceedingly low when compared with the result which can be obtained at the present time. The final result was that, while the company was able to pay a dividend for a few years, it could not meet its depreciation charges, nor obtain the additional capital required to improve the plant and extend the system of lighting. Thus, after the public lighting had been done by the company for about seven years, it was ultimately arranged that the Corporation should buy the whole of the undertaking. We believe that there must be some Irish blood amongst the leading inhabitants of the town, which would account for the strenuous opposition which the proposal to purchase called forth. Reports and counter reports, rival experts, and endless newspaper war, ended in the Corporation gaining the day. The electric lighting undertaking as a municipal work was then handed over to a committee, of which Alderman Potter was chairman, and he has had this honour and the heavy responsibilities of the post ever since. Before proceeding to the works as now arranged, a

Digitized by Google

few notes on the old equipment will be of interest. Thus Fig. 1 shows a general view of the old plant in the engine-room, from which it will be seen that slow-speed horizontal steam-engines were used to drive a countershaft which occupied the whole of the middle of the engine-room, while from this countershaft were driven the various arc lighters, etc.

In Fig. 2 we show a group of four of these Thomson-Houston arc lighters, while Fig. 3 is an illustration of the complicated system of belts and guards which was employed. In the background of this last view a certain amount of the new plant can be seen. As an example of the variety of the plant in the station for the conversion, we may mention that in 1896 the Corporation had one 50-h.p. Bumsted and Chandler engine which ran at 380 revolutions. The two horizontal engines seen in the illustrations were of 75 h.p. each and ran at 128 revolutions. These were of the Ruston and Proctor make. Besides these there was a Belliss engine of 180 b.p. and two Willans engines of 135 h.p. The Willans engines were, we believe, used for belt driving. The collection of alternators of the Thomson-Houston make included one of 30 kw., two of 70 kw., and one of 90 kw. These worked at a voltage of 2,000, and at that date were mostly employed in supplying transformers in consumers' houses, although at that time a few lengths of low-tension distributors had been laid. The arc lighters were designed to give 1,500 volts. As in the boiler-house a similar diversity of plant was to be found, it is not to be wondered at that the cost of coal per unit sold was considerable.

ALDERMAN W. POTTER, CHAIRMAN OF THE TAUNTON ELECTRIC LIGHTING COMMITTEE

MR. E. B THORNHILL, BOROUGH ELECTRICAL ENGINEER.

It was in the early part of 1898 that Alderman Potter and his committee advocated that this station should be remodelled. It was then decided to call in an expert adviser, and Mr. E. Manville, of the firm of Kincaid, Waller, and Manville, was commissioned to prepare plans and specifications for the entire reorganisation of the work. Mr. W. H. Couzens, who for some years was the borough engineer at Taunton, and now is with the above firm, has had charge of the work for Mr. Manville, and his knowledge of the local situation has done much to enable the changes to be made without interfering with the continuity of the supply.

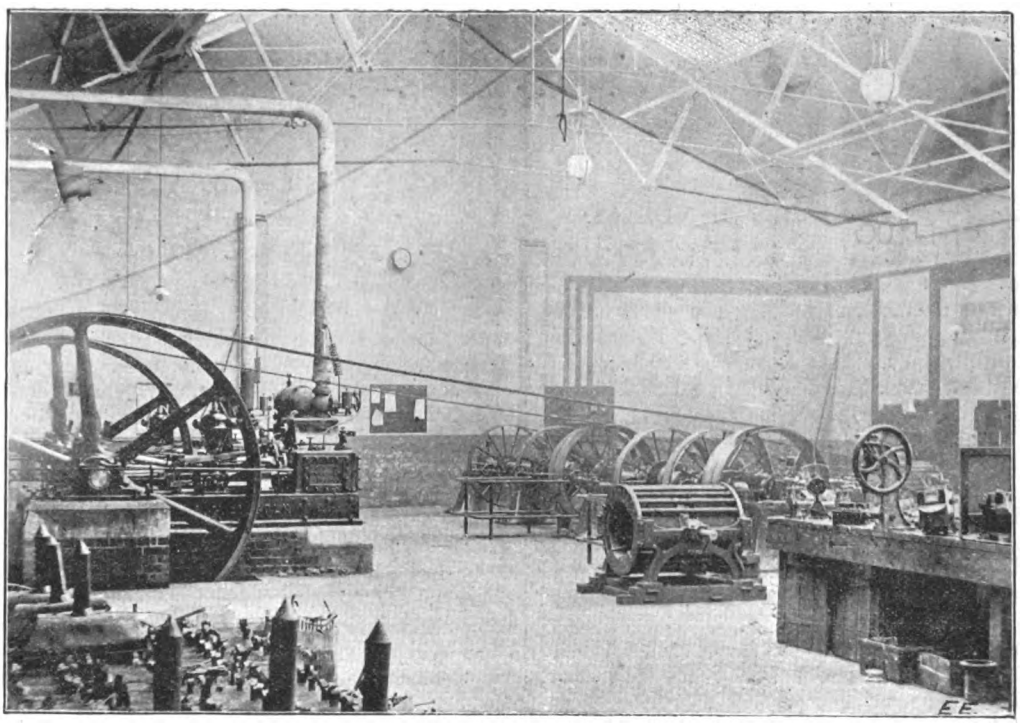


FIG. 1.—Taunton Electric Light Station as equipped with the Old Plant.

(To be continued.)

Digitized by Google

THE ELECTRICAL ENGINEERS' CONFERENCE IN PARIS.

[BY OUR SPECIAL CORRESPONDENT.]

THE VISIT TO MOLINEAUX.

On Friday afternoon the members of the two institutions assembled at the Gare St. Lazare, where they were received by M. Clérault, chief engineer of the Compagnie de l'Ouest, and M. Mazen, engineer, who conducted them over the various installations. A special train conveyed the members to Molineaux, and before visiting the electrical generating works, M. Mazen described the leading features of the scheme which is being carried out by the Compagnie de l'Ouest for equipping the line on the left bank of the Seine from the Gare St. Lazare to Versailles with electrical traction. There are certain difficulties in working this line, which has a length of a little more than 11 miles, owing to the fact that on a long section, where the new line has to cross the heights between Meudon and Viroflay, the gradients are as much as 10 per cent. It was found that the only economical way of working this line was by running electric trains with a third rail. The construction of the tunnel at Meudon, which has a length of more than 1·9 miles, presents some difficulty in consequence of the presence of loose sand, but these drawbacks are being successfully overcome, and the line will shortly be completed. The Molineaux installation has been carried out by the Compagnie Générale de Traction, and the electrical plant supplied by the Westinghouse Company. It generates triphase current at 5,000 volts, which is transformed at the Champ de Mars, Meudon, and Viroflay sub-stations into continuous current at 550 volts.

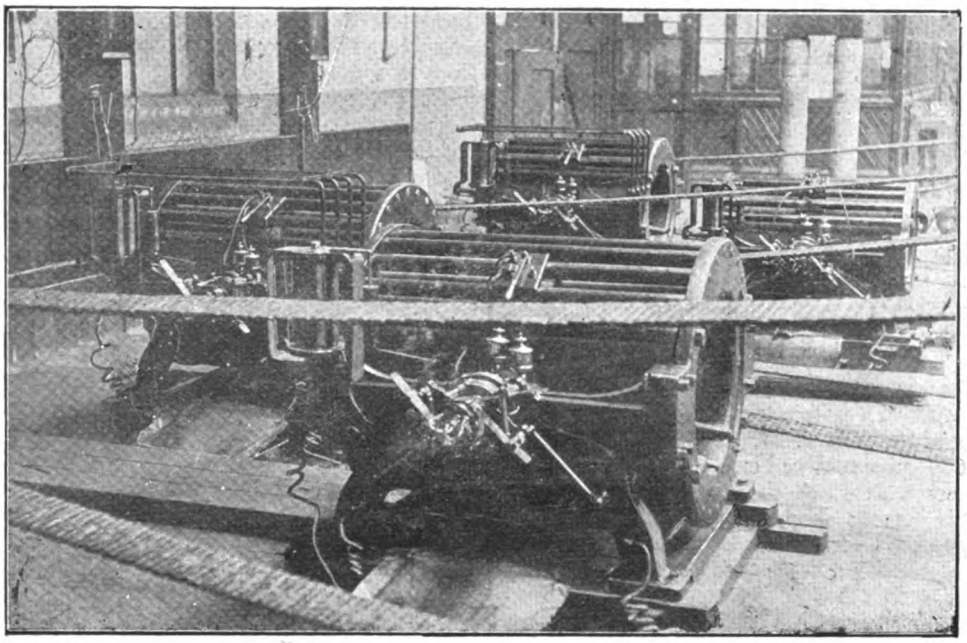


FIG. 2.—Group of Thomson-Houston Arc Lighters as previously used at Taunton.

The current is not only employed for traction purposes, but is used for operating the lifting gear and other mechanism in the stations, and for working a large number of pumps, machine tools, travelling cranes, etc. Electrical traction is at the present confined to the section between the Champ de Mars and the Gare des Invalides, where it is largely used by visitors in going from one part of the Exhibition to another.

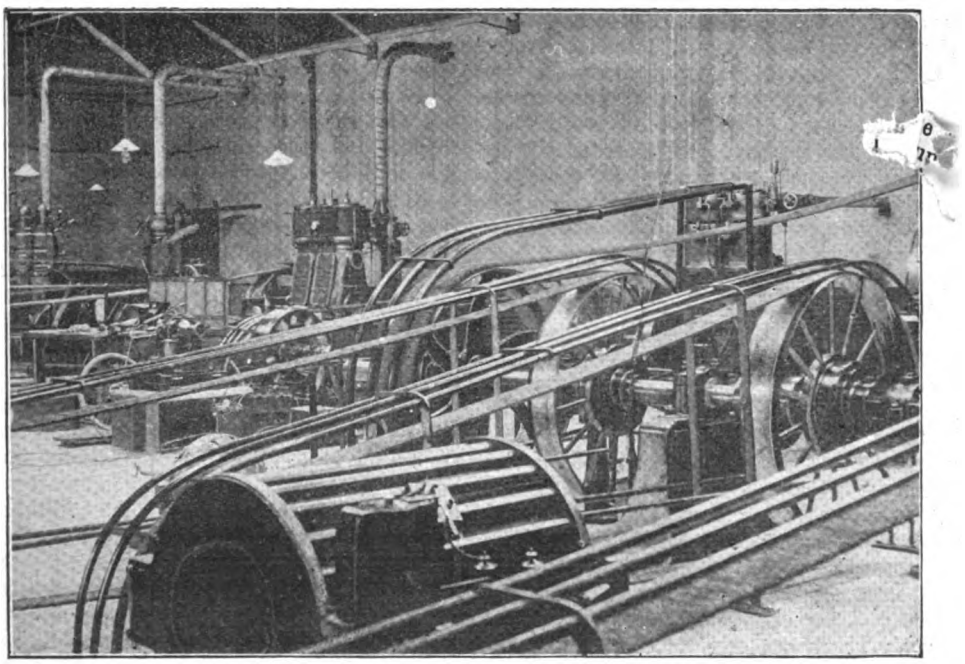


FIG 3.—View of the Arc Lighters, showing the Countershaft, Belts, and Guards, at Taunton.

The members were then conducted to the generating station, which will eventually contain nine dynamos, of which six will be driven by four-cylinder triple-expansion horizontal steam-engines, while the three others, which are already at work, are operated by horizontal compound engines. These two systems are being adopted with a

Digitized by Google

view of instituting a comparison between them. The building has a length of 365ft., and when the installation is completed it will be the largest in France. Current for the section of the line already working, as well as for operating the machinery in the stations and in the workshops, is generated by three dynamos of the flywheel type, driven by two compound engines constructed by Dujardin et Cie., of Lille. The rest of the building, where the other machines are being laid down, is boarded off, but judging from the progress being made it seems as if the whole installation will be completed before long. The dynamos have an output of 800 kw., and for short periods will run up to 1,000 kw. In this building are two travelling cranes, each able to lift 25 tons. Behind the engine-room is the boiler-house, which will eventually contain 27 semi-tubular boilers, constructed by Meunier et Cie, of Fives-Lille. Nine of these boilers are at work, and the rest are under construction, to supply steam to the engines now being laid down.

From here the members were conducted to the pumping station, where there are three centrifugal pumps, each driven by an electric motor of about 40 h.p. These pumps draw the water from the Seine into a basin and elevate it to a reservoir, where the water is always maintained at the same level, so as to secure a constant feed for the condensers. When the tank is full, the water in the basin has attained a certain level which automatically stops the working of the pumps. Each of these pumps has a capacity of 31,600 cubic feet an hour.

The thoroughness with which the installation is carried out is seen in the testing shop, which is equipped with every possible apparatus for testing the condition of the high and low pressure mains, the running of the alternators and steam-engines, as well as the working of the boilers and the electro-mechanical plants at all the installations now completed and about to be laid down by the Compagnie de l'Ouest. Arrangements are also made for testing every kind of apparatus supplied by manufacturers before they are accepted by the company. These comprise pressure indicators, tachometers, manometers, and all necessary apparatus for testing the condition of the steam and compressed-air plants, voltmeters, ammeters, wattmeters, galvanometers, etc., photometric instruments, and the necessary apparatus for testing the insulation of alternating current cables for voltages up to 50,000 volts, as well as for monophase, two-phase, and three phase currents from 5,000 volts to 2 volts, and continuous current from 10,000 volts down to the lowest pressure. In an adjoining room there is a feeder board, where the current is brought from the alternators by one cable of 5,000 volts, and split up to supply the feeders. Each feeder has its separate meter, and a duplicate meter is provided in case of accident. The high-tension main is composed of cables in which the three conductors are insulated with paper. The section of the cable varies from 25mm. to 150mm., and it is laid along the side of the railway in sand and covered by earthenware slabs and metallic wire. Each cable branches off into two cables at the sub-station, so that in case of leakage or other defect in one, the other can be used without interfering with the service.

On leaving the installation the members were conveyed by a special train to the Champ de Mars sub-station. This installation is composed of two separate parts—one for lighting the Champ de Mars station and working the various machines, turntables, lifting gear, and the like, and the other for supplying the energy required for traction. In each sub-station there is a special plant for transforming the triphase current into continuous current at 125 volts for lighting purposes and for operating cranes, turntables, and other machinery. There are two or three groups of transformers in each sub-station, and each group comprises a static transformer for reducing the tension from 5,000 volts to 100 or 200 volts, and a motor operating a generator for producing continuous current at 125 volts. The three sub-stations for transforming the current for traction purposes are situated at the Champ de Mars, Meudon, and Viroflay. Each has a transformer reducing the triphase current from 5,000 volts to 340 volts, and a rotary converter receiving the triphase current at 340 volts and transforming it into continuous current at 550 volts. These converters are got up to speed by means of a small machine producing continuous current at 550 volts.

The visitors now utilised the electric railway for reaching the Gare des Invalides. The trains at present running are nothing more than tramcars, but they will be replaced by larger vehicles when the whole line is in working order. In the stations the conducting rail is protected by boards which are inclined inwards on either side, so that the edges project slightly above the level of the rail, leaving just enough room for the contact-piece to pass between them. The rail is insulated by wooden blocks steeped in paraffin. The wood is boiled or rather left in a bath of paraffin at a very high temperature for about 24 hours, and it appears that this preparation results in an entirely satisfactory insulating material. On arriving at the Gare des Invalides the members proceeded to the machine shop, which is a particularly interesting building, and M. Mazen explained that it might be regarded as the cradle of electric traction in France, as it contains the first electric locomotive to convey passengers in that country. It is simply an ordinary locomotive frame upon which has been placed four Heilmann motors. These motors, constructed by Brown, Boveri, and Co., drive direct, and in order to give the required elasticity the motor carries at each end a metallic plate with pin projections at right angles to the plate, so that each pin is between the ends of two spiral springs fastened between the spokes of the wheels. There are four pairs of springs on each wheel, and, as may be understood, their purpose is to gradually overcome the inertia in starting. The motor is of the four-pole type, and is entirely enclosed. Ten electric locomotives of 800 h.p. are now under construction. In four of them the motors are geared with spur-wheel gearing, and in the others they are mounted direct on the axle. Another interesting thing in the machine shop is an electric crane, which is operated by a cable hanging down from the centre and carrying a small hand switch, which gives six separate movements to the crane and the winding gear.

The Compagnie de l'Ouest has not confined its attention solely to electric traction, as is seen in the adjoining compressed-air machine shop, which contains the first locomotive on this system used by the company. Three other locomotives are now being built. The idea in using compressed-air locomotives is partly to be able to rely on this form of power in the almost improbable event of the electric current failing, but more especially for shunting purposes and for running in conjunction with electric trains at moments when the traffic is particularly heavy. The frame is much the same as in the ordinary locomotive, but the suppression of the chimney and the steam-dome, as well as the rounding of the ends, naturally give it an entirely different appearance. The reservoirs have a capacity of one ton of air, and this will allow of the locomotive drawing 200 tons for a distance of 12½ miles.

From here the members went to the compressed-air station, which contains two groups of air-compressors operated by three electric motors of from 250 h.p. to 300 h.p., and supplied directly by triphase current at 5,000 volts. The compressors are on the Mékarski system, constructed by Brulé et Cie., of Paris. The air arrives from the main at a pressure of 13lb. per square centimetre into the first compressor, where it is compressed to 44lb., and after being further compressed in the second machine is delivered from the third compressor into a battery of accumulators at 176lb. Adjoining this building are the Belleville generators for supplying steam to raise the temperature of the air in the locomotives and for warming the station and other purposes.

The visit now having come to an end, Mr. GRAY, on behalf of the Institution of Electrical Engineers, thanked M. Mazen, M. Clérault, and the other engineers of the Compagnie de l'Ouest, who had displayed so much courtesy in showing them round these installations, and he was followed by M. MAILLOUX, on behalf of the American Institute, who felicitated the Compagnie de l'Ouest on the enterprising spirit they had manifested in carrying out these installations, and said it gave a denial to the reproach Americans were in the habit of making that European countries were behindhand.

M. CLERAULT briefly responded, and said that all nations

Digitized by Google

were closely united when it came to a question of industrial progress.

In terminating this report, it is only just to record the services rendered by Mr. Maurice Coster, manager of the Westinghouse Company's works, who assisted M. Mazen in explaining the different installations visited, and by Mr. W. G. McMillan, secretary of the Institution of Electrical Engineers, who was indefatigable in his efforts to make the meeting a successful one.

[In his first instalment of "The Electrical Engineers' Conference in Paris," our special correspondent, in speaking of the visit to the Exhibition, inadvertently mentioned that the Galloway engine shown was coupled to a dynamo by Siemens Bros. and Co. As a matter of fact, Messrs. Mather and Platt, of Manchester, and not Messrs. Siemens Bros., were the makers of the dynamo in question.—ED. *E. E.*]

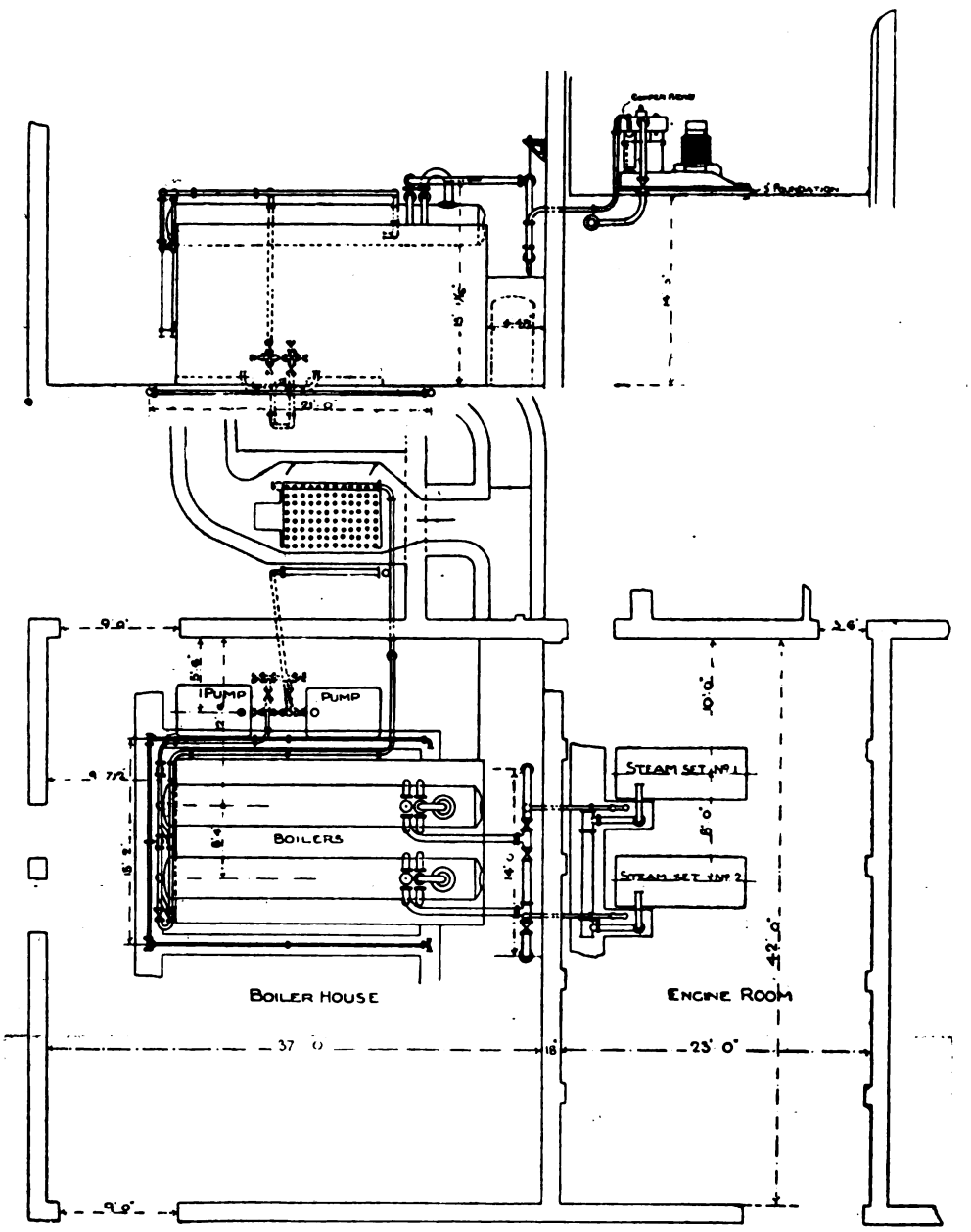


FIG. 1.—Ground Plan of Edmundson's Guernsey Station.

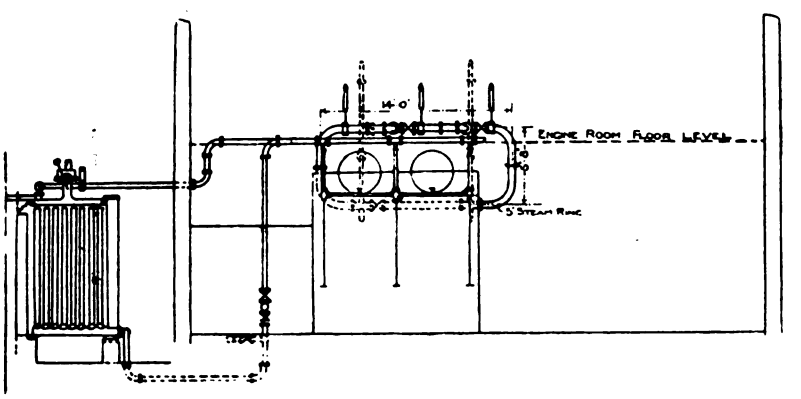


FIG. 2.—Details of Steam Ring, Guernsey Station.

EDMUNDSON'S ELECTRICITY CORPORATION'S WORKS AT GUERNSEY.

In our issue of Aug. 3 we gave a short description of the above works without illustrations. By the courtesy of Messrs. Edmundson's Electricity Corporation, Limited, we are now enabled to give a few reproductions of photo-

Digitized by Google

graphs taken at the works, besides a diagram of the switchboard connections, and a ground plan of the station, showing the positions occupied by the several items of plant installed. It will be remembered that this plant consists of two Babcock and Wilcox 100-h.p. water-tube boilers, fitted with superheaters; one Worthington feed pump, capable of delivering 10,000lb. of water per hour to the boilers; one Hayward Tyler three-throw electrically-driven pump, capable of delivering 13,000lb. of water per hour; two E.C. 5 Belliss 100-b.h.p. engines, running at 500 revolutions per minute, with a steam pressure of 130lb.; two 74-kw. Parker dynamos, yielding 160 amperes at 410 to 460 volts each; one Green's economiser with 96 tubes; 230 D.P. accumulators with a rated capacity of 715 ampere-hours; one balancer-booster set, the balancers being able to supply 50 amperes at a terminal pressure of from 210 to 230 volts, while the booster gives 80 amperes at 70 volts terminal pressure. The steam-piping is arranged on the ring system, the pipes being of wrought steel with welded seams and heavy forged flanges screwed on hot and brazed. The feed pipes are arranged in duplicate to allow of either pump supplying either boiler. Both the exposed parts of the boilers and steam-pipes are covered with magnesia lagging. The switchboard is of Messrs. Edmundson's standard type in marble, and is arranged for four dynamos and four feeders. The feeders are triple-

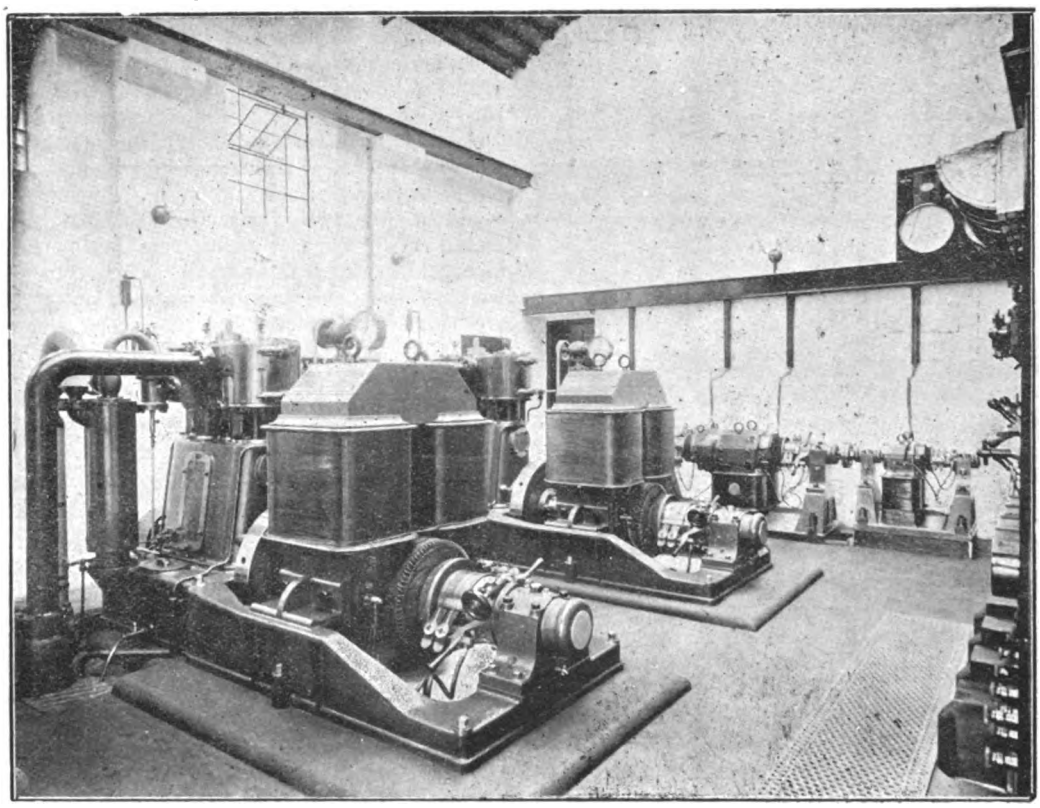


FIG. 3.—Interior View of Engine-Room, Edmundson's Guernsey Station.

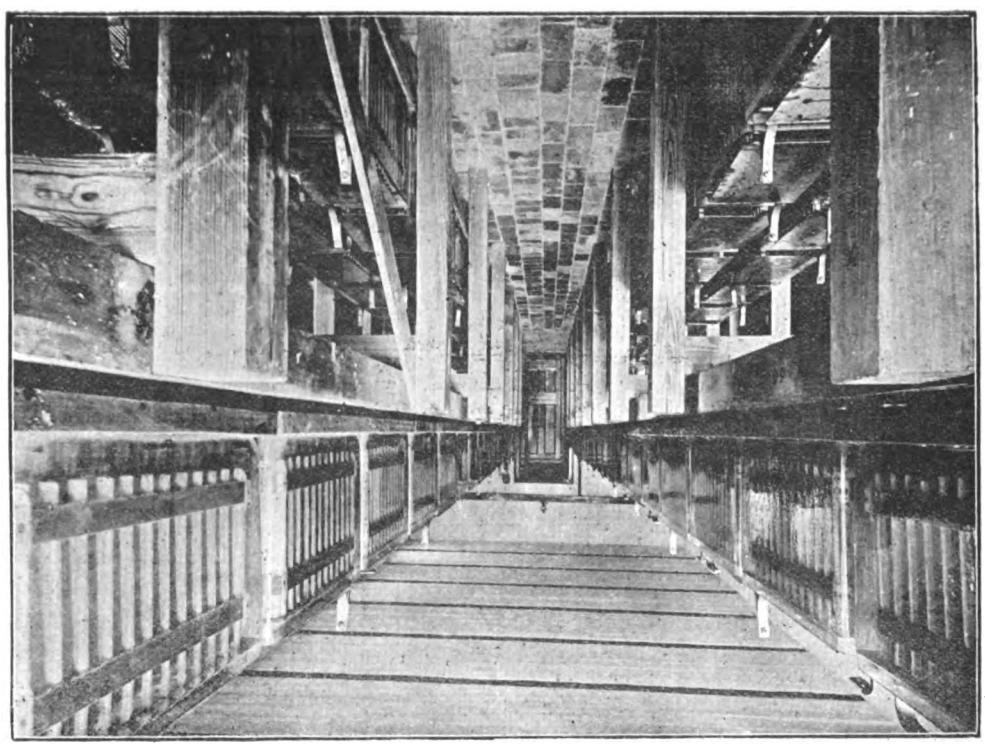


FIG. 4.—Interior of Accumulator-Room, Edmundson's Guernsey Station.

Digitized by Google

concentric, and the distributors of the three-core type, all being lead-covered and armoured.

The following additional plant is now on order: one Babcock and Wilcox boiler, fitted with superheater, and

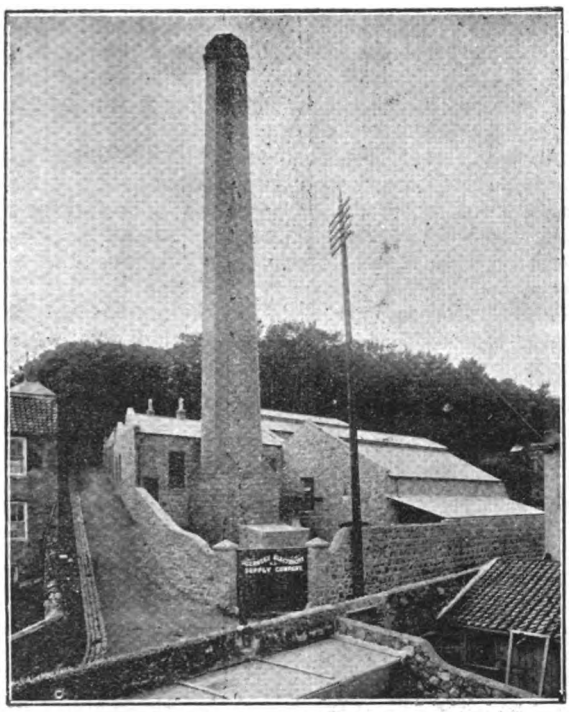


FIG. 5.—Exterior View of Edmundson's Guernsey Station.

possessing 2,437 square feet of heating surface; one T.E.T. 3 Belliss three-crank triple-expansion engine, to develop 270 b.h.p. at 420 revolutions per minute; and one Parker dynamo to yield 420 amperes at from 420 to 460 volts terminal potential. For further particulars of the station we must refer the reader back to our issue of Aug. 3.

MESSRS. DAVEY, PAXMAN, AND COMPANY'S STANDARD IRONWORKS, COLCHESTER.

(Concluded from page 274.)

Leaving the boiler shop we enter the smiths' shop, which is at the present moment undergoing structural alterations. The shop is conveniently arranged for the production of the forgings required in the manufacture of the works products, being served by several steam-hammers, and further equipped with the usual cutting-off appliances, upsetting machine, etc. This shop is 170ft. long by 45ft. wide. From the smiths' shop we proceed to a second power-house. In this building are installed two 8ft. diameter by 14ft. long Paxman patent "Economic" boilers, made for a working pressure of 160lb. per square inch, and having a regenerative combustion chamber at the back, so that any unburnt gases escaping over the bridge are ignited before entering the return tubes, from whence they are carried by means of wrought-iron casing on the front of the boilers to the side flues, and so to the chimney. An electric generating plant, consisting of one steam-driven continuous current set, serves for lighting the offices and stores.

Continuing our round of inspection, we enter the fitting shop, which consists of three 40ft. bays, 100ft. long, devoted to the lighter class of erecting and general fitting. On the left as we enter is noticed one of Davey, Paxman, and Co.'s "Windsor" vertical compound engines, driving the works dynamo, which is temporarily housed pending the erection of a new power-house, which it is proposed to place at the north-east corner of the erecting shop, where the boilers at present installed are used for testing purposes and supplying steam to the machine shop engine. Proceeding to the erecting shop, which is 150ft. long and has a clear span of more than 70ft., many engines and compressors were seen in course of erection. The whole of the floor of this shop is within the traverse of the overhead travelling

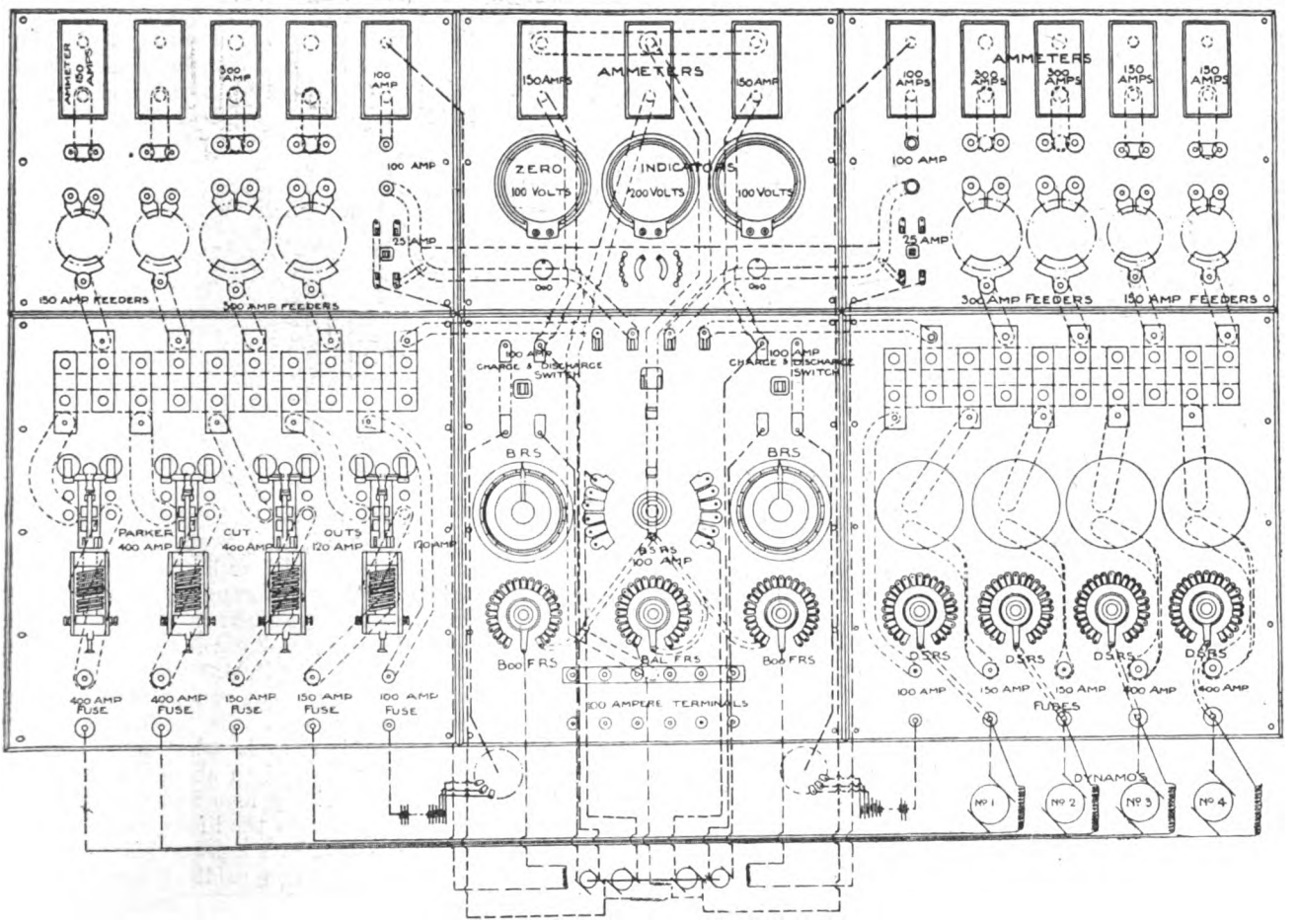


FIG. 6.—Diagram of Switchboard Connections, Edmundson's Guernsey Station.

crane, capable of lifting 20 tons. Amongst the many machines noted in this department may be mentioned a 14in. by 23½in. by 32in. tandem compound engine, driving a compressor; an 18in. by 28½in. by 32in. coupled com-

Digitized by Google

pound engine, driving tandem air-compressors suitable for an air pressure of 60lb. per square inch; a small independent jet condensing plant, consisting of a "Colchester" compound engine with girders extended to carry the air-pumps, which are driven by a prolongation of the high and low pressure rods.

Another of the firm's specialities—namely, the Peache single-acting high-speed engine—was also very much in evidence. Several examples were seen in various stages of progress. The Peache engine is now very well known, and has already been described in these columns, but a few general particulars with regard to the same may be recapitulated. As previously noted, the engine is of the high-speed single-acting type. The steam-cylinders are carried on four wrought-iron columns. They are thus entirely isolated from the working chamber; consequently the bath of oil and water does not get overheated and decomposed, no matter how long the engine is kept at work. No oil can be drawn from the working chamber to the condenser and boilers. There are no internal glands in the engine, and of the external glands one is subject to low-pressure steam only, and the other to exhaust steam only. In case of water in the cylinders, the piston rings act as relief valves and prevent damage. Every part of the engine is readily accessible for examination or repair. The working chamber has large doors, connecting rod, cross-head, and valve motion, or any of these parts can be readily disconnected and removed even in the smallest sizes without dismantling the engine. The valves can be withdrawn by removing the steam-chest cover only. Any high-pressure cylinder can be taken off by breaking one joint only, and both high-pressure and low-pressure pistons can then be removed without further dismantling. The governor with its gear, also steam and exhaust pipes, are all attached to the main cylinder casting. Therefore every part of the engine is accessible without touching the governor gear, steam, or exhaust pipes. This engine has been on the market for some five or six years, and has been largely adopted for electric lighting and power installations, some 15,000 i.h.p. having been supplied for this purpose. At the time of our visit an engine of 260 i.h.p. coupled to a Siemens dynamo was undergoing its steam trial in the testing shop preparatory to its dispatch to the electricity works at High Wycombe. The beautifully smooth and quiet working of the engine was much admired. What most appeals to the engineer is the very substantial character of the various parts which go to make up the engine. Bearing surfaces are evidently very liberally provided for. In the machine shop we noticed the parts of some 550-i h.p. Peache engines which are now being made for the Folkestone electricity station, and which are the largest size so far constructed. Fig. 3 shows a Peache engine direct-coupled to a dynamo.

The testing shed in which we saw the 260-h.p. engine undergoing her tests, though only of a temporary character, is conveniently placed, and equipped with testing beds, independent condenser, measuring tank, and other impedimenta necessary for accurately testing the steam consumption of the various engines manufactured. On the right-hand side is situated the resistance frame, through which the current from the dynamos is passed. This is built up in sections so as to give the requisite artificial load for engines up to 1,000 h.p. When the new boiler-house is completed, it is proposed to build a fresh testing-house to run parallel with the whole length of the erecting shop. Passing through the temporary boiler shed, the machine shop was next reached. This shop is 210ft. long by 124ft. wide, and consists of four bays, two of which are devoted to the lighter class of machine tools, and are each 27ft. wide. The remaining two bays, each 35ft. wide, are filled with the heavier class of machine tools. Light in this shop is taken entirely from the north, and the glazing is equal to about 40 per cent. of the floor area covered. Every man and machine tool in this fine shop is directly within the lifting range of the travelling cranes. In the light bays these consist of handy runner cranes attached to the under-side of the tie-beams of the roof; and in the heavier bays the cranes are rope-driven, being carried on the usual crane tracks. Driving power is obtained from a 120-h.p. "Colchester" compound horizontal steam-engine, placed in the south-east corner of the department. The structure is composed of mild steel throughout, the only inflammable material employed being the roof boarding; hence the fire risk

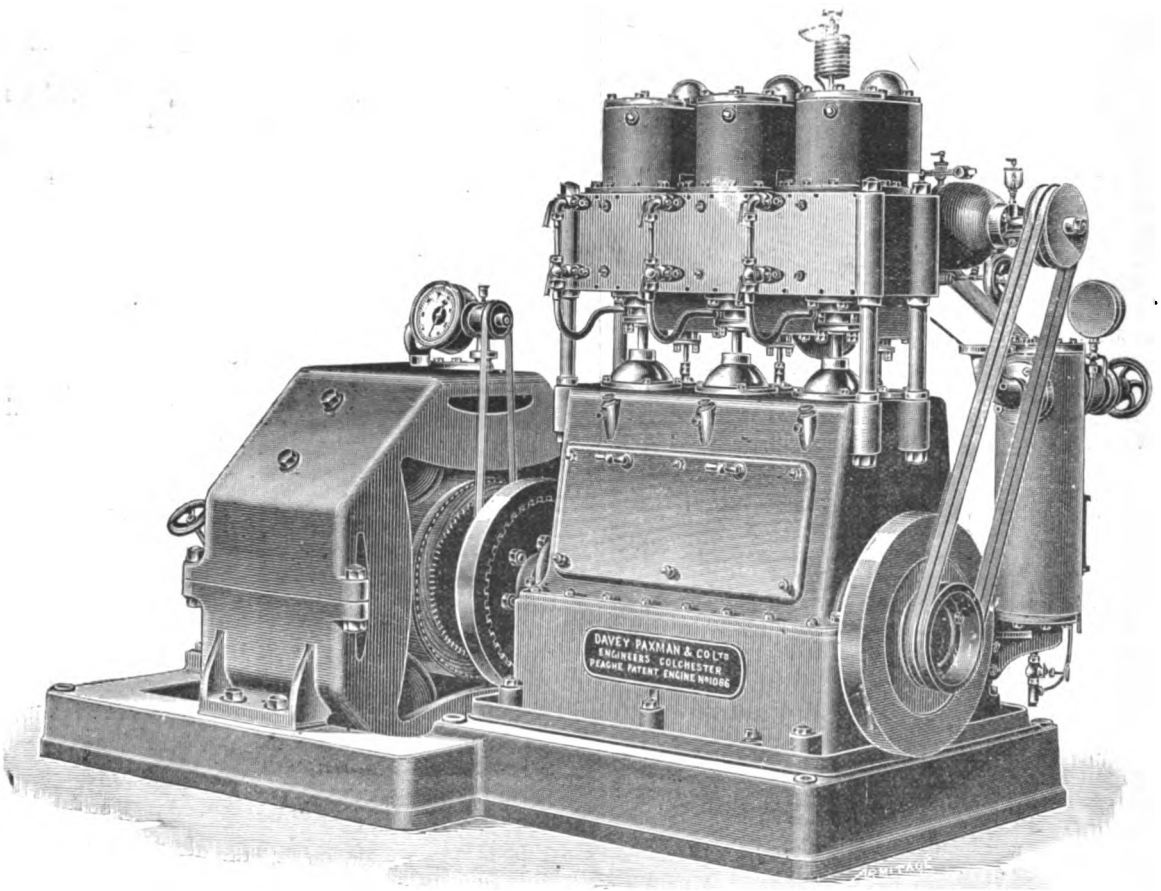


FIG. 3.—Elevation of Peache High-Speed Single-Acting Engine.

Digitized by Google

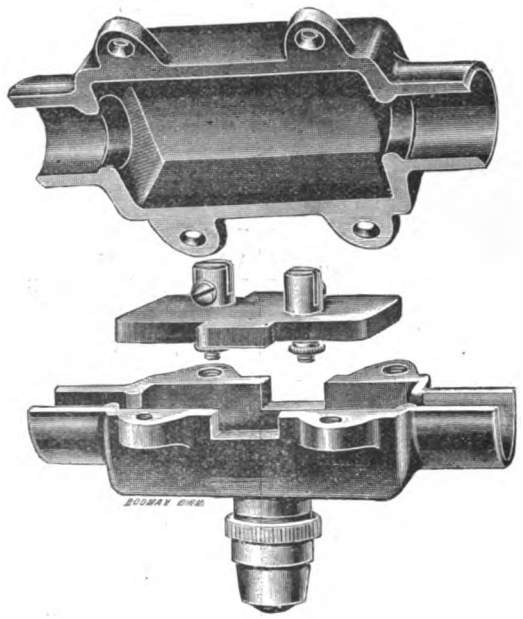
is reduced to a minimum. In the south bay is situated a vertical boring machine of massive proportions, specially designed for machining the high-speed engine cylinders, of which the three bored holes are tooled without rechucking the centres, the correct location of the cylinders being determined by stop-pins in template bars. There is also a lathe equipped with the necessary tackle for machining girder beds up to the largest sizes, performing all the operations required coincidently. The two large boring machines in this bay were made to Davey, Paxman, and Co.'s own designs. A new flywheel lathe, situated in the same bay, is capable of performing at one time and at one setting the whole of the operations necessary for the machining of the flywheels. There is also a large and powerful planing machine in the shop, screw-driven, on which the largest castings required for the works manufactures can be machined. The foundations are being got out to receive a new side-planing machine, having 22ft. stroke, and fitted with two heads, one of which carries two tool boxes. One of the most noticeable tools in the second bay is the crank-pin and dip turning machine, in which the turning tool revolves, held on a ring housed in a concentric frame. This method of turning the crank-pins eliminates all spring usually present when the shaft is revolved on eccentric centres, even when supported by solid eccentric chucks, and the cranks produced by this tool are absolutely correct. In the same bay is a series of special labour-saving tools, consisting of pipe facers and facing machines, double-headed side planers and shapers, drilling machines equipped with tapping and studding machine, a large milling machine, and numerous other tools of interest. In the smaller bay there are eight rows of light machine tools which extend throughout the length of the shop, amongst which are many tools of economical value in the production of the special details for which they have been designed. These tools consist of capstan and turret lathes, automatic screwing machines, milling tools, special brass-turning lathes, grinding machinery, etc. The artificial light for this shop is provided by 40 2,000-c.p. arc lamps.

Illustrating the happy conditions which exist between the employer and the employé at the Standard Ironworks, it may be stated that Mr. Paxman has around him as members of his staff some of those employés who formed the original nucleus of the works now occupying responsible positions in the management. There are quite a number who have seen upwards of 20 to 35 years' service with the firm, and under Mr. Paxman's able guidance the business has grown from small beginnings until there are now employed upwards of 900 men, and with the further extension of the works in view, this number will be greatly augmented during the next few years. Every department of the works is now fully employed, so much so, in fact, that it is found impossible to replenish stocks of standard parts, which are used up as fast as manufactured. Boilers destined for the proposed new power-house, the shaft of which is already in evidence, have thrice been relegated to other purposes, so great is the demand from outside. In connection with the contemplated extensions, it is proposed to construct a branch railway from the works to the main line.

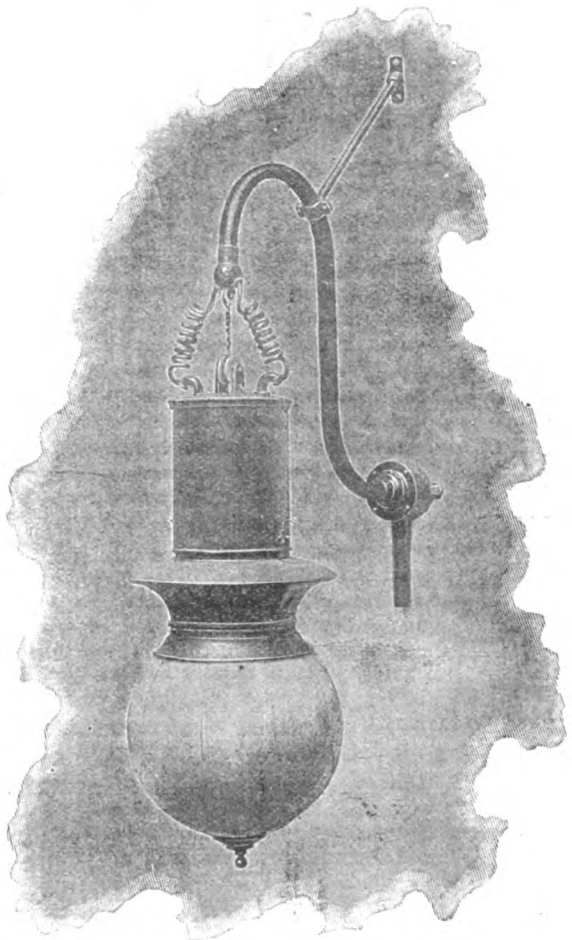
It only remains to be added that the visit of the Ipswich Engineering Society to Colchester proved in every way a complete success, a most enjoyable and instructive evening being spent.

THE SIMPLEX STEEL CONDUIT COMPANY.

We have received from the above company a copy of their new supplementary list, which includes the latest improvements to their steel conduit system. The list is intended to be used in conjunction with the firm's 1900 catalogue. Amongst other things that have recently been added are a screwed brazed conduit of heavy gauge and screwed fittings for use in places such as breweries, etc., where a watertight system is insisted upon; split bends and tee pieces; a new type of box enamelled iron-cased switch and fuse distributing boards; pendant fittings with porcelain bridge with connection terminals fitted. They have also a split box with bridge terminals (of which we give an illustration), and a connection box for connecting up branch circuits from a pair of bars fitted on to porcelain in the box; removable porcelain interiors and connection bars for use with the firm's standard junction boxes are also made. The arrangement in this latter case consists of a



porcelain cradle, which just fits inside the junction box and supports two brass connection bars, which are each made in two parts. The bars are drilled along their length, and terminal screws are fitted to clamp the branch circuit wires, and a half-lap joint in the middle allows the two ends to be easily sweated on to the main lead, it being thimble bored to receive same.



Our second illustration shows one of the Simplex arc lamp brackets, which are made specially strong and watertight for outside use.

The Simplex Steel Conduit Company has, we learn, been awarded a gold medal distinction at the Paris Exhibition.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	289	Forthcoming Events	307
Sunderland Tramways	294	A Manchester Load Curve,	310
Taunton Electricity Works,	297	On the Effects of Strain on the Thermo-Electric Qualities of Metals.—Part II.	311
The Electrical Engineers' Conference in Paris	299	Electrical Measuring Instruments	313
Edmundson's Electricity Corporation's Works at Guernsey	301	Questions and Answers	315
Messrs. Davey, Paxman, and Company's Standard Iron-works, Colchester	303	Contracts for Electrical Supplies	318
The Simplex Steel Conduit Company	305	Lighting Notes	319
Unpunctuality	306	Traction Notes	321
Correspondence	307	Legal Intelligence	323
The Submarine Telegraph Jubilee	307	Companies' Meetings and Reports	323
The Evolution of Switch Gears for High-Pressure Alternating Currents	307	Provisional Patents	323
		Traffic Returns	324
		Companies' Stock and Share List	324

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

UNPUNCTUALITY.

The inconvenience of the travelling facilities afforded by the railway companies in and around London, and also in the provinces, is a fruitful source of conversation. In fact, if by some means yet to be discovered absolute punctuality in the departure and arrival of trains could be attained, a certain class of the community would be deprived of the subject in which they can best discourse to a casual acquaintance by the half-hour. A certain amount of personal glory seems in these individuals' minds to attach itself to them if, after a mishap on a given railway line, they have been detained an hour or two more over a journey than they would have been if the schedule time had been maintained. It is quite certain that, whatever the improvements in the everyday traffic, no engineering skill or powers of organisation, nor even the miracle-working electricity, will ever be able to avoid the disorganisation which follows a railway accident, in which one or more of the running lines is blocked by heavy *débris*. What, however, can be avoided is the daily inconvenience resulting from either lax management or poorly-equipped lines. The delays in the traffic are always more marked on the suburban lines for two reasons. The first is that the large companies always give preference to the main-line traffic, and a delay in this is hence reflected in the suburban traffic, because the local trains are made to wait for a clear line. The next reason, which practically is an outcome of the first, is that old and inferior engines are used for the suburban traffic. These engines are often only just sufficiently powerful to do their work, so that a slight increase in the load or a greasy state of the permanent way causes delay. There is a further cause, which is alluded to in a leader in the *Times* on Wednesday last, and that is a deficiency in discipline amongst the staffs at the various stations. This applies more to the country stations as a rule than to the suburban ones, but it is also often very marked at the great London termini. In our opinion this laxity of discipline can be explained by the adage, that "He who pays the piper has the right to call the tune." The railway companies allow the general public to pay in tips the greater part of the wages of their porters, with the result that their time is unduly taken up over individual passengers to the detriment of the bulk of the travelling public, and to the discipline of the men. The unrest amongst the staffs of the various railway companies at the present time is most to do with the wage question, and this wage question is intimately connected with the question of tipping. To return, however, to the question of the unpunctuality of the railway companies, we believe that electricity, after all, will afford a solution of the difficulty. On the suburban lines, with their frequent stoppages, locomotives capable of quickly accelerating the trains are needed. The one fact which is most prominently brought out by the trials of the electrical section of the Metropolitan Railway Company is the enormously greater accelerating power of the electrical locomotive over the steam-engine. In cases where the conversion from

Digitized by Google

steam to electricity is not undertaken, the punctuality of the trains and the time taken over the journey can both be improved if an active competition by means of an electric tramway is established. If one compares the schedule times for small journeys round London, it will be found that an average speed on steam railways of eight to ten miles per hour is quite common. This speed can be obtained on an electric tramway, and with a frequency of service which puts the steam railway quite out of court, we hold that competition will in such cases either kill the steam road or else cure it of its crawling propensities. The deep level electric line is, of course, a much more convenient alternative of providing such competition, and where the traffic is dense the capital outlay for such lines is quite warranted. We trust that the success of the Central London Railway will bring financial support to similar schemes, and that the result will be the spread of the population of our great towns over a much larger area than at present.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—You will, of course, agree with me that anything in the way of slip-shod language should be carefully avoided when stating a scientific principle, and you may, therefore, allow me to point out a serious inaccuracy in the statement of a law of electromagnetic induction that is often given by writers who ought to know better. On p. 230 of Slingo and Brooker's "Electrical Engineering," we read as follows: "When a conductor is mechanically moved in a [magnetic] field transversely to the lines of force traversing that field, a certain E.M.F. is determined, which sets up a current in the wire if its two ends are connected." But suppose that a rectangle of wire, facing north and south, is moved northwards across a uniform magnetic field whose lines run eastwards. The vertical sides of the rectangle will then be cutting lines of force. But so long as the rectangle still faces north and south there will be no E.M.F. whatever, because there will be no change in the number of lines passing through it, this number being zero all the time. It will thus be seen that one might design a dynamo which *should* give, according to Slingo and Brooker, an enormous E.M.F., but which *would* give absolutely none at all.—Yours, etc.,

W. F. DUNTON.

26, Tregothnan-road, Stockwell, S.W., Aug. 25, 1900.

FORTHCOMING EVENTS.

WEDNESDAY, SEPT. 5.

British Association.—Annual meeting at Bradford.

SEPT. 18 21.

Iron and Steel Institute.—Paris meeting, Sept. 18, 19, 20, and 21

Sept. 17.—Secretaries' office opens at the Société d'Encouragement pour l'Industrie Nationale, 44, Rue de Rennes, at 3 p.m. 6 p.m., meeting of council at Mr. Henry Chapman's office, 10, Rue Laffitte.

Sept. 18.—9.30 a.m., reception of the president in the hall of the Société d'Encouragement; reading and discussion of papers. 2 p.m., visit to the Exhibition. 9 p.m., Soirée Musicale et Littéraire by the Comité des Forges de France.

Sept. 19.—9 30 a.m., general meeting in the hall of the Société d'Encouragement; reading and discussion of papers. 2 p.m., visit to the Exhibition. 7 30 p.m., the Institute entertains the Reception Committee at a banquet at the Hôtel Continental, Rue Castiglione.

Sept. 20.—10 a.m., visit to the exhibition at Vincennes (locomotives, railway plant, and machine tools). 8 p.m., Group A will start for the St. Chamond Works. 10 p.m., Group B will start for the Hayange Works.

THE SUBMARINE TELEGRAPH JUBILEE.

Articles have recently appeared in the London daily Press respecting the jubilee of the submarine telegraph, the first great experiment being carried out in 1850, and cablegrams having passed between France and England on Aug. 28 of that year. The pioneers of the submarine telegraph were John and Jacob Brett. These formed a company to lay a cable on the French coast. They obtained a concession from the French Republic, and the company, consisting of Mr. J. W. Brett, Mr. Charles Fox, Mr. Francis Edwards, and Mr. C. J. Wollaston, undertook to lay the cable by Sept. 1, 1850. Of these four gentlemen, Mr. Wollaston, who is still alive, acted as the engineer to the company. Directly on arriving in England from Paris after obtaining the concession, Mr. Wollaston arranged with the Wiremakers' and Guttapercha Company for the supply of materials. He also had a drum constructed from which to pay the cable out from the ship's deck. On a tug this drum, on which was wound 24 miles of wire, was fitted, and, says the *Times*, on the morning of Aug. 28, 1850, the tug was at Dover. A coil of wire was twisted round a pile belonging to the harbour works and then carried up above to a horse-box, which the South-Eastern Railway Company had lent the Submarine Cable Company to serve as their Dover office. The tug then started off in a straight line for Cape Gris Nez. The cable was weighted with small pieces of lead to keep it down, and was sunk without accident, the other end being made fast in an old custom house on the French cliffs. Considering the imperfect insulation, the simple method of keeping the cable down, and the strain that was put upon the unsupported guttapercha wire, it seems a wonder that the experiment succeeded at all. But succeed it did, and proved that the promoters had, so far as they could, gone the right way to work. The instrument in the horse-box at Dover railway station clicked out a message to Louis Napoleon congratulating him upon the happy result of the experiment. The cable, however, naturally soon ceased working, but the fact that communication could be made was proved, and another concession was given. In order to work this the Submarine Telegraph Company was formed, which laid down a four-wire cable, with strong wire insulation, and on Nov. 13, 1851, this was opened for public use. Submarine communication was now a well-established fact, and in 1853 the England-Ireland cable was laid, quickly following which was the Dover-Ostend cable. It was not, however, until 1858 that the Atlantic Telegraph Company supplied communication between America and England. Since that time cables have been laid in all parts of the world, and submarine communication has developed to such an extent that if it were suddenly cut off to the average business man nowadays, life would hardly be bearable.

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

(Continued from page 276.)

Figs. 23 and 24 are photographs of a large board fitted with Lowrie-Hall switching appliances which has been in use at the Leeds Corporation electricity works for some years past. One photograph shows almost the whole board, and the other a few panels. In Fig. 23 the ammeters in the immediate foreground are in the exciter circuits, and below them will be seen the rheostats fixed on a table in front of the main board. At the top of the high-pressure board are the dynamo fuses, synchroniser bases, and leakage indicators; below are four rows of plug switches for dynamos and circuits, and at the bottom of the whole the circuit fuses.

Fig. 25 is a diagram of the connections of a portion of the board, which will serve to illustrate the general arrangement. It will be seen that there are two bus bars, on to either of which any dynamo or circuit may be switched—there are no actual bars in the rear of the board, but the

Digitized by Google

machines and circuits are coupled as though there were, and the diagram has been drawn up in this manner to make the connections as plain as possible—and these bars may be

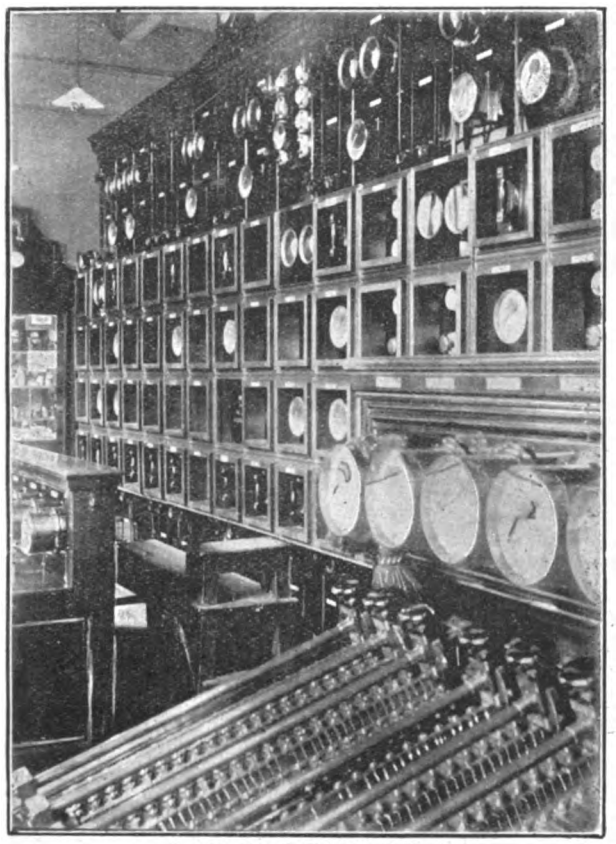


FIG. 23.—Lowrie-Hall Board, Leeds.

sectionised so that a particular dynamo will feed a particular circuit. Any machine cannot, however, be run on any circuit. If all the machines are run in parallel, the discon-

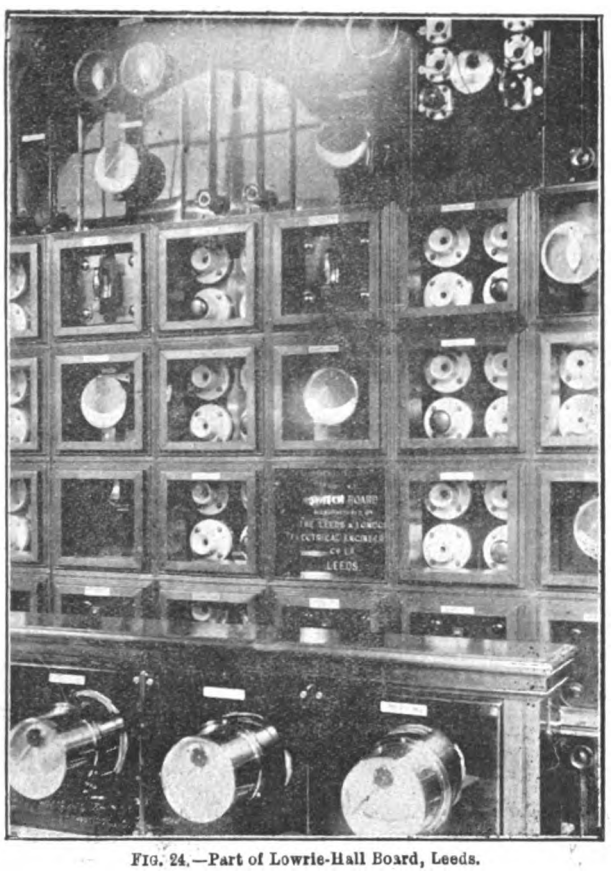


FIG. 24.—Part of Lowrie-Hall Board, Leeds.

necting switches are all left closed, and two circuit switches are plugged in to couple the two bars together. The duplicate bars necessitate the provision of two plug switches for each dynamo and circuit. All connections are made at the back of the board by means of rubber-covered cables, arranged as circumstances and space will allow.

Messrs. Fowler have recently introduced a high-tension

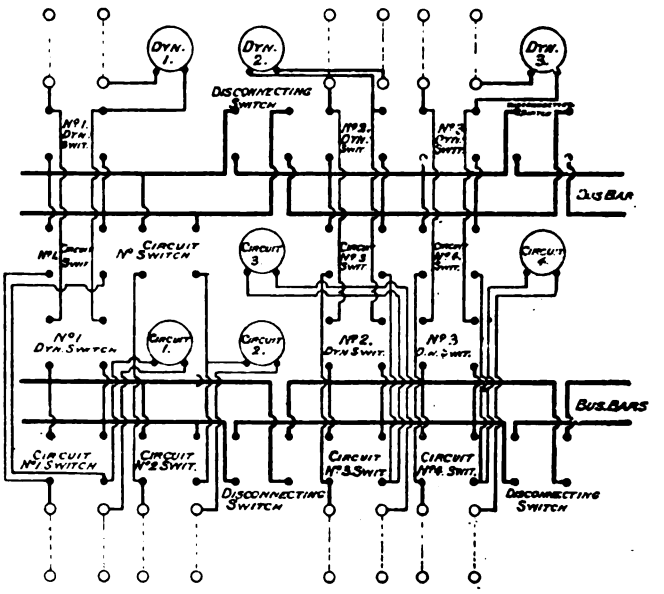
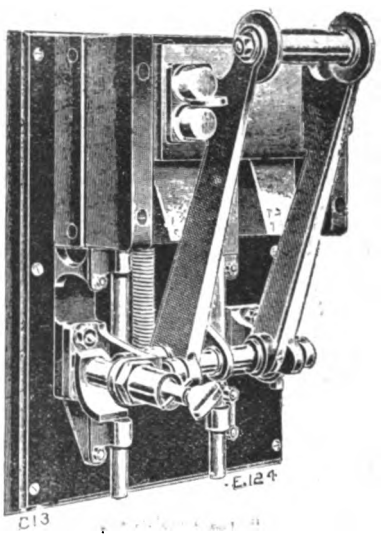
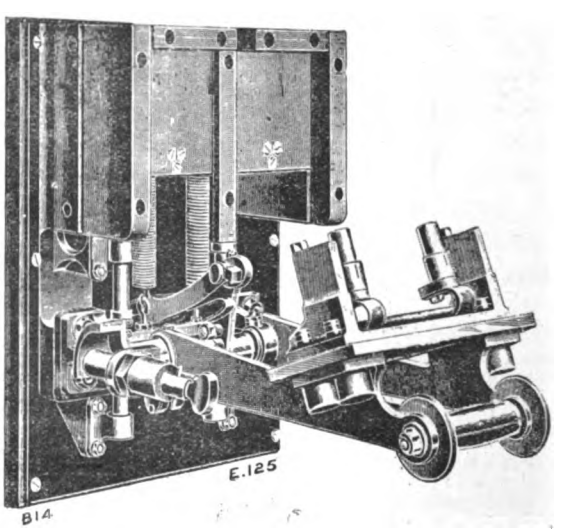


FIG. 25.—Diagram of Connections, Lowrie-Hall Board, Leeds.

shutter switch for breaking heavy currents. Fig. 26 illustrates this switch, open and closed. The base of enamelled



SWITCH CLOSED.



SWITCH OPEN.

FIG. 26.—Lever Shutter Switch.

slate carries two socket terminals mounted in heavy porcelain insulators. These terminals are fitted at the back with sweating thimbles and at the front with spring jaws and spring-pressed carbons. Fixed to the base slate are the

Digitized by Google

brackets for the level centres and shutter guide rods and the guard slates. The lever of the switch comprises two brass arms, pivoted at their lower ends on a spindle and fastened at their upper extremities with the handle, and an insulated bridge

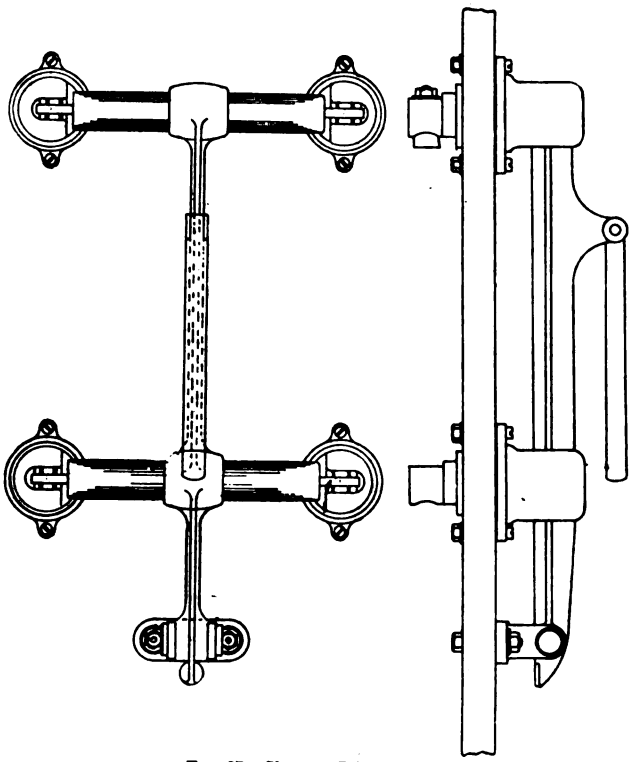


FIG. 27.—Siemens D.P. Switch.

contact fitted with carbons. A shutter is arranged for each contact, and each is mounted on brackets and guide rods, the latter being joined by a cross-piece. The shutters are firmly held by two springs against the top guard, and they

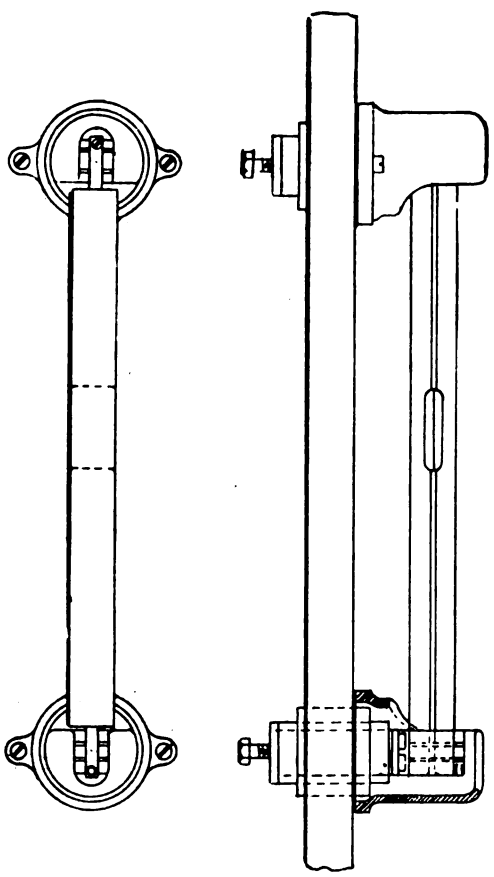
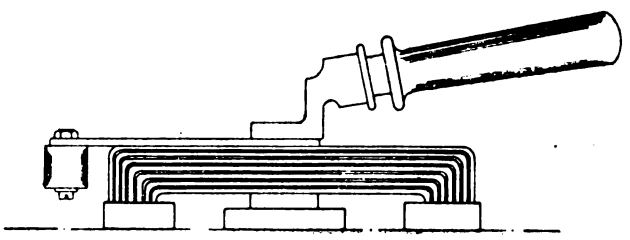


FIG. 28.—Siemens H.T. Fuse.

are further guided by grooves suitably arranged in the side guard slates. The switch is opened by pulling down on the handle fixed to the lever. The ends of the connecting bridge will first be drawn from the contact jaws, leaving the carbons pressed together, until the holder of the spring-pressed carbon, which telescopes into a tube, comes to its limit of travel, when the final break will take place at the carbons. At this moment the shutters will be released and fly up to break any arc which may be forming, and at the same time close in the "live" parts of the switch. When the lever is in the "off" position there is no danger from shock at the bridge contacts, as these are only in circuit during the time the switch is closed. In closing the switch the shutters are caused to moved downwards against the tension of the springs attached to them, and to thus uncover the contact jaws to receive the connecting bridge. When the lever is finally pushed home, the shutters are pressing against the underside of the contact plugs, ready to fly up when the switch is opened. A locking device and synchronising contact are fitted to the switch, and it is a noticeable feature of the apparatus that neither in the on or off positions is it



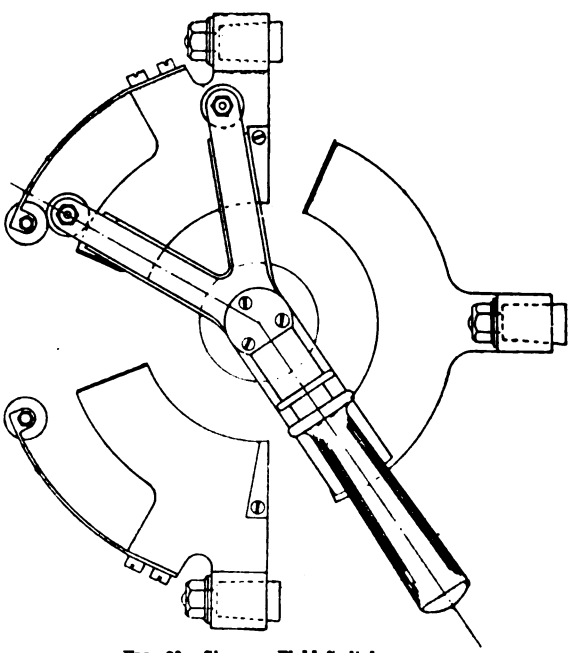


FIG. 29.—Siemens Field Switch.

possible to touch any "live" part. It is constructed to break currents up to 1,500 amperes at 2,000 volts.

SIEMENS.

Messrs. Siemens Bros. have equipped many alternating-current stations in this country, and consequently have fitted up a number of switchboards. Like almost all early gears, they erected double-pole boards, but since the earthing of the outer has become generally adopted the switching arrangements are confined to one pole. The gear resembles those before described, also, in that all connections are made at the back, which is rendered accessible by building the board up some distance from the wall. A double-pole switch suitable for breaking high-pressure currents up to 350 amperes is shown by Fig. 27. The contacts consists of copper spring clips screwed to brass shanks, which are enclosed in porcelain tubes, these latter thoroughly insulating the fitting from the slate. The shank is provided with cable attachment at the back. Each contact is covered by a porcelain hood, which serves the double purpose of confining the arc and preventing accidental contact should anyone stumble against the panel. The hoods are provided with a slot, to allow the switch blade to enter the contact. The blade is formed of a copper bar, enclosed in a porcelain tube, which is firmly fixed in the

Digitized by Google

switch lever, and the ends of the bar project from the tube to allow of contact with the clips. When the switch is open there is no danger of shock from touching these ends, as they form no part of the circuit, except when the switch is closed. The switch lever has a hinged handle attached to it to facilitate the quick opening of the circuit, and to keep the hand of the operator clear of any arc which may form. A double-pole switch to break circuits up to 75 amperes is also made, but the handle is similar to that shown attached to the switch on the complete panel (Fig. 30) The lower end of the switch arm is pivoted in a bearing attached to the slate, and it is also provided with an extension at this end, which strikes against a rubber stop set in the bearing casting. This damps the blow of opening the switch quickly, also serving as a stop to the arm.

A high-tension fuse capable of safely opening a circuit of 250 amperes capacity is shown by Fig. 28. The contacts are precisely similar to those used in the switches, but are arranged vertically instead of horizontally. The fuse wire, which has a length of 18in., is embedded in a slate bridge of square section, a groove being run down its length for the reception of the fuse. Gunmetal blocks are fitted at each end of the bridge, and to these the fuse is firmly screwed after passing through a hole in the block. A slight hole is provided in the centre of the bridge for purposes of examination. The fuse is inserted in the contacts by slight pressure, and is held in position by the spring clips.

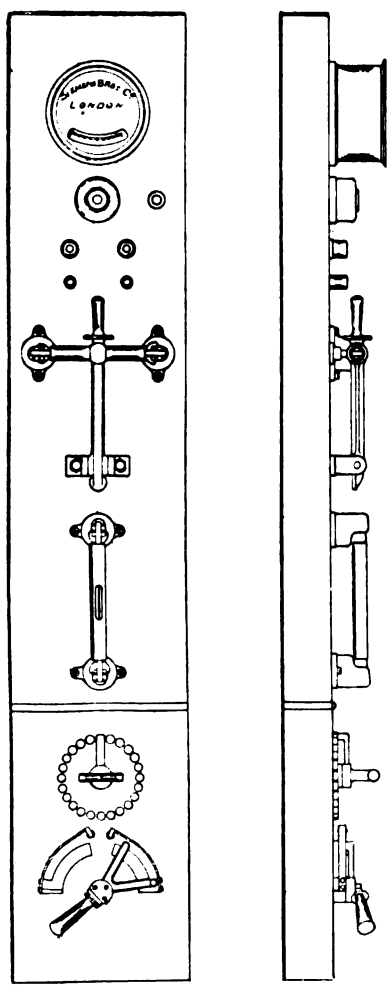


FIG 30.—Siemens Single-Pole Alternator Panel.

A carbon break switch for breaking the field circuit is shown in Fig. 29. This type is intended for use with heavy currents and connections at the front, but where smaller currents are dealt with, the lower contact segment is not used, the centre bearing of the switch acting as part of the circuit. The switch is a two-way one, the segments being joined together by a slider of copper laminations actuated by a handle of ebonite. The bridge is pivoted at its centre, where it is also divided into two parts, which take the shape of a Y. The two arms thus formed are fitted with carbon rollers so arranged that they engage with other rollers fastened on springs to the contact segments. These carbons take the break of the circuit, and when burned away can be easily renewed. The lower segment is connected to the alternator field, the right-hand to one pole of the exciter, and the left-hand to the other pole through a non-inductive resistance. Connected in this manner with the switch in the position shown in the drawing, the field circuit will be closed. When in the intermediate position, with the brush connecting both segments, the field and non-inductive resistance are placed in parallel across the exciting source, and when put over to the left the field is short-circuited by the non-inductive resistance.

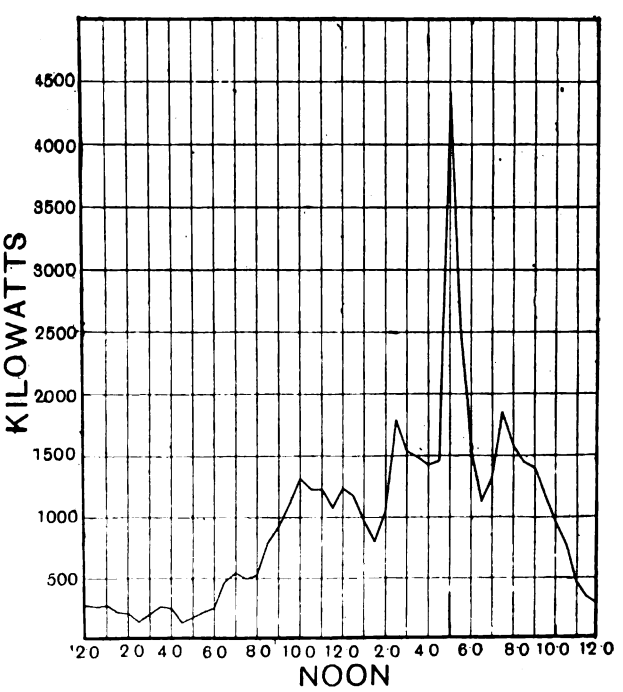
Fig. 30 illustrates a complete panel with high-pressure switching arrangements on one pole. The primary ammeter is fixed at the top of the slate, with a short-circuiting plug and holder below it. Lower down are the synchronising sockets, with a rest for the plug below them, and beneath these are the main switch and fuse. At the bottom of the panel is the exciter slate, separated from the primary slate by a thickness of ebonite. This slate has a rheostat and field switch as above described mounted on it.

Such panels are mounted in a wood framing, finished with teak or other mouldings, and arranged with space between the slates and wall for examination or alteration of the connections.

(To be continued.)

A MANCHESTER LOAD CURVE.

Through the courtesy of the Corporation electrical engineer, Mr. C. H. Wordingham, we are able to reproduce in this issue a unique load curve, which was taken on Tuesday, Aug. 21. On that day a very heavy thunderstorm passed over the city of Manchester, which caused a very sudden and heavy increase in the load. This load curve, in fact, would be a useful record to a meteorologist in tracing the progress of the storm, as it fixes the exact point at which



Load Curve for the Dickenson-street Station at Manchester for Aug. 21, 1900.

darkness commenced and ended. It will be seen from the curve that the ordinary load of about 1,750 kw. was supplied in the usual way at about half-past two, due, we presume, to the light required in restaurants, and that at half-past four the storm began to make itself felt. The load rapidly increased to nearly 4,500 kw., or approximately three times its normal volume. Such a sudden increase was a great tax on the steam-raising plant, and we learn from Mr. Wordingham that the pressure at the boilers could not be maintained. He, however, succeeded in maintaining the voltage on the lamps, for which every credit should be given to the engineering staff of the Dickinson-street station. The

Digitized by Google

unfortunate consumers in the City of London know what disastrous effects a thunderstorm has on the voltage of electric supply in that area.

ON THE EFFECTS OF STRAIN ON THE THERMO-ELECTRIC QUALITIES OF METALS.—PART II.*

BY MAGNUS MACLEAN, M.A., D.SC.

A.—*Thermo-electric difference between free wires and wires previously subjected to longitudinal extension and lateral compression, by drawing them through the holes of a draw-plate* (§§ 1-17).

§ 1. In Part. I of this paper, read to the society on Feb. 2, 1899, the object of the experiments was stated to the determination of the magnitude of the thermo-electric effects, obtained from any one metal strained and unstrained. The results then given were obtained from two wires of the same material, one wire being previously drawn through a draw-plate, so as to reduce it in size from No. 18 standard gauge (0·122cm. diameter) to about No. 24 standard gauge (0·0559cm. diameter). The arrangement of the experiments to measure the thermo-electric effect is shown diagrammatically in Fig. 1. One junction of the wires was kept in a glycerine bath, which could be heated by a Bunsen burner. This junction was tied by a fine copper wire to the bulb of a thermometer, T. The other ends of the wires were joined to short

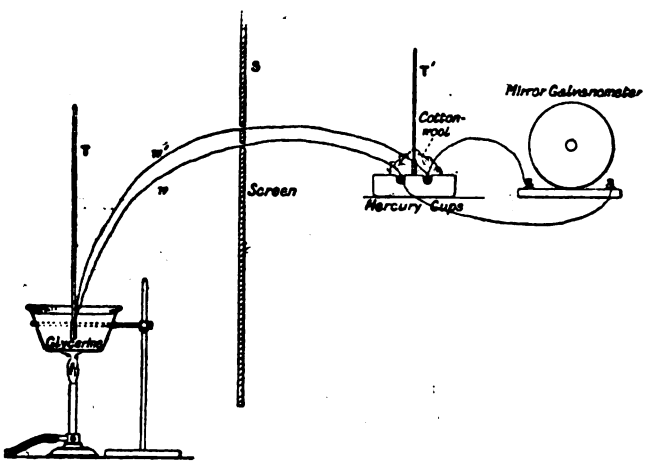


FIG. 1.

copper wires, which served as terminals of the low-resistance galvanometer used in the experiments. These junctions were wrapped in paraffin paper or cotton wool, which contained the bulb of a thermometer, T', reading half degrees from 0deg. C. to 25deg. C. A paper screen, S, was hanging vertically between the Bunsen burner and the thermometer T' and the galvanometer, to prevent any heat from the flame reaching the rest of the circuit by radiation. These precautions were taken to make certain that all junctions, except the hot junction, would be at the same temperature. The sensitiveness of the galvanometer was 0·09 mikroampere per division, and as its resistance is 1 5 ohms, the E.M.F. at its terminals was 0·135 mikrovolt per scale division.

§ 2. The metals for which results were given in Part I. were copper (six specimens), lead (two specimens), platinoid, German silver, reostene, and manganin.† The present paper gives results of similar experiments made on specimens of commercial‡ and pure lead, obtained from Messrs. Johnson and Matthey; and specimens of annealed steel, of aluminium, and of nickel.

§ 3. The method of experimenting was to take a piece of the wire and draw it through a few holes of a draw-plate so as to reduce its cross-sectional area to about a quarter. Then two pieces of the wire, one drawn and one undrawn, each 60cm. long, were joined as in Fig. 1. The glycerine bath was very slowly heated by the Bunsen burner. When there was a rise of temperature of 5deg. C., the Bunsen burner was drawn slightly aside so as to give as much heat to the glycerine bath as it lost by radiation. When both the thermometer reading and the spot of light on the scale were seen to be steady, the readings were noted. The circuit was then broken and readings taken of the galvanometer zero and the thermometer T'. The circuit was again completed, and readings taken when there was 5deg. C. further rise of temperature, and so on up to a difference of about 100deg. C., the greatest difference tried in these experiments. A curve was plotted with differences of temperature between the hot and the cold junction as abscissæ and currents through the galvanometer as ordinates. The mean current per degree difference of temperature as found from each curve is given in Table I.

TABLE I.

Conductor.	Condition of conductor. Current from 1 to 2 through the hot junction.	Current in mikro-ampere per degree up to 100deg. C.
Annealed steel	1. Drawn 2. Undrawn	0·0567
Aluminium	1. Drawn 2. Undrawn	0·0065
Nickel	1. Drawn 2. Undrawn	0 213
Lead, commercial	1. Undrawn 2. Drawn	0 0124
Lead, pure	1. Undrawn 2. Drawn	0·0036

§ 4. The steel was annealed by coiling it round a large cast-iron ball, which was heated in a bright coal fire for about an hour. After being taken out of the fire, the ball, with the iron wire round it, was allowed to cool slowly for about an hour and a half in the ashes below the fire. It was previously found that heating the wire to red heat by an electric current and allowing it to cool slowly did not anneal it.

TABLE II.

Conductor.	Cross-section of undrawn and drawn wires in sq. cm.	Specific gravity of undrawn and drawn wires.	Resistance of the undrawn wires in C.G.S. units at 14deg. C.	
			Per c.c.	Per cm. long, weighing a gramme.
Steel, annealed	0 007504 0·004141	7·78 7·762	13,900	108,100
Aluminium	0 04594 0 01697	2·8 2 796	3,546	9,931
Nickel	0 01179 0 002475	8 9 8 85	9,430	83,920
Lead, commercial	0 01145 0·00256	11·36 11·36	20,560	233,100
Lead, pure	0·01150 0 00236	11·35 11·357	20,300	230,200

TABLE III.

Conductor.	Resistance in ohms of 60cm. of wire.		Total resistance external to galvanometer.	Total resistance in circuit.	Thermo-electric difference in mikrovolt per deg. C. difference of temperature.
	Undrawn.	Drawn.			
Steel, annealed	0·1111	0 2015	0 3126	1 813	0 1028
Aluminium	0·0047	0·0125	0·0172	1 517	0·0099
Nickel	0 0480	0 2287	0 2767	1·777	0·3784
Lead, commercial	0·1077	0 4820	0·5897	2 09	0·926
Lead, pure	0 1059	0·5162	0 6221	2·12	0·0076

§ 5. The resistances of all the undrawn wires, and the

* Paper read before the Royal Society.

† Dr. Anderson, Chemical Laboratory, the University, Glasgow, gave me the following analyses for reostene and for manganin:

Reostene.		*Manganin.*	
Si	0 61 per cent.	Sn	0 073 per cent.
Fe	79 95 ,,	Fe	0·6 ,,
Ni	16·53 ,,	Cu	86·62 ,,
Mn	1·21 ,,	Mn	8 031 ,,
		Ni	3·261 ,,
Total	98·30 ,,	Total	98·585 ,,

‡ Dr. Anderson analysed the commercial lead and found it contained 99·12 per cent. of lead.

Digitized by Google

specific gravities of both the undrawn and drawn wires, were carefully determined by the usual laboratory methods. The results obtained are given in Table II.

§ 6. By multiplying the current per division given in Table I. by the total resistance in the circuit, calculated from the results in Table II, the thermo-electric difference per degree between drawn and undrawn wires is found. The numbers are given in Table III.

§ 7. The thermo-electric difference between glass hard tempered steel, annealed steel, and unannealed steel was found by similar experiments to be:

1. Glass hard steel
2. Unannealed steel } 7·5 mikrovolts per degree C.
1. Unannealed steel
2. Annealed steel } 0·18 " "
1. Glass hard steel
2. Annealed steel } 7·67 " "

The direction of the current through the hot junction was in every case from hard steel to soft steel.

B.—*Thermo-electric difference between free wires and wires previously permanently elongated by longitudinal stresses* (§§ 8-10).

§ 8. Attempts were now made to determine the thermo-electric difference between free wires and wires previously permanently elongated by a longitudinal stress. It was found difficult to elongate the hard wires permanently to any appreciable extent before they broke. Several methods for stretching the wires were tried, and the method finally adopted was to take two pieces of stout copper rod, bent into the shapes shown at A and B in Fig. 2, and to wind the wire to be stretched several times round A and B.

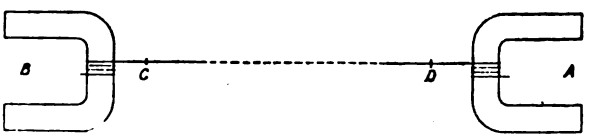


Fig. 2.

The end A was clamped in a fixed vice, and the end B fixed in the clamp of a screw arrangement. By turning the screw the wire was stretched tight. Two ink marks were then put on the wire at C and D 60cm. apart. The screw was very slowly turned, and the distance between C and D measured until the necessary elongation was produced or until the wire broke. The wire generally broke where it lay tangentially to either rod A or B.

§ 9. The greatest percentage permanent elongation that could by this method be got in hard-drawn copper, manganin, nickel, and German silver, was 0·7, 0·5, 0·7, and 0 5 respectively. The thermo-electric difference between the stretched and the unstretched wires was then determined, as described in § 3, and the results are given in Table IV.

§ 10. It will be noticed that the current is from unstretched to stretched, through the hot junction for three specimens of copper, and from stretched to unstretched through the hot junction for other three specimens. The probable explanation of these results is suggested in §§ 13, 14, 15.

C.—*Thermo-electric difference between free wires and wires under stress, producing* (1) *temporary elongation*, (2) *permanent elongation* (§§ 11-18).

§ 11. The arrangements shown diagrammatically in Fig. 3 were now made to determine the thermo-electric difference between free wires and wires while (*a*) under stress, stretching them within their limits of elasticity, and (*b*) under stress, stretching them beyond their limits of elasticity. A B is a brass tube through which steam from a kettle is allowed to pass. The wire under test is wound round this brass tube three times, and then round a small brass tube in the triangular frame below, and then to one of the terminals of the galvanometer. The wire is thus quite continuous, from one terminal of the galvanometer to the other terminal. Some cotton wool is loosely packed at the hot junction of the wire to ensure that the temperature of the wire is at steam temperature. The weight of the triangular frame (two sides wood and one side brass tube) with its hook for hanging weights on was 220 grm. This is the smallest weight used for each wire, everyone of which was about No. 30 S.W.G. (diameter, 0·315cm.).

Table IV.

Conductor.	Condition of conductor. Current from 1 to 2 through the hot junction.	Percentage permanent elongation.	Current in mikroampere per degree up to 100deg. C.	Total resistance in circuit in ohms.	Thermo-electric difference in mikrovolt per degree centigrade difference of temperature.
Messrs. Johnson and Matthey—					
(*a*) Copper, electrotype	1 stretched 2 unstretched	1·0	0·0021	1·517	0·0032
(*b*) Copper, for alloy	1 stretched 2 unstretched	1·0	0·003	1·519	0 0046
(*c*) Copper, commercial	1 stretched 2 unstretched	1·5	0·0051	1 548	0 0079
Messrs. Glover—					
(*a*) Copper, hard	1 unstretched 2 stretched	0·7	0·0018	1·519	0 0027
(*b*) Copper, soft	1 unstretched 2 stretched	1·5	0·005	1 531	0·0077
Copper, laboratory	1 unstretched 2 stretched	1·5	0·0024	1 518	0·0036
"	1 unstretched 2 stretched	20·0	0·174	1·52	0 0264
Reostene	1 unstretched 2 stretched	2·0	0·009	2·312	0·0208
Platinoid	1 stretched 2 unstretched	1·0	0·047	1 937	0·0910
German silver ...	1 stretched 2 unstretched	0·5	0 056	1·835	0·1027
Manganin	1 stretched 2 unstretched	0·5	0·036	1·924	0·0693
Aluminium	1 stretched 2 unstretched	1·0	0·0135	1·51	0·0204
Nickel	1 unstretched 2 stretched	0·7	0 084	1·596	0·1341

The object of the small brass tube in the triangular frame was to keep the temperature of the cold junction at any determined temperature by allowing water or other fluid to flow through it. In all the experiments hitherto made, the temperature of the cold junction was taken as the temperature of the air at the time of each observation.

§ 12. The experiments were performed as follows: The wire was put into the circuit, as shown in Fig. 3. After

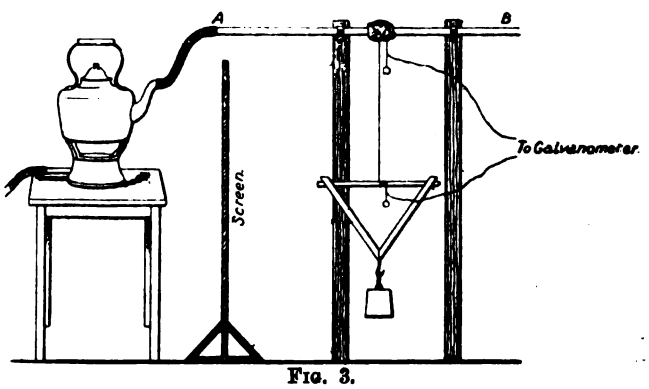


Fig. 3.

steam was allowed to pass through the tube for some time, the galvanometer reading and the air temperature were taken. The circuit was then broken, and the metallic zero of the galvanometer was noted. The circuit was made, and a weight was added on to the hook of the triangular frame. Three readings of the galvanometer were now taken: (1) with the weight on, (2) with the weight off, and (3) with the circuit broken. A heavier weight was hung on and other three readings taken, and so on to the heaviest weights used in the experiments.

§ 13 The readings of the galvanometer were in the same direction for all the wires tried with weights on and off, except for soft copper and iron. The greatest permanent elongation produced in any of the hard copper wires experimented on was 0·17 per cent., and for this permanent elongation the reading on the galvanometer was in the same direction for weights off and on, though always greater for the latter.

(*To be continued.*)

Digitized by Google

ELECTRICAL MEASURING INSTRUMENTS.*

BY J. FRANKLIN STEVENS.

In attempting a brief discussion of so broad and comprehensive a subject as that assigned me for this evening, I have been principally concerned in trying to decide just what portion of the general subject I should touch upon, and in what manner I could treat that portion briefly, for I cannot hope to be comprehensive and yet have my remarks present a semblance of coherence.

Since we have available a very extensive literature bearing on the subject of laboratory testing instruments, in which can be found descriptions of the instruments employed, their construction, application, and approximate laws, I shall pass over that portion of the subject and confine myself to commercial direct-reading indicating instruments, such as are to be found in everyday use.

The history of the art embodied in the commercial manufacture of indicating instruments is extremely interesting, but shows many analogies to the development of other branches of electrical engineering, with the single exception that practical data in published form is extremely scarce. Everyone entering this field is compelled to master some of the most intricate problems known to the profession, and must learn for himself how best to apply theoretical deductions to practical mechanical devices. Until very recent years our sole guide has been the study of early and primitive types, which in their time were useful and valuable, but which to-day fail to reach the high standard we have learned to demand of an instrument whose function is to indicate the input or output of our many and varied electrical devices. Every new device put before the public has meant a new condition to be met by the instrument manufacturer, requiring of him a new design or modification of an existing design. Two rather recent examples of this occur to me: one, the increasing tendency to employ high voltages in commercial work, reaching frequently 12,000 volts in the case of series constant-current arc-light systems and 33,000 volts in long-distance power transmissions; the other, the rapid development of the electric automobile, which requires a volt-ammeter of as high a degree of accuracy as the portable laboratory instrument, yet able to withstand the roughest usage ever accorded an instrument of precision, coupled with restrictive specifications as to size and weight. In every instance instrument manufacturers have met the demand made upon them better, I think, than many of our fellow-workers have in some other lines. Much yet remains to be done, and much, I am confident, will be done in the matter of perfecting existing instruments in the near future. Gradually inefficient or unreliable types are being relegated to oblivion, and the remaining ones brought closer and closer to staudard uniform construction.

The greater number of measurements required to-day can be made with a voltmeter, ammeter, and wattmeter, and, while it might be thought that the wattmeter is merely a combination of the voltmeter and ammeter mounted in one case, this is not true in all classes of measurement. While it is true that the reading of the wattmeter represents the product of the readings of the voltmeter into the ammeter in the case of direct-current measurements, it is not true in the case of alternating-current measurements, save in the very exceptional case of a circuit possessing neither capacity nor inductance or a balance of the two. When either inductance or capacity exist, there is a consequent lag or lead of the current wave relative to the pressure wave, and, since the instantaneous readings of the volts and amperes represent the mean effective or virtual values—that is, the square root of the mean square—their product differs from the reading of the wattmeter, which indicates the integrated values of two curves, the maximum and minimum values of which occur at different times. To obtain an agreement between the values obtained by volt-ampere readings and watt readings, it is necessary to multiply the volt-ampere readings into the cosine of the angle of lag or lead, so that the ratio of the watt readings, as given by a properly-constructed wattmeter, to the volt-ampere readings gives us the power factor of the circuit, and from the two sets of readings we can readily determine the angle of lag or lead and the so-called wattless current. Probably this is well known to all of you, yet scarcely a week passes but I have to explain the matter to one or more customers, who cannot reconcile the difference in the two sets of readings, and are inclined to believe that some, if not all, of their instruments are indicating erroneously.

Before touching on the different types of indicating instruments which are most commonly found in commercial use, let us consider for a moment the essential requirements of a practical and satisfactory instrument for measuring voltage, current, or power. To start with, the instrument must be direct-reading. We have no time to-day to convert angular deflections into true values by means of tables of constants, but insist that the pointer shall indicate directly in definite units the value of the passing load or the impressed E.M.F. We must next be assured of the accuracy of the calibration, and for that depend principally upon the reputation of the maker or check the indications by comparison with a secondary standard. Beyond this we must know that the accuracy of the indications is not affected by the influence of ordinary external fields or by normal variations of temperature, due either to heating within the instrument, by means of the passage of the current to be measured, or to variations in the temperature of the room in which they are installed. All instruments should be mounted in dust proof cases, and the systems carried in jewelled bearings; the movement of the pointer should be aperiodic or dead-beat, and, so far as possible, the system should contain nothing subject to change or deterioration, and should be constructed so that it will withstand successfully the ordinary rough usage liable to be accorded it in practice. The question of gradual change of accuracy, due to the change in some constituent part of the system, has led me to strongly advocate the use of electromagnetic instruments with gravity control for switchboard use whenever the conditions render them applicable, and I fully expect to see this type of instrument become more popular, as its advantages become more widely appreciated. Such a system is not applicable for portable instruments, save the dynamometer system for alternating currents, and even then a spring control must be used: nor is the series electromagnetic ammeter practical above about 1,500 amperes, due to the structural difficulties involved in carrying the 'bus bars directly to the instrument terminals. The one objection most commonly urged against the electromagnetic instrument for direct-current switchboard use is the unequally divided scale, for, as a rule, the scale only covers a range starting at 10 per cent. of the total up to maximum. In most cases, however, this objection is purely captious, for a switchboard voltmeter is seldom used to indicate more than 10 per cent. above or below the normal voltage, and the ammeter indications are of principal importance in the higher ranges to prevent a possible overload of the circuit or generator. In alternating-current circuits an equally divided scale is an impossibility, so why should we sacrifice constancy in direct-current measurements for the sake of an equally divided scale when the lower registers are so seldom used? In portable direct-current instruments the proposition is somewhat different, as we desire to cover the maximum limits of possible measurement on a single-scale instrument, therefore an equally divided scale is desirable and practically necessary.

Taking up now the different types of instruments which are in most common use, we find they may be roughly divided into six classes, depending on the principle by means of which measurements of voltage, current, or power are made; (1) the hot-wire; (2) the tangent galvanometer; (3) the electrostatic; (4) the dynamometer; (5) the D'Arsonval galvanometer, and (6) the electromagnetic.

The hot-wire instrument is designed to operate by the expansion of a fine wire or strip of conducting material due to the heating produced by the passage of the current to be measured, and, therefore, the indications are proportionate to the square of the current. This type of instrument possesses the advantage of indicating with equal accuracy the current flow on either direct or alternating current circuits, and is independent of the frequency of

* From the *Journal* of the Franklin Institute.

Digitized by Google

the circuit or of the shape of the current wave; it is further unaffected by the presence of external fields. These advantages, however, are all that can be claimed for this system, and to offset them are many serious disadvantages. Since the instrument operates by virtue of temperature differences, it is extremely susceptible to variations of external temperature, and such variations must be compensated either by mechanical means, which provide for bringing the pointer to zero by increasing or decreasing the tension on the working wire, or by providing auxiliary heating strips, which are supposed to automatically adjust the tension of the working wire on the general principles of a thermostat. This may seem a small matter to most observers, but to me it signifies an error in principle, and reminds me of one of our early types of arc dynamos which, by reason of incorrect construction, was found to spark badly; so, in place of correcting the design, an air blast was provided to blow out the spark. Another point of objection is the constant change of zero, due to the fact that until the wire has been stretched to its elastic limit it will fail to return to the same point after having been stretched by the heat applied, and will always show a slight residual strain. To attempt to correct this prior to installation in the instrument means, judging by my own experience, that at least 90 per cent. of the wires will break during the preliminary stretching process and the remaining 10 per cent. will stand but a very slight overload in service. As overloads are quite common, this would constitute a serious objection, for it means the return of the instrument to the manufacturer for the insertion of a new wire and recalibration. Another very serious objection is the amount of current required to operate the instrument. The average resistance of a modern hot-wire voltmeter is four ohms per volt, which means a current flow of ·25 ampere. This low resistance effectually bars this type of instrument for accurate testing, since the amount of power abstracted from the circuit to be tested vitiates the accuracy of the results obtained and introduces serious errors, which must be allowed for in all calculations. Recently an attempt has been made to introduce the hot-wire instrument as a shunt ammeter, particularly for alternating-current measurements. As a shunt ammeter, the hot-wire instrument is a distinct failure, for, while the manufacturers claim it can be operated on a drop of ·3 volt for full scale, my personal experience has shown a drop of six volts to be necessary. On the makers' figures, 300 watts would be required to operate a 1,000-ampere ammeter (nearly 4 h.p. per instrument), while on the sample I have tested 6,000 watts, or 8 h.p., would be required. Again, it has been shown that these ammeters when calibrated on direct current are not accurate within 10 per cent. when used on alternating currents, unless the reactance in the shunt is exactly equal to the reactance in the instrument, a condition almost impossible to obtain even with the most careful design.

A modification of the hot-wire system has been proposed, consisting of an enclosed chamber containing a fixed resistance wire, one end of the chamber, which is made airtight, consisting of a flexible diaphragm operating the pointer through a system of levers. In this case the heat supplied to the wire by the passing current causes the air in the enclosed cylinder to expand, and, consequently, puts the diaphragm under tension, very much on the principle employed in the aneroid barometer. I find by actual experiment that such a system could be applied to voltmeters, and could be so made that it would be accurate in its indications, and would possess a reasonably high resistance. The feature, however, which renders this system impracticable is the slowness with which the readings can be taken. The pointer will not come to rest until after the heat supplied the air enclosed within the chamber is equal to the heat radiated by the walls of the enclosing chamber, and from 1½ to 2 minutes are required before the pointer will come finally to rest at the part of the scale marked to indicate the impressed E.M.F. This is true no matter how small the air chamber is made, and while it is possible to shorten this time by carefully covering the sides and one end of the cylinder by a heat-insulating jacket, still it cannot be constructed so as to give an instantaneous reading, and every attempt to shorten the time by covering the walls of the chamber results in a corresponding increase of the time required for the pointer to come back to zero after current has been shut off. In other words, the instrument is similar in its action to an ordinary thermometer, which, as you know, cannot be made to respond instantly to changes of temperature.

Electrostatic instruments, which depend for their action on the mutual attraction of two plates connected to the opposite sides of the line, are still used, but not extensively, for high-tension measurements. They will indicate correctly on either direct or alternating current circuits, but are limited to measurement of voltage. It is impossible with this type of instrument to obtain a low reading, as the attraction of the plates toward one another varies approximately with the square of the potential difference between them. I say "varies approximately" advisedly, as the capacity of two plates varies directly with the square of the voltage only when the distance between the plates is maintained constant, which in this case is an obvious impossibility. As a rule, these instruments cannot be made dead-beat without introducing elements liable to seriously interfere with their accuracy; and while there are no errors due to temperature changes, and while they are also extremely efficient, requiring no current flow at all, they are affected very considerably by external influences, particularly by static charges, which are almost invariably present in power stations or dynamo rooms, and, as you probably know, it is practically impossible to provide a shield for static effects.

Instruments employing the principle of the tangent galvanometer are still employed, and for certain classes of measurements are extremely useful. They can be particularly recommended for use as ground detectors or differential voltmeters, where the actual value of the indicators is of small moment, the particular object being to show a balance of two opposing voltages or the presence of a ground by deflection. In this system the magnetised needle is suspended vertically, and is acted upon by two equally and oppositely wound solenoids; that is, the solenoids are wound with two wires in multiple and then cross-connected, so that we have two circuits equal in effect but opposite in action. I might say, in passing, that if the proper proportions of solenoids to magnetised needle are employed, and the length of the magnetised needle properly proportioned to its area, the tangent galvanometer instrument may be made extremely accurate and also quite permanent. Care must be taken, however, that under no conditions can the direction of the lines generated by the solenoids oppose the lines existing in the magnetised needle, otherwise the value of the calibration is almost instantly destroyed.

For measurements of alternating-current voltage, and also for the measurement of the watt output of any alternating-current source of energy, the dynamometer system, in one of its many modifications, is unquestionably the best type of instrument that can be used. This instrument indicates directly the mean effective voltage of the line to which it is connected, and is equally accurate for direct-current measurements, provided readings are taken with the direct current flowing through the instrument in one direction, then the direction of the current flow reversed and a second reading taken, the mean of the two readings being the correct value of the impressed E.M.F. This for the reason that the instrument is extremely susceptible to the influence of external fields. Further, the dynamometer type of instrument is only properly adapted for use in portable instruments. The fact that two readings are necessary on direct current prohibits its use as a switchboard instrument on direct-current circuits, and its delicacy, coupled with its field of low intensity and its susceptibility to error, due to the presence of iron in its immediate neighbourhood, whether used on direct or alternating current circuits, renders it impracticable as a switchboard instrument for alternating current circuits. As an ammeter it cannot be successfully employed for measurements above ·5 ampere, due to the difficulty of providing perfectly flexible contacts capable of carrying large currents. When you attempt to convey a current into a moving coil beyond the carrying capacity of a flexible conducting spring, recourse must be had to mercury contacts,

Digitized by Google

and a mercury contact should never be employed in a portable or enclosed type instrument. In the dynamometer instrument great care must be taken to have the moving coil as light as possible, and to render the instrument aperiodic, or dead-beat, an aluminium air-vane, moving in a partially enclosed chamber, must be employed. Manually operated brakes acting on the delicate moving system should be avoided, as their continued use results in a serious derangement of the moving parts.

Instruments based on the principle of the D'Arsonval galvanometer are very extensively used to-day for both switchboard and portable instruments on direct-current circuits; they can be calibrated so as to show an equally divided scale, and, if properly constructed, are an extremely efficient instrument. Further, they are very well adapted to the measurement of resistances and grounds. In the construction of this type of instrument the important factor is the permanency of the permanent magnet fields employed. It is essential, in the first place, that the proper grade and quality of steel shall be employed, which means a steel possessing high permeability and a high degree of retentivity; then this steel must be carefully worked within definite limiting temperatures and must be treated with great care and skill in the process of magnetising and ageing. Further than this, the moving coil should be extremely light and the whole system carefully shielded from the influence of external fields, and yet so shielded that the moving coil will not be robbed of an appreciable number of lines of force, due to the presence of the shielding iron. The greatest field for this type of instrument is in the measurement of heavy currents—that is, for currents of 1,000 amperes and upwards, due to the fact that it can be operated as a shunt instrument, requiring an extremely small drop of potential, full scale being obtained with a drop of from ·03 to ·05 volt. This means a relatively high efficiency, and, while the instrument does not possess all the advantages of a series ammeter, yet it is far easier to instal, and where a high degree of accuracy in current indications is not demanded, will be found very satisfactory in practice.

Further than this, the D'Arsonval instrument, which gives deflections directly proportionate to the current flow, lends itself readily to a large variety of measurements, such as determining resistances and measuring the drop of potential from which resistances and grounds may be readily computed. It is, however, a type of instrument which should be handled with great care, as rough handling or the presence of powerful external fields will permanently destroy the accuracy of its indications. Further, since it depends primarily for its continued accuracy of the maintenance of a field of uniform strength, as supplied by its permanent magnet field, instruments of this type should be frequently checked to ascertain whether the permanent magnets have maintained their initial strength.

A great deal might be said on the subject of the last type under consideration—namely, the electromagnetic system—for there are probably more variations in practical construction contained in this type than in all the other types put together; some are good, many very bad. It is, however, unfair to adopt the policy of certain engineers, who unqualifiedly condemn every electromagnetic instrument, solely and entirely on the grounds that they contain a moving mass of iron, which, in their opinion, must render the instrument subject to errors of lag and hysteresis. My practical experience with this type of instrument, covering a great many years, has taught me that it is perfectly possible to so construct an electromagnetic instrument containing a mass of moving iron that errors of lag and hysteresis. if they are present, are so small as to be negligible. In order to achieve this result, it is necessary first to proportion every part of the instrument with reference to all other parts; to carefully shield the instrument from the influence of external fields, and this by means of a shield that will not introduce errors due to its own retentivity. The iron employed should be very small and very light, and should be selected after careful test for purity and absence of retentivity. It should then be formed up with care, and so treated that oxidation is practically impossible. The field due to the actuating solenoid should likewise be carefully studied, and should be designed so that the moving iron will at no time be completely saturated, and yet of sufficient strength, in conjunction with the shield employed, as not to permit the indications of the instrument to be seriously influenced by external fields. In no case should two masses of iron be employed, as is common in some types of instruments, which depend on the repulsion of a moving vane by a fixed vane of similar polarity, both being energised by the actuating solenoid. It is almost impossible to free double-vane instruments from errors of lag or hysteresis, and there is a further tendency for the pointer to stand off zero, due to the residual magnetism mutually induced in the two vanes.

The fact that the instruments constructed on the electromagnetic principle contain no material subject to change or deterioration, coupled with the fact that they can be built solidly and substantially, and controlled by gravity in place of a spring or springs, renders them exceedingly reliable in practice. If their calibration is correct when first installed, there is no reason why the calibration should change with time.

In the above brief description of the most common types of indicating instruments, it may be noted that there is no one type which is universal—that is, adapted for switchboard and portable use for either direct or alternating current measurements. While we can very readily dispense with the hot-wire and electrostatic instruments, the other four types are essential for some class of measurement, and for any particular line of measurement the most suitable system should be selected. It is possible that some day a universal system may be found, but until that time the user must select from existing types the one which in principle seems most applicable, not only to the character of electrical energy to be measured, but also to the conditions under which measurement must be made.

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

303. Explain the use and working of the Kelvin earth-current recorder, with automatic short-circuiting switch. Give diagram of connections?—K. V. R.

304. What are the best and most useful forms of earth-plates used for lightning arresters?—F. H.

ANSWERS.

Question No. 295.—What is the best arrangement and the best machinery to use to run 14 direct-current arcs taking 25 amperes?

Best Answer to No. 295 (*awarded* 10*s.*).—If the lamps are situated close together for the purpose of lighting a single factory or other building, it would be best to run them either all in parallel off an ordinary compound dynamo wound for about 60 volts, or in seven parallel groups of two lamps each off a 110-volt or 120-volt generator. In either case, a steadying resistance should be placed in series with each lamp or pair of lamps. This arrangement will allow a standard and therefore cheap dynamo to be used, it obviates the use of a dangerously high voltage, and the same generator can be conveniently

Digitized by Google

used for incandescent lighting if any should be required. If, however, the 14 lamps are distributed over a considerable space, as in street-lighting or similar work, it will be distinctly more economical in copper to work them all in series at 700 to 750 volts. In this case the dynamo must be a series-wound arc lighter with a drooping characteristic curve, so as to ensure steady burning. The lamps need not have any special steadying resistances, but must be fitted with automatic cut-outs, so that in case of accident to one lamp it will be at once short-circuited, and the remaining lamps will continue to burn uninterruptedly. If lowness of price of the installation is the great object, the dynamo should be a high-speed belt-driven one, but if space is of more importance, a direct-coupled engine set would probably be preferable, though more expensive.—Q.

Answer to No. 295 *(awarded* 5*s.).*—The best way of running the arc lamps is by the series method. Compared with parallel running, the series system possesses many advantages, both as regards steady burning and first cost.

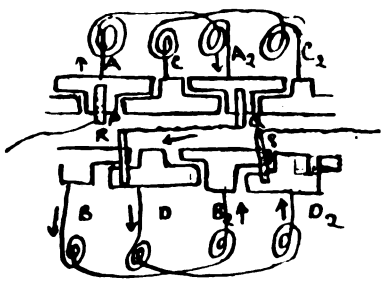


FIG. 1.

With parallel working for 14 arc lamps, each taking 25 amperes, we should require a generator capable of giving 350 amperes at 50 to 60 volts. This, in the first instance, is against parallel working; the quantity of copper in a system using such a large current would cost far more than a series system. Besides this disadvantage of first cost, the lamps are found to run very unsteadily, and require resistances to reduce the current, or a general burn-up in the lamp is the result. It will be seen from the above that everything points to series working when arc lamps only are to be used on the generator. The generator in a series system gives out a small current at a high voltage—in the case in question 25 amperes—and the voltage = (14 × volts required for each lamp); in addition, a small percentage must be allowed for drop in line. The lamps are all connected in series, and are provided with automatic cut-outs which cut out a faulty lamp. A disadvantage to this system is the high voltage used, which requires great carefulness in handling any apparatus, or fatal results may happen. The machines or generators used to generate the current are known as the open-coil type, the two best-known machines being the Brush arc lighter and the Thomson-Houston. The Brush machine is hardly so complicated in the armature winding as the

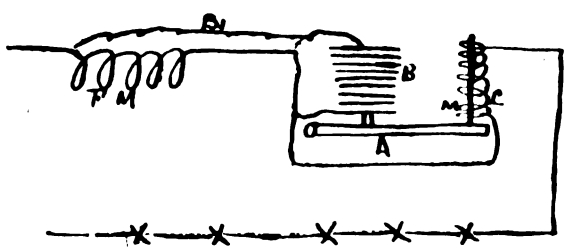


FIG. 2.

Thomson-Houston, and as this is a very important item, as the armature is generally damaged before any other part, I should advise the adoption of this type of machine. In a series machine the E.M.F. is taken from the coils at the moment of greatest activity—*i.e.*, when the E.M.F. is at its maximum. This leads to tremendous sparking at the brushes, but as no mica enters into the construction of these commutators, practically no damage is done. The coils are connected in pairs, and each pair is thrown out of the circuit when it is generating no current, and comes into the circuit again as the E.M.F. rises.

In Fig. 1 it will be seen that C C_2 are the pair of coils entirely cut out, whilst A A_2 are in the best position, and in series with these coils are B B_2, D D_2, four coils, which are rising to their best position. The commutator is in two parts, as shown, the brushes, R Q, being connected across, whilst P S feed outside circuit. The regulation of the current is accomplished by an ingenious regulator devised by Brush. When the current in outside circuit increases, the magnet core, C, is attracted, lifting the lever, A, and compressing carbon plates, B, thus enabling more current to go through B, and thereby weakening F M, the field magnets of the machine, and keeping the current steady. In starting a series machine, the current rises better if the terminals are shorted with fuse wire to allow the magnets to become excited.—F. M. M.

Answer to No. 295 (*awarded* 5*s.*).—As the number of lamps to be used is small, presumably only a small space is therefore covered. That being the case, an ordinary shunt-wound drum machine giving 100 volts (180 amperes) could be used as generator, the lamps being connected two in series across the mains. The lamps, if possible, should be arranged so that if any are cut out it will be two that are in series. If one of two in series is cut out, a compensating resistance must be put in to prevent injury to the remaining lamp. As an alternative to the above method, all the lamps can be connected in series and run from a series-wound generator giving 25 amperes at 720 volts. Any lamps cut out must be replaced by a compensating resistance, unless a special dynamo is used to keep the current constant, which is often done by shifting the position of the brushes by suitable mechanism.—F. H. PALMER.

Question No. 296.—In a continuous-current circuit, three-wire system, with 120 volts in the mains, which is the best way for supplying power in the daytime at 240 volts without any trouble, with the supply of light in the evening at 120 volts? It is needed that power cannot be used in the evening, nor the light in the daytime.

Best Answer to No. 296 (*awarded* 10*s.*).—The demand that it shall be impossible to use both the 240-volt motors and the 120-volt lamps at the same time distinguishes this from all ordinary three-wire systems. The required result can, however, be fairly simply obtained by means of the arrangement shown in Figs. 1 and 2.

The 120-volt lamps are connected between the middle and the outer wires as usual, the total number of lamps being divided as evenly as possible between the two sides of the system, so as to reduce the current in the middle wire to a minimum. The 240-volt motors, as will be seen by the figures, are connected between the middle wire and one of the outers, the same outer being used for all the

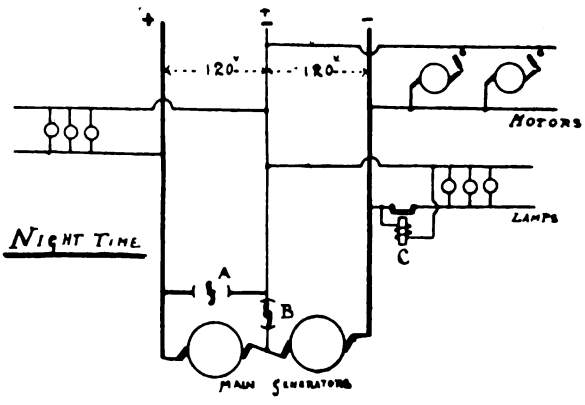


FIG. 1.

motor connections. The method of working the system is as follows: During the night-time, when lamps only are to be used, switch A will be open and switch B closed, as in Fig. 1, and the arrangement will be the ordinary three-wire system in every particular. During the daytime, when motors only are to be used, switch A will be closed and switch B open, as in Fig. 2, thus disconnecting the middle wire from the ± terminal of the main generators (or balancer if one is used) and connecting it directly to one of the outer wires (the outer to which no motors have been

Digitized by Google

connected), with the result that the volts across the left-hand side of the system (Fig. 2) are made zero, and the volts across the right-hand side, to which all the motors are connected, are raised to 240.

Now, with regard to the impossibility of running both lamps and motors at once. With the night-time connections (as shown in Fig. 1) it will be seen that the voltage across the motors is only 120, so that even if switched in they would run at a very slow speed, would take a very large current, and would consequently heat and spark, and thus effectually prevent any consumer continuing to run them. A more satisfactory arrangement, however, and one preventing any risk of damage to the motors, would be to have all motors fitted with automatic release starting switches, S, of the Cutler-Hammer pattern, which are now so commonly used. These would prevent the motors ever starting at all with 120 volts, as the switch handle would simply fly back to its "off" position as soon as the hand is removed. With the daytime connections (as shown in Fig. 2), the voltage over the lamps on

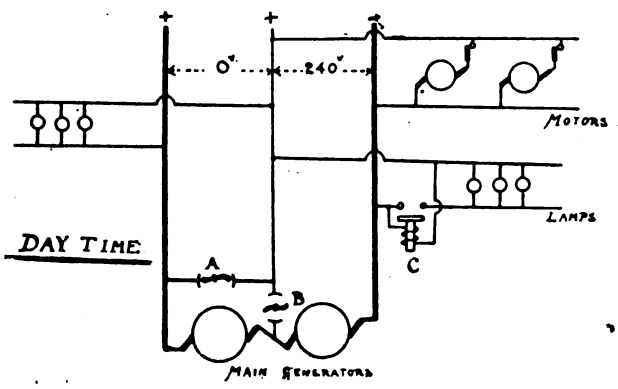


FIG. 2.

one side of the system is zero, so that they could not possibly be used, whilst the voltage on the other side would be 240, which would immediately burn out any lamps that might be switched in. In order to prevent this burning up of lamps it would probably be better to fit the lamp circuit in every house connected to that side of the system with a simple form of automatic cut-out, such as at C (Figs. 1 and 2), which would open the lamp circuit as soon as the voltage rose above 120. Failing such a cut-out, it would be necessary to close switch, A, slowly through a resistance, so as to give consumers who had left lamps on timely notice. With the arrangement described it will be noticed that the middle wire of the system must have sufficient section to carry the whole of the motor current. With the relation of out-of-balance current to motor current found in an average supply station, this would, however, not necessitate a larger middle wire than would anyway be put in.—Q.

Answer to No. 296 (*awarded* 5*s*).—This question has been so vaguely drafted that it is difficult to discover what

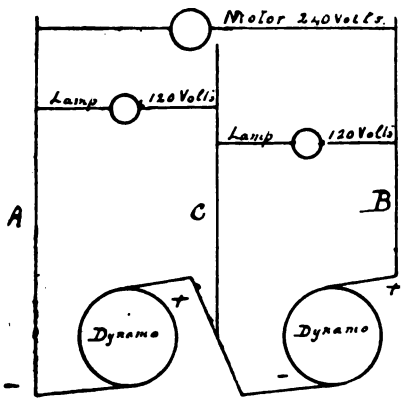


FIG. 1.

is required. The writer has assumed that it applies to a central station where the generating plant is too small to provide for both the lighting and power demands, and that it has been decided, since "it is needed that power cannot be used in the evening nor the light in the daytime," to supply current for power purposes only at 240 volts in the daytime, and for lighting purposes at 120 volts in the evening, and that now a simple and effective arrangement of switchboard and mains is required. If this be the correct interpretation, it is evident that the ordinary three-wire system, shown diagrammatically in Fig. 1, cannot be used where the motors would be coupled across the two outers, A and B, and the lights approximately equally between the outers and middle wire, AC and BC; for although by opening a switch placed between C and the

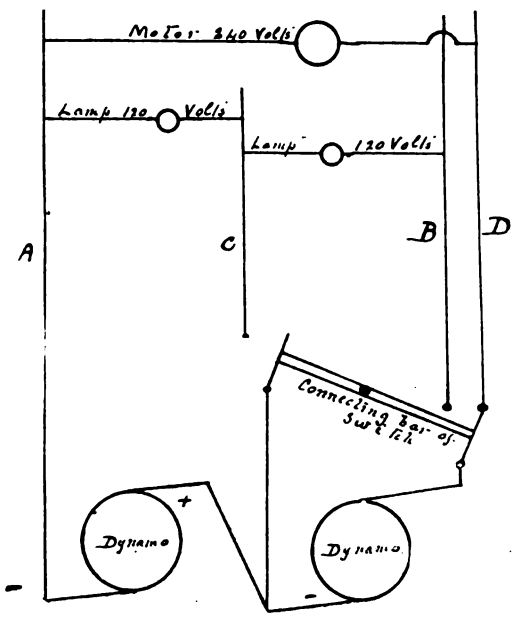


FIG. 2.

dynamo leads it would be easy to prevent the lights being used in the daytime, it would be impossible to prevent the motors being thrown into circuit in the evening. If, however, one of the outers, say B, were duplicated by an additional wire, D, the motors could be connected across from D to A, and the lighting circuits from B to C and C to A, while Fig. 2 shows an arrangement of one single-way switch fixed in C, and one two-way switch for D and B, and this is so arranged that if D be connected to the dynamo, the switch in C would be open, while if C be closed the same movement will cause D to be broken and B to be connected to the dynamo.—M.

Answer to No. 296 (*awarded* 5*s*.).—It is here assumed that the three-wire system mentioned is supplied at a pressure of 240 volts across the outers. If this supposition is correct, there is no reason why the motor supply at that pressure and the lighting supply at 120 volts should not go on at the same time, unless, of course, it so happens that the generators are not capable of a greater output than the motor load.

Fig. 1 is a diagram of connections for running both motors and lights at the same time. The motors are placed directly across the outer bars, and are supplied by two-wire circuits quite distinct from the lighting circuits at 240 volts. M and L are the motor and lighting circuits; G_1, G_2, and G_3 are generators. G_1 and G_2, giving a pressure of 120 volts, are coupled in series on either side of the neutral wire. During lighting hours they will act as balancers, in addition to maintaining a pressure of 240 volts across the outers. G_3, a generator giving a pressure of 240 volts, is shown connected directly across the outers. This is not really a necessary arrangement, as generators connected as G_1 and G_2 will do all that is required. C_1, C_2, C_3, and C_4 are automatic cut-outs set to open the circuits if the current passing through them should fall below a certain value; f_1, f_2, f_3, and f_4 are safety fuses; and s_1, s_2, and s_3 are the shunt field windings of the dynamos. If it is desired to so arrange matters that the lights and motors cannot be used at the same time, leads from the three bars can be brought to a triple-pole change-over switch, as shown in Fig. 2. When the switch is in the lighting position, the contacts, a_1 a_2, b_1 and b_2, c_1 and c_2, are bridged across by

Digitized by Google

the three blades with which the switch is provided. With the switch in the motor position, the contacts, a_3 and a_4, c_3 and c_4, are bridged across, and the lighting contacts opened so that the two sets of circuits can never be closed

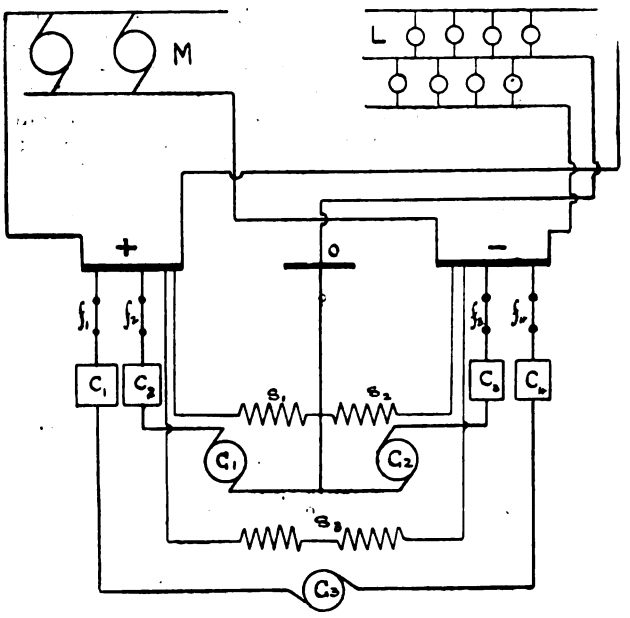


FIG. 1.

at the same time. The switch is shown in the off position. In connection with the blades is a powerful arrangement which ensures a quick break. This, however, does not

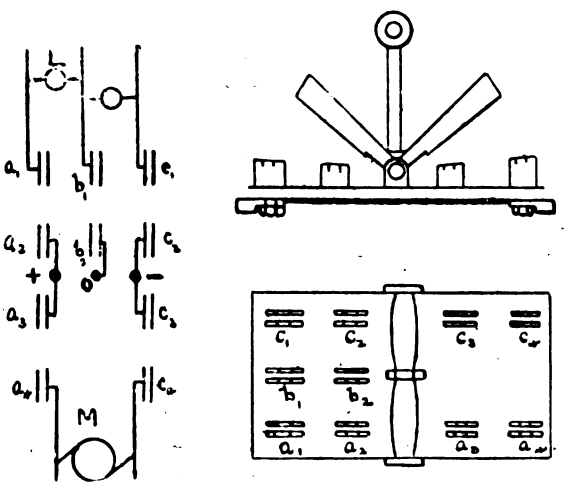


FIG. 2.

take place until the handle has been well pulled over, so that the operator's hand is quite clear before the switch opens.—P. S. T.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Lincoln.—The Town Council invite tenders for wattmeters and demand meters. Tenders by Sept. 14.

Hamburg.—Two 30-ton electric cranes are required. Enquiries may be made at the Town Hall. Tenders by Sept. 10.

Preston.—Tenders are invited for the electric lighting of the Preston and County of Lancaster Royal Infirmary. Tenders by Sept. 1.

Hampstead.—The Vestry invite tenders for various plant for their central station, Lithos-road, Finchley-road. Tenders by Sept. 27.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the lighting of the town by electricity for 30 years by Nov. 2 (concession).

Plumstead.—The Vestry invite tenders for the supply and erection of various plant and machinery for electricity works. Tenders by Sept. 19.

Worthing.—The Corporation invite tenders for the construction of a new electric generating station and alterations of buildings at the Corporation yard.

Perth.—The Commissioners invite tenders for meters (direct-current) and cut-outs. Tenders by Sept. 15. Details in our advertisement columns.

Philippopolis (Bulgaria).—The Town Council invite tenders for erection and working of electric lighting and working of tramways. Tenders by Nov. 4 (concession).

Oldham.—The Electric Light Committee invite tenders for the supply, delivery, and erection of boilers. Tenders by Sept. 11. Full details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of a 200-kw. steam dynamo for their electricity works. Tenders by Sept. 8. Details in our advertisement columns.

Southampton.—The Harbour Board invite tenders from crane builders for one 30cwt. portable electric wharf crane. Tenders by Sept. 10. Details in our advertisement columns.

Preston.—The Guardians invite tenders for an electric light installation at Fulwood Workhouse, near Preston. Tenders by Sept. 10. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for the erection of a new boiler-house (all trades except ironfounder) at the generating station, Crown Point. Tenders by Sept. 3.

Hammersmith.—The Vestry invite tenders for two single-phase alternate-current motors, coupled to two centrifugal pumps, with accessories. Tenders by Sept. 12. Full details in our advertisement columns.

Horton (Surrey).—The Asylums Committee of the London County Council invite tenders for the installation of boilers, engines, dynamos, etc., at the Horton Estate, Epsom, Surrey. Tenders by Sept. 22.

Cupar Fife.—Estimates are wanted for the electric lighting installation at the Fife and Kinross District Lunatic Asylum. About 800 lights. Tenders to Mr. Osborne, clerk to the Board, Cupar Fife, by Sept. 3.

Doncaster.—The Corporation invite tenders for the wiring and supply of sundry fittings for an installation of electric light at the Mansion House, Doncaster. Tenders by Sept. 5. Details in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for steam and water pipes, feed pump, water softener, etc., at their Sculcoates-lane generating station. Tenders by Sept. 27. Full details in our advertisement columns.

Southampton.—The Guardians invite tenders for the erection and completion of electrical plant and installation for the lighting of the new workhouse infirmary, Shirley Warren. Tenders by Sept. 11. Details in our advertisement columns.

Tunbridge Wells.—The Corporation invite tenders for the supply and delivery of high and low tension cables. Specification and full particulars can be obtained from Mr. Horace Boot, borough electrical engineer. Tenders by Sept. 20.

Wrexham.—Tenders are invited for three electric motors and all accessories, working at 500 volts, to drive centrifugal pumps. Also one dynamo, capable of supplying energy for the above motors, together or singly. Details in our advertisement columns.

Greenock.—The Police Board invite tenders for traction plant as follows: water-tube boilers, two steam dynamos (high-speed enclosed engines), boosters, switchboard, steam and exhaust pipes, etc. Tenders by Sept. 10. Details in our advertisement columns.

Poplar.—The Managers of the Poplar and Stepney Sick Asylum District invite tenders from firms willing to perform sundry work in connection with the new telephonic installation at the sick asylum. Tenders by Sept. 10. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for erection of an electric tramcar shed at Thornbury. Drawings, specification, and general conditions may be seen, and bill of quantities obtained, at the office of Mr. J. H. Cox, city surveyor, Town Hall. Tenders by Sept. 3.

Doncaster.—The Corporation invite tenders for the conversion of existing gas fittings and the supply of new fittings for the purpose of lighting with electricity the whole of the Mansion House, Doncaster. Tenders by Sept. 5. Details in our advertisement columns.

Hackney.—The Electric Lighting Committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, public arc lamps meters, travelling crane, and workshop equipment. Tenders by Sept. 12. Full particulars in our advertisement columns.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the following plant: lighting switchboard, traction switchboard, and balancing transformers at their new electricity works, Strawberry-road, Pendleton. Tenders by Sept. 3. Details in our advertisement columns.

Whitby.—The Council invite tenders for the following plant: two water tube boilers, pumps, condensers, pipes, etc., two steam dynamos, balancer, and boosters, switchboard and connections, battery, travelling crane and cables, arc lamps, etc. Tenders by Sept. 3. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for supply of (1) two 200-kw. direct-coupled continuous-current generators and one 120-kw. balancing set; (2) one 420-kw. direct-coupled continuous-current generator. Specification and form of

Digitized by Google

tender can be obtained from Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen. Tenders by Sept. 29.

Walthamstow.—The Council invite tenders for the supply, delivery, and erection of electric lighting plant and apparatus, consisting of gas plant, gas-engines, dynamos, switchboard, booster, balancer, and measuring instruments. Tenders by Sept. 25. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the supply, delivery, and erection of the whole of the plant and apparatus necessary to completely equip for electric traction their proposed power station at Vivash-road, Fratton-grove, Portsmouth. Tenders by Sept. 4. Details in our advertisement columns.

Dundalk.—Tenders are invited by the Urban District Council for a transfer of their electric lighting order for the purpose of supplying electricity for public and private lighting and energy for manufacturing purposes within the urban district of Dundalk. Tenders by Sept. 18. Details in our advertisement columns.

London, E.C.—The Commissioners of H.M. Works and Public Buildings invite tenders for the enlargement of Block E of the telegraph factory at Mount Pleasant, E.C. Drawings, specification, and a copy of the conditions and form of contract may be seen on application to Mr. J. Wager, at H.M. Office of Works, etc. Tenders by Sept. 18.

Salford.—Tenders are invited for the supply and delivery of the following materials for the ensuing 12 months: high and low tension single and concentric cables, and house fuse-boxes, meters, and meter boards. Full particulars from Mr. F. A. Wilkinson, borough electrical engineer (pro tem.). Electricity Works, Walness-road, Salford. Tenders by Sept. 10.

Mexborough.—The Council invite tenders for the supply and erection of a Lancashire boiler; two 50 kw. steam dynamos, balancer and boosters, feed-water heater, and feed pump; switchboard and connections; storage battery; mains; a five-ton hand travelling crane; and for adapting public street lamps from gas to incandescent electric. Tenders by Sept. 15. Details in our advertisement columns.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and laying of electricity supply mains and accessories. Specifications and form of tender may be inspected at the office of the city engineer, Mr. Spencer Harty, M.I.C.E., City Hall, Dublin, and at the offices of Mr. R. Hammond, consulting engineer to the Corporation, 64, Victoria-street, S.W. Tenders by Oct. 4.

Worthing.—The Corporation invite tenders for the supply and erection of the following plant: (1) three 96-kw. steam dynamos (vertical enclosed high-speed engines); (2) two boilers of the dry-back marine type, with fittings, etc.; (3) steam and exhaust, drain and other pipes, in engine and boiler house, pumps, condensing plant, etc.; (4) cast-iron manhole covers; (5) cast-iron arc lamp posts; (6) stoneware casings; (7) cable work; (8) arc lamps; (9) storage batteries; (11) balancing transformers and motor-generators; (12) economiser; (13) five-ton overhead engine-room travelling crane. Tenders by Sept. 3.

Fenton (Staffs).—Tenders are invited for works in connection with the construction of a single line of railway (2ft. 6in. gauge) from Waterhouses to Hulme End, Staffordshire (about eight miles two furlongs), and incidental works connected therewith, for the Leek and Manifold Valley Light Railway Company. Plans, specifications, bills of quantities, and forms of tender may be inspected at the offices of the company's engineer, Mr. Joseph Forsyth, Heron's Cross, Fenton, Staffs, on and after Aug. 4, and copies of same may be obtained from him. Sealed tenders must be sent to Mr. Edward Challinor, secretary, Leek, by Sept. 1.

RESULTS OF TENDERS.

Wimbledon.—The Electric Lighting Committee have accepted the tender of Messrs. J. Dorking and Sons (£73) for the erection of a temporary shed for engine-room extensions.

Souleoates.—The Works Committee of the Guardians have accepted the tender of Mr. J. Morley, for electric wiring and fitting the Beeton street relief office, at £24. 15s. 6d.

Radcliffe.—The Nottinghamshire County Council have accepted Mr. Scott Anderson's tender and scheme for the lighting of the new county asylum at Radcliffe. It comprises engines, dynamos, and the complete electrical and steam equipment for the asylum.

Ashington.—The Ashington Industrial Co-operative Society, Limited, have received the following tenders for the electrical lighting and heating by hot water of their business premises in New Hirst:

Electric light.

Gateshead Electric Supply Company, West-street, Gateshead-on-Tyne (accepted)	£395
Carrick and Stevenson, Newcastle-on-Tyne	310
Bland Bros., Barras Bridge, Newcastle-on-Tyne	398
T. G Usher and Co., Newcastle on-Tyne	420
T. S. Brown, Newcastle on-Tyne	425
Corlett Engineering Company, Newcastle-on Tyne	430

Heating apparatus.

Dinning and Cooke Newcastle-on-Tyne (accepted)	107
Emley and Sons, Newcastle-on-Tyne	112
Bland Bros.	120
T. S. Brown	160
T. S. Vaux and Sons, Newcastle-on-Tyne	75

Epsom.—The London County Council have accepted the tender of Mr. T. Scott Anderson, electrical engineer, Sheffield, for the electrical equipment of the asylum at Horton, Epsom.

Shoreditch.—The Vestry have received the following tenders for electric cable:

Siemens Bros. and Co., Limited	£2 262 8 4
W. T. Henley's Telegraph Works Company, Limited	2,147 15 1
W. T. Glover and Co., Limited	2,129 12 6
British Insulated Wire Company, Limited	1,930 8 2

BUSINESS NOTES.

LIGHTING AND GENERAL.

Keighley.—Sanction has been obtained to the loan for electricity works.

Nuneaton.—We understand that the Urban District Council are about to supply electric light to the New Theatre Royal.

Eastern Cables.—The telegraph steamer "Pender" left Shanghai on Aug. 29 to lay a cable between Wusung and Chefoo.

Maryport.—Applications for a supply are already coming in before the Council have settled the preliminaries in connection with the electric lighting.

Penny-in-the-Slot Telephones.—The General Post Office authorities are introducing coin-receivers in connection with the new telephone system for London.

Wimbledon.—The surveyor has been instructed to forthwith prepare the foundations for the new engines, and remove the end gable wall of the electricity works.

Fleetwood.—The Fleetwood and District Electric Light Company now destroy the whole of the town's refuse, so that the objectionable refuse tips are now things of the past.

Aberdare Electric Lighting Co., Limited.—This Company has been registered, with a capital of £2,000 in £1 shares, to carry on the business of an electric light company in all its branches.

Darlington.—Owing to the slow delivery of the engine and machinery for the power station, it is doubtful whether the electric light will be inaugurated at the beginning of October, as anticipated.

Finchley Electric Light Co.—This Company has been registered with a capital of £3,000 in £1 shares, the object being to carry on at Finchley or elsewhere the business of an electric light company in all its branches.

Telephone Novelties.—Several new telephone inventions having been recently patented in the United States, the general manager of the National Telephone Company has sailed for New York in search of novelties for the London service.

Goole.—At the meeting of the Rural District Council on Monday a resolution was carried unanimously that the clerk should at once take steps to apply for a provisional order, and that the clerk notify the Northern Electric Light Installation Syndicate to that effect.

French Prices.—In consequence of the rise in prices of materials, the manufacturers of electrical fittings in France recently raised their prices of meters 15 per cent., those of copper work 15, ironwork 35, rubber 15, electric cables 25, and joints, etc., 15 per cent.

Wycombe.—The whole of the 1,000 £5 shares offered to the public by the Wycombe (Borough) Electric Light Company, as additional capital, have been taken up. We learn that a large proportion of the applications came from the town and neighbourhood of Wycombe.

Maidstone.—It is reported that the Local Government Board have notified the town clerk that while they are virtually prepared to approve the scheme of electric lighting for the borough, they would like to have the opinion of an independent expert with regard to the same.

Liverpool.—On Wednesday the successful inauguration of the electric light to the wholesale fish market took place. The gas jets have been replaced by 20 arc lamps, which impart infinitely more candle-power than could ever have been dreamt of under the old system of gas lighting.

Paris Exhibition Awards.—Messrs. Salviati, Jesurum, and Co., Limited, London and Venice, have been awarded at the Universal Exhibition, Paris, the following: grand prize for lace, grand prize for glass, grand prize for mosaics, and gold medal for electrical chandeliers and other fittings.

Crieff.—In consequence of the intended application of the North British Electricity Supply Company for a provisional order to supply the town with electric light, the Town Council in committee have agreed that they themselves should apply to Parliament for such provisional order.

Bury St. Edmunds.—The inaugural supply from the borough's electric lighting works was switched on about sunset on Tuesday, the lamps being principally in private houses. As soon as the work of erecting arc lamps has been completed the principal thoroughfares of the borough will also be lighted.

Stirling.—Four tenders have been received for the work in connection with the electric lighting of the old burgh buildings,

Digitized by Google

Broad-street, St. John-street, and police and Parish Council offices and night shelter, excluding the police court-room. The estimate was £60. The tenders have been remitted to the electric lighting engineer.

Kidderminster.—The electric tramway company has combined lighting with traction. In the presence of the Mayor the first public electric light was switched on on the 22nd inst. Mr. J. B. Clarke, the resident engineer to the tramway company (late of the Electric Construction Company, Bushbury), is assisting with the lighting of the town.

Rathmines.—The postponed opening of the electricity works by their Excellencies the Lord Lieutenant, K.G., and the Countess Cadogan, will take place to-day at 3 p.m. After the opening ceremony a reception will be held by Mrs. Hodgson, on behalf of the Council, in the grounds of the Leinster Cricket Club (adjoining the electricity works).

Wrexham.—At Tuesday's meeting of the Town Council the engineer presented a satisfactory report upon the progress of the electric lighting of the town. It was decided to extend the distributing main into Egerton-street. The Council adopted 6d. per unit as the price of the current for lighting purposes and 3d. per unit for motor purposes.

Bury (Lancs.).—Business in the new post office buildings in Crompton-street was commenced on Monday morning. Although gas fittings have been provided, the building will be lighted throughout by electricity, for which purpose an installation of 122 lamps, principally of 16 c.p., has been put in by Messrs. Crowther and Co., of Manchester and Liverpool.

London Gazette.—Receiving orders have been made out *re* R. Foster and Co. (also trading as the Nelson Electrical Engineering Company), Adlington-street, Nelson, Lancs., and F. L. Lindsay, 216, High-street, Bangor, both on creditor's petition. The estate of W. Dalzell, 13, Forsyth-road, West Jesmond, Newcastle-on-Tyne, has been released from trusteeship.

Burnley.—The Guardians intend to apply for sanction to borrow £3,000 to defray the cost of an electric light installation at the workhouse, and the erection of a new boiler-house and the provision of two new boilers. Messrs. Shepherd and Watney are to carry out the necessary works in connection with the proposed electric light installation, and Messrs. Keighley will be engaged as architects in connection with the erection of boiler-house and other buildings.

British Thomson-Houston Co.—We have received from this Company their pamphlet No. 69, which deals with electric traction. The pamphlet gives practically a history of the development of electric traction, and more particularly of the British Thomson-Houston system. At the end of the article is a table containing a list with particulars of the tramways and railways in the United Kingdom which are equipped, or about to be equipped, with apparatus manufactured by the above Company.

Stock Exchange.—The Stock Exchange Committee have appointed Thursday, Sept. 13, a special settling day in Potteries Electric Traction Company, Limited, £125,000 4½ per cent. debenture stock; and have ordered the undermentioned securities to be quoted in the official list: Edmundson's Electricity Corporation, Limited, further issue of 9,400 ordinary shares of £5 each, fully paid, Nos. 17,401 to 17,407, and 26,108 to 35,500; and Potteries Electric Traction Company, Limited, £125,000 4½ per cent. debenture stock.

Llandudno.—The Electric Lighting Committee last week reported to the Urban District Council that they had been advised by Mr. Rooke, the representative of Mr. A. H. Preece, electrical engineer to the Council, to extend the condenser at the works to cope with the increased requirements. The cost was estimated at £1,500. The committee recommended the Council to make the proposed extension, and to instruct Mr. Preece to prepare plans and specifications, and obtain quotations for the work previous to application being made to the Local Government Board for sanction to obtain a loan to defray the cost.

Chiswick.—Great progress is being made with the electric lighting works of the district which have been carried out during the last two months by the Aberystwyth and Chiswick Electricity Supply Corporation, Limited. Consumers are coming on the system rapidly, and we understand that the new offices of the Urban District Council and the large assembly-rooms attached are to be supplied as soon as completed. The station is situated next to Messrs. Thornycroft's shipbuilding yard, on the banks of the Thames, and is rapidly approaching completion.

Hanley.—The Town Council have accepted a number of tenders for works required in connection with the electricity department to meet the increased demands made upon it, and application is to be made for sanction to borrow a further sum of £7,000. From January to July 473,000 units have been generated, while the output amounted to 311,000 units only. The committee are naturally anxious to find out where the leakage is. With regard to domestic lighting, it has been found that the consumption in many cases had been so small that the meters would not register it. This, however, they hoped to be able to remedy.

Bath.—At Wednesday's meeting of the Electric Light Committee it was decided to lay cables, at a cost of £370, in the Sion and Lansdown roads. The price of current from June 30 was considered, the electrical engineer (Mr. Metzger) saying the extra worked out at ½d. per unit. The question was whether they would make private consumers pay the whole, or charge part to public lamps. Adoption of the former course would mean an increased cost of nearly 1d. per unit. It was agreed to make the increased cost ½d. per unit for private and public lighting. The Chairman said work in connection with the electric light extensions was going on by leaps and bounds.

Fire.—An outbreak occurred on Wednesday in the Telephone Company's wire subway at the Embankment end of Northumberland-avenue, London. Large volumes of smoke arose from the manhole. Five of the six telephone linesmen who had descended for the purpose of examining and repairing wires made good their escape at the point of entrance. Another who was working further along the subway escaped by another exit. In the interim the company had been apprised of the outbreak, all currents passing along the circuits within the area were turned off, and in the course of half an hour the subway was again accessible and practically clear for the resumption of work.

Halifax.—Three new tramlines were passed here on Wednesday by Mr. A. P. Trotter, of the Board of Trade, and opened for traffic. The lines comprise the extension from King Cross to Cote Hill; a connection link, *viâ* Warley-road, between the King Cross and the Highroad Well routes; and an extension of the Illingworth branch to Causeway Foot. This latter line, from its commencement in the centre of the borough, is about four miles long, and has its terminus near to Ogden reservoir, a popular resort. About 15 miles of tramway belonging to the Corporation are now open for traffic. The extension of the Booth Town route to Queensbury, and the continuation of the Cote Hill branch to Hebden Bridge, will be undertaken shortly.

Appointments Vacant.—The Gas and Electric Committee of the Belfast Corporation invite applications for the post of an assistant electrical engineer, at a salary of £120 per annum.—The Commissioners of Partick require the services of a resident electrical engineer. Full particulars of these vacancies appear in our advertisement columns.—The Corporation of Eccles require the services of a borough electrical engineer, at a commencing salary of £200 per annum. Applications, stating age, endorsed "Borough Electrical Engineer," and accompanied by copies of not more than three recent testimonials, must be addressed to the Public Lighting and Electricity Supply Committee, and delivered at the office of Mr. Henry Hickson, town clerk, Town Hall, Eccles, by noon on Sept. 3.

Glasgow.—The Tramway Committee of Glasgow Corporation on Tuesday inspected the power station in course of construction at Pinkston, Port-Dundas, for the supply of electricity for the electric cars. According to a report in the *Scotsman*, Mr. Parshall, the consulting engineer, showed them over the buildings, and explained the machinery and its arrangements. There were two special cars of different designs submitted for the consideration of the committee, with the result that the present double-decker now on the Mitchell-street-Springburn route was formally selected as the most suitable for the new system over the whole city. Two very fine horse cars reconstructed to electric traction were also exhibited. At the car-sheds at Coplawhill new cars are at present being turned out at the rate of five every week. Mr. Young, the manager, believes that the electric system, embracing the entire city, will be inaugurated about the beginning of April next year, just on the eve of the exhibition.

Insulating Materials.—Amongst the numerous exhibits at the Paris Exhibition is that of Mr. H. Weidmann, of Rapperswyl, Switzerland. The exhibit consists of compressed pasteboard and other subjects which are used for insulating purposes. The works were originally intended for the manufacture only of glazed cardboard, but owing to the substance being found of use for electrical insulation purposes, Mr. Weidmann began to manufacture it especially with that view. A particular brand of insulating pasteboard is made with a very carefully-prepared surface. For this quality it is claimed that a thickness of about ·004in. will resist an alternating current of 3,000 volts. The compressed cardboard is usually supplied in sheets of about 3ft. square, but can be obtained in long rolls if desired. Micanised cardboard with layers of mica outside are exhibited, and also a number of small articles illustrating the use of asbestos hardened by a special process, which keeps its elasticity under practically all conditions. Other insulating substances are shown, amongst which are Japanese paper, or waterproof felt, friction rolls, by which the speed of small motors can be regulated, etc.

Aron Electricity Meter Co.—The exhibit of this Company at the Paris Exhibition consists of a meter for registering charge and discharge of accumulators, which adds 10 per cent. automatically at charge for the efficiency of the battery, reading direct in ampere-hours, at a constant-potential circuit of 230 volts, arranged for a battery of 50 amperes maximum discharge and 500 ampere-hours capacity; a direct-current 30 ampere 440 volt meter; an ampere-hour meter for accumulator use; a prepayment hour meter arranged for a tension of 220 volts direct current, adjusted for 6d. per Board of Trade unit for 2 c.p. lamps at 220 volts with 6d. in the slot; an hour-meter, recording the hours which a circuit is closed; a day and night load meter, 15 amperes, 110 volts, adjusted so that during the peak of load consumers may be charged a higher price than during the rest of the day; an alternating-current single-phase 30-ampere 100-volt type as approved by the Board of Trade, and as usually supplied for use in consumers' houses; an alternating-current single-phase meter for switchboard work for central-station purposes; and a lamp battery on slate with brass letters indicating the words "Aron Meter," on which letters are mounted lamps. The Aron instrument is stated to be equally applicable for continuous two-wire, three-wire, and five-wire, alternating-current single-phase two-wire and three wire, and two and three phase methods of distribution. It is interesting to note that all the meters on exhibition were constructed in the company's English factory.

Digitized by Google

Stockport.—We are informed by Messrs. Robert Dawson and Co., Limited, Stalybridge, that they were the contractors for the electric light installation at the Theatre Royal, the firm having been referred to by our correspondent as Messrs. Robert Dawson and Sons in our last issue. They also state that the rotary transformer referred to has been provided purely for the purpose of running stage arcs only.

St. George's, Hanover-square.—The Vestry have rescinded their resolution adopting the electric light as the illuminant for the streets in the parish. This step has been taken not because the members are opposed to electric lighting, but there is a feeling that the present time is inopportune for the introduction of the scheme, and that it is more advisable to wait until the borough council has been elected.

British Westinghouse Co.—We have received from the British Westinghouse Company a copy of a pamphlet entitled "Drop in Alternating-Current Lines," written by R. D. Merson. The matter appeared as an article in the *American Electrician*, and it goes very fully into the subject of loss of voltage. The reprint is naturally used as an introduction to the Westinghouse type of compensator, for which it is claimed that it will indicate the voltage at the load whatever may be the current strength or the character of the load. It is also capable of adjustment for circuits of different ohmic loss and different reactance. Diagrams of connections for compensators in single and three-phase circuits are shown in the pamphlet.

Dumfries.—Several companies have offered to take over the provisional order obtained by the Town Council for supplying the town with electricity both for lighting and motive power on very similar terms. The price demanded works out as follows: All electric current required for street-lighting, or for lighting the public buildings, to be supplied to the Council at the special rate of 7d. per unit for the first hour and 2d. per unit afterwards. For all-night street-lighting this will work out at 2½d. per unit. Prices to be charged to private consumers not to exceed 7d. per unit for the first hour and 4d. per unit afterwards. The Council to have the option of repurchasing the undertaking within 12 months after the expiration of 10 years.

Scunthorpe.—The electric light was formally switched on at the new Wesleyan chapel last week. The installation, which has cost about £500, was put down by Messrs. J. Dewhurst and Son, Sheffield. A dynamo giving 100 volts at 45 amperes is worked by an oil-engine of about 8 h.p., accumulators also being employed. One day's running of the engine will produce sufficient supply for a week. There are 111 incandescent lights in the building, the chief light coming from two handsome candelabra suspended from the ceiling, consisting of 25 lights each on six brackets, five four-lights, and one four-light. The lights in the centre are of 8 c.p., and those round the building of 16 c.p. The light is very satisfactory, burning quite steadily without being too brilliant; not hurtful, but restful for the eye.

Dublin.—At a recent meeting of the South Dublin District Council a letter was read from the Dublin United Tramway Company referring to the application of the Council *re* the proposed lighting by electricity of Templeogue and Rathfarnham. In this connection it was mentioned that it would not only be an advantage for the public to have these districts lighted by electricity, but it would enable the inhabitants to avail themselves of lighting their premises by electricity. The charge for gas was excessive. They paid 4s. 6d. per thousand cubic feet, and the quality was not the best. The smell of it was terrible. The Dublin Corporation on Monday decided, by a majority of 38 to 14, to carry out the electric lighting of the city as a municipal concern, instead of accepting the proposals of the electric tramway company.

Torquay.—An enquiry was held last week into the application of the Council to borrow £15 000 for electric lighting extensions. The Town Clerk stated that while at the end of March, 1898, there were 55 consumers, on March 31 they had increased to 221. The total equivalent number of 8-c.p. lamps connected in March, 1898, was 5,688, of which 3,310 were private lamps, and in March last there were 10,070 lamps. The total revenue for the first year was £2,837, and £3,699 for the last year. There was a gross profit of £1,057 on the first year's working, and of £1,256 on the second year's. The interest and sinking fund in each year was £1,188. There was thus a deficit of £138 on the first year, and a profit of £67 on the second. They had now some applications which they could not comply with. The borough electrical engineer (Mr. P. Storey) explained the details of the work proposed.

Yeadon.—The *plébiscite* taken on the electric lighting question cannot be described as satisfactory. Of the 890 papers distributed only 570 were returned to the collectors, and of this number 337 were blank, whilst of the remaining 173 papers 98 were in favour of the adoption of the electric lighting and 75 against. The 98 also promised to take 365 lights at a charge of 5d. per unit, or 304 if the charge was 6d. This number includes 100 from one person. At a meeting of the District Council on Friday night a motion to call a town's meeting was negatived, as was also a proposal that the Council recommend that the provisional order be transferred to a syndicate, provided reasonable terms could be arranged. The question is, therefore, at a deadlock. The period of grace allowed by the Board of Trade for the Council to take steps to carry out their order expires at the end of October.

Aberdeen.—The Corporation electric light accounts for the year ended July 31 last have been issued, and show from the revenue and expenditure account that, while the total revenue was £14,211. 3s. 10d., the expenditure amounted to £6,062. 0s. 10d., leaving a balance of £8,149. 3s. to be carried to net revenue account. From this, £2,343. 15s. 11d. was paid as interest on mortgages and other loans, £2,438. 15s. 4d. for depreciation, £1,336 to sinking fund, and £2,487. 18s. 11d. of a balance is carried to the reserve fund, which now stands at £2,609. 17s. The general balance fund stands at £100,727. 8s. 1d. During the year 1,005,505 Board of Trade units of electricity were generated and sold, as against 279 950 in 1899, but that was for seven months only. There are 76 public arc lamps and 80 incandescent. The amount of capital authorised to be borrowed is £82,000, and this has been exercised on mortgage to the extent of £81,953.

Personal.—We learn that Mr. H. F. Street, the Halifax electrical engineer, who was to have gone to Bolton, has decided to remain in Halifax, after having representations made to him by members of the Corporation.—The Bolton committee have appointed Mr. Arthur A. Day, A.K.C., A.M.I E E, of Manchester, chief assistant engineer Manchester Corporation electric works, to the post of borough electrical engineer. It is also proposed to present Mr. Ellis, the retiring engineer, with an honorarium of £200 for services rendered.—The appointment of Mr. Ernest Marples, chief assistant to the Liverpool Electric Lighting Company, as resident electrical engineer to the Hoylake and West Kirby Council has been confirmed.—On the 30th inst. the wedding took place, at St. James's Church, Muswell Hill, of Miss Pattie Klein and Mr. J. H. Heathman, the patentee and manufacturer of telescopic ladders and fire extinguishing appliances known under that name.

Gloucester.—At a meeting of the City Council held on Tuesday Mr. C. H. Clutterbuck, chairman of the Electricity Supply Committee, said they had received several applications from citizens to extend the system of arc lighting. The committee were making enquiries, and at the right time they hoped to extend the lighting in a direction where they knew it would not only be appreciated, but be profitable. The resident engineer (Mr. Bache) had furnished him with an up-to-date statement of their position with regard to the lighting, which was as follows: public street-lighting (equivalent in 8-c.p. lamps), 730; total number of lamps connected, 9 230; number of lamps being wired, and for which final applications have been received, 1,960; number of lamps for which preliminary applications have been received, 2,134—total, 14 058. It would, continued Mr. Clutterbuck, be remembered that Mr. Hammond reported on Aug. 29, 1899, that it would be permissible to instal on their mains 12,000 8-c.p. lamps. A short discussion followed, the speakers being unanimously in favour of the extension of the electric lighting into the Barton district.

TRACTION.

Bradford.—The Tramways Committee have decided to extend the new Westgate tramway to the corner of Godwin-street, a distance of about 150 yards.

Bilston.—The British Electric Traction Company have arranged to run a number of large two-horse omnibuses until the lines for the new electric tramways are in working order, for which they now have the Local Government Board's sanction.

Maryport.—Representatives of the Urban District Council will attend the conference (referred to in our last issue) with reference to Messrs. Dick, Kerr, and Co.'s proposal to obtain a provisional order to construct an electric tramway between Whitehaven and Maryport.

Wrexham.—At Tuesday's meeting of the Council, the Mayor announced that the Drake and Gorham Electric Company had taken over the old Wrexham Tramway Company's undertaking, and that there was now a prospect of there soon being electric trams in the town.

Motors.—Furious driving on the part of Paris automobilists is to be punished in future by imprisonment. The British Consul in Rome, Mr. C. Morgan, after referring to the increasing number of motorcars in the Italian capital in 1899, says that these are all of Continental manufacture, and thinks that the superiority of the British machine would secure patronage.

Paisley.—The tramways question is again to be discussed shortly at a ratepayers' meeting. We also learn that a petition from residents in Paisley and at the Glen has been forwarded to Mr. Murphy, expressing approval of the system of tramways proposed by him for Paisley and district, and requesting him to bring forward his Bill in the next session of Parliament.

Darwen.—At a public meeting of the householders of Hoddlesden, Blacksnape, Waterside, and Pickup Bank, held on Thursday week in the Co-operative Hall, Hoddlesden, resolutions were passed to urge upon the Darwen Town Council the advisability and the necessity of running trams to Hoddlesden, so as to bring Hoddlesden and the surrounding districts more into touch with Darwen.

South Lancashire Tramways.—Notification was received on Thursday week by the authorities affected from the South Lancashire Tramways Company stating that they intend asking Parliament next session for powers to extend their electric tramways from Worsley, through Little Hulton, to Farnworth, Little Lever, Radcliffe, and Whitefield—nearly 10 miles. This is in addition to a 70 miles network of tramways which the company are about to lay down in South Lancashire.

New York.—The first electrically-equipped train on the Manhattan Elevated Railway, New York City, will, according to the *Scientific American*, probably run on Sept. 15. The engines and generators are being rapidly completed. A trial train is nearly finished, and by next summer it is thought that the steam locomotives will be entirely dispensed with. The Second-avenue Railroad will be the first line to be equipped electrically. The total cost of making the change is said to be 12,000,000dol.

Digitized by Google

Preston.—The Streets and Buildings Committee of the Preston Town Council have decided to recommend the Council to undertake the working of an extensive scheme of electric tramways, powers to carry out which were obtained by an Act promoted by the Corporation this year. At present the cars are worked by horses, the system being leased to a company, whose powers expire in 1902.

Brierfield.—The District Council on Tuesday passed a resolution agreeing to purchase the tramways within their own district, and the decision was in every respect similar to that which was arrived at by the Nelson Corporation last week. Burnley and then Padiham, now Nelson and Brierfield, have agreed to purchase the various lengths of tramway within their own respective districts. Thus another stage has been passed in the scheme for acquiring and municipalising the Burnley and district tramways.

Overcrowding.—Mr. S. J. Wilde, who presided over the ordinary meeting of the South London Tramways Company, on Friday, said he regretted that two of their conductors had been fined the previous day for having an excess of passengers in the workmen's early trams. This was manifestly unfair, for no one could prevent these men forcing their way in, and if the conductor tried to stop them they would simply fight him. He maintained that this overcrowding could only be prevented by the police themselves. We quite concur; the police not only could, but should, prevent the unseemly rush and the ensuing overcrowding of both tramways and railways.

Nottingham.—Satisfactory progress is now being made with the works in connection with the Nottingham tramway undertaking. The track commencing at Sherwood is now practically completed as far as the Mechanics' Hall. Work has also commenced in Parliament-street. No definite decision has yet been arrived at as to when the work in the Great Market-place will be started, but in all probability this will be before Goose Fair. It is expected that the next section of the undertaking which will be commenced is to be the Bulwell one. The operations will begin at Bulwell Market-place, and the present route to the Great Market-place will be retained.

Sheffield.—In a note last week we referred to the intended tramcar improvements. The dry-seat to be tried by the committee is non-corroeive wire netting, about ⅜in. thick, which is laid on the top of the seat. The wire netting is covered with an amalgam of non-corrosive metal, so that it will not stain or damage the most delicate fabric. It can be attached to any existing seat at a small cost. The chief disadvantage of the patent would be in the case of snow. Another experiment is also to be made in order, if possible, to secure better ventilation of the cars, and a ventilator designed by Messrs. Turton, Platts, and Co., Sheffield, is to be affixed to a number of trams running on the different sections.

South Hams Light Railway.—At the Totnes Town Council on Monday, it was reported that the application of the promoters of the Devon South Hams light railway had failed, owing to the necessary formalities not having been complied with. A letter was read from Mr. T. W. Barber, engineer of the company, stating that it was remarked at the last enquiry that he had been requested by the Town Council to attend and discuss the matter, and that he had not done so. No invitation of the kind reached him, or he should have attended. As the promoter intended applying again in November, he should be glad to attend by appointment to arrange any matters of difference. The Council decided to wait until formal notices were given.

Durham.—The county of Durham is to witness an important development of the tramway service during the next two or three years. The company which is promoting the scheme is a large and influential one, and their intention is to connect the large and important mining centres by a service of electric cars. Thus tramways will be run from Easington-lane, through the Hettons, to Houghton-le-Spring, thence by way of Newbottle, Philadelphia, Shiney Row, New Herrington, Silksworth, Tunstall to Sunderland, where they will strike the borough boundary at Silksworth-road. An important branch of the several branches to be eventually laid down is that from Houghton-le-Spring to Fence Houses Station, and from Shiney Row to Penshaw Station. Naturally, some time will elapse before all this is an accomplished fact, but it is a sign of the times that the scheme has just received the Royal assent.

Blackpool.—Recently the employés on the promenade tramway memorialised the Corporation as to increased rates of pay, etc. Mr. J. Lancaster reported to the Tramways Committee on Tuesday that he had made enquiries from 21 tramway undertakings connected with municipalities in various parts of the country. As the result, he found that the wages and the conditions of employment at Blackpool were certainly as good as prevailed anywhere else, and that they were better than most places. Glasgow, which came out at about the top of the list, employed its tram-men for 10 hours a day at wages varying from 24s. to 28s. per week, but the maximum was not reached until a man had worked under the Glasgow Corporation for seven years. In Blackpool all drivers and guards receive 24s. per week as the minimum, while good men reached the maximum of 28s. per week after about two years' service. Then the longest hours worked by the Blackpool employés do not average more than 60 hours and 20 minutes per week. Replying to other points in the memorial, Mr. Lancaster stated that he had always observed the rule of promotion by merit, but, of course, it was impossible to allow the men to say who should or who should not be promoted.

Seaforth Junction.—Negotiations are, it is understood, proceeding with the Lancashire and Yorkshire and the Liverpool Overhead Electric Railway Companies touching the carrying out of the Seaforth junction scheme, for which the electric company recently obtained parliamentary powers. The position needs a little explanation. In order to effect the junction the electric line would have to sever land hitherto reserved by the trunk line for future sidings, and a clause was inserted in the Act securing to the trunk line the power of sale. Hence the carrying into effect of the scheme virtually rests with the decision of the Lancashire and Yorkshire directors as to whether they will hold the feeding of their line by the overhead or the prospective sidings in a specified position the more valuable. The carrying out of the scheme means direct connection between the south of Liverpool and Waterloo, Crosby, Formby, Southport, and especially by the West Lancashire route with Preston and the north. At present a large amount of traffic in South Liverpool remains undeveloped, and hence the Seaforth scheme has considerable popular support, which will grow as the scheme becomes better understood. It is not proposed to mix the electric and steam traffic, but both passenger and coal traffic would be exchanged.

Accidents.—While an electric car was proceeding along Myrtle-street, Liverpool, recently, an accident happened, the first of the kind since the electric system was adopted in the city. Owing to a sudden jerk or strain, a rosette broke away from the building to which it was attached. The rosette and several wires attached to it fell on the top of the car amongst the passengers. There was a general stampede from off the car, many persons complaining of being struck. The traffic was delayed for about 20 minutes.—Mr. T. E. Sampson, city coroner, last week held an enquiry into the circumstances attending the death of Christopher Wm. M'Gurn, aged 22, a labourer in the service of the Liverpool Corporation Tramways Committee, who was killed in Robson-street, Everton, through being struck by a falling electric wire. The coroner explained the nature of the enquiry, which was to ascertain, if possible, the cause of an iron strap breaking and allowing it to fall on the unfortunate youth, M'Gurn, killing him. The strap in question was put on the pole, and had not been finished in a way in which the Corporation would have taken it over for use by the tramways. It was waiting to be completed by the contractor before being handed over to the Corporation for use. On the day on which the occurrence happened there was a very severe thunderstorm, and also a severe storm of wind. Whether that caused an extra strain or not they would have to consider the possibility—at any rate, while the storm was raging the strap gave way. The jury found that death was accidental, and was caused by a defect in the strap, probably caused when being hammered over for bending on the anvil. They exempted the workman from blame, and recommended that the strap should be tested before being galvanised if possible. Two minor electric trolley wire accidents also occurred in the same city on the 23rd inst. The supporting span in Dale-street snapped, causing fusing of the wire and several explosions; while in London-road a trolley broke and fell among the passengers, but no injury was caused to any of them.—An accident also occurred near Dolly-mount, when two electric cars proceeding in opposite directions collided, whereby a driver was somewhat severely injured. There was practically no interruption of the traffic.

Ticket-Printing and Fare-Recording Machine.—A new method of collecting fares on the Leeds tramways is about to be introduced. Hitherto, what is known as the box system has been exclusively used. The reason for the change has not been officially stated, but the object is to prevent the leakage which it is believed exists. The *Leeds Mercury* says whether the appliance the Council are about to introduce will enable them to attain the desired ends remains to be seen, but that it is a very ingenious contrivance will be admitted. It is called a ticket-printing and fare-recording machine. The apparatus is contained in a case 5½in. square and 1¾in. in depth, and the conductor carries it in front of him strapped round his waist. As the name indicates, it is a ticket system, but, unlike that known as the "bell-punch," the ticket is printed by the machine as it is required, and upon it is recorded the date, the exact time of day it is issued, the sum the passenger has paid for it, the stage to which he is entitled to travel with it, and the number of the machine which printed it. The machine will likewise print an advertisement on the back of the ticket, and "spur" it so that it would be impossible to counterfeit it. Nor is this all. On the front of the case is recorded in figures the total number of pence which has been received for the whole of the tickets issued, and the number of passengers who have paid fares. Further, the sum which each passenger hands the conductor also appears on the front of the case. All this is obtained by a very simple process. When the passenger hands his fare to the conductor, he tells him the stage at which he wishes to alight. Say that he enters the Headingley car in Boar-lane, and intends to ride to the Oak. The fare is 2d., and on receiving it the conductor presses what is called the "plunger" on the upper side of the case twice. Each time a bell sounds, and simultaneously the figure "2" appears in a little disc in front of the case, where it can be seen; 2d. is added to the indicated total receipts, and "1" to the figures showing the number of passengers. To indicate the stage, a little switch near the "plunger" is moved. The printing of the ticket follows, and this is effected by the moving of a lever, which at the same time liberates the ticket from the interior of the case. One of the most curious parts of the affair is the recording of the time of issue on the ticket. In the left-hand corner of the case in front is a small clock, and by an ingenious internal arrangement a facsimile of the clock face is printed on the ticket. The advantage of the record is this: one of the drawbacks of a ticket already printed, and not showing the time of issue, is that

Digitized by Google

a dishonest conductor might procure it after it had been handed to the passenger, and dispose of it to another passenger, thereby securing for himself the face value. A conductor, however, would hesitate to resort to such dishonesty when the ticket bore the time of issue and was evidence against him. With such an appliance in use there would be no need for a waybill. As already shown, a check is supplied by the machine. At the office it would simply have to be noted whether the cash received from the conductor corresponded with the amount recorded on the front of the case. We understand, however, that men checkers will be employed to compare the figures recorded with the number of passengers on the car. The machine is the invention of Mr. Wilfrid I. Ohmer, and is manufactured by the Ohmer Syndicate, Limited, Suffolk House, London, E.C. The Tramways Committee have ordered 250, and the delivery of the first 50 is now due.

LEGAL INTELLIGENCE.

GUTTA PERCHA CORPORATION.

Meetings of the shareholders and creditors of the Gutta Percha Corporation, Limited, were held before Mr. Winearls, assistant-receiver, on Friday. This company, which was to trade in and manufacture guttapercha, was originally promoted by the Omnium Syndicate, Limited, and the Globe Venture Syndicate, Limited. The consideration was fixed at £150,000, of which £120,000 was for the letters patent and patent rights, and £30,000 for the stock of guttapercha leaves and other things sold to the company. The sale was conditional upon the company's proceeding to allotment before Oct. 14, 1897, on a subscription of £30,000. However, not more than £26,280 was subscribed for. The working capital was by a modifying agreement reduced to £10,000, but the provision that the vendor should underwrite £30,000 was not complied with. It now appeared that in spite of favourable reports in the propectus as to the patent process the company was not able to manufacture guttapercha of marketable value, and its total sales of stock amounted only to about £14. In the official receiver's opinion the purchase price paid to the vendors was very much inflated, and the action of the directors in proceeding to allotment upon insufficient subscription, contrary to the provisions of the purchase agreement, required further investigation. A report would probably be made with a view to obtaining an order for the public examination of some of the officers of the company. The statement of affairs disclosed total liabilities £20,303, of which £15,110 were stated to be unsecured, and no available assets, the whole of the amount (£5,195) being covered by debenture bonds. The total deficiencies as regarded creditors and shareholders was returned at £177,067.

It was resolved at both meetings that the official receiver should continue to act as liquidator under the proceedings.

COMPANIES' MEETINGS AND REPORTS.

W. T. HENLEY'S TELEGRAPH WORKS.

An extraordinary general meeting was held on Friday at Cannon-street Hotel.

Mr. Sydney Gedge, M.P., who presided, moved the confirmation of the resolutions passed on the 9th inst., providing that the ordinary capital should be increased from £150,000 to £200 000 by the creation of 10,000 additional ordinary shares of £5 each, to be issued to the existing ordinary shareholders *pro rata* at such times and at such prices as the Board should determine; also that the preference capital should be increased by the creation of 10,000 additional preference shares of £5 each, to be issued to the holders of the existing preference shares. The new ordinary shares are to be offered to shareholders at £10 each *pro rata* of one-sixth of their present holding. The Chairman said the price should be regarded as satisfactory, because, although it represented a premium of 100 per cent. to the Company, the market value of the shares was a good deal higher than £10.

The resolution was agreed to without discussion.

LEAMINGTON AND WARWICK TRAMWAYS.

The annual meeting of this Company was held at the Dale Temperance Hotel on Wednesday last week.

Mr. R. C. Heath, the chairman, who presided, said, with reference to the negotiations which had been going on between the boroughs of Warwick and Leamington, that the negotiations were proceeding at the present moment so far as the borough of Leamington was concerned. In the month of October they made up their minds with a view of obtaining provisional orders for both Warwick and Leamington, and also seeking to extend the line to Radford and along the Whitnash-road. They did not do this with any hostile view, but in order to save time if an agreement should be come to. With regard to Leamington the extensions were lost, and they were unable to come to any agreement, and they had up to the present time been unable to agree with Leamington. They went on with their negotiations, and were happy to say that they had come to an agreement with the Warwick Corporation, and that with their consent a provisional order was obtained for the working of the tramways by electric traction in Warwick for a lease extending over 28 years. That order had now become law, and, of course, they would in time make arrangements for converting the line. For that purpose they entered into negotiations with the British Electric Traction Company, because it was tolerably obvious that they were not strong enough to work the line themselves, nor able to find necessary capital without outside assistance. A reconstruction of that company would be necessary, and they hoped a number of old shareholders would join the new company.

The report, already noted by us, was adopted.

WINDERMERE AND DISTRICT ELECTRICITY SUPPLY.

The annual general meeting of this Company was held on Monday at Windermere, Mr. William Long, chairman of directors, presiding.

The directors' report for the year ended Dec. 31, 1899, stated that the year's trading profit amounted to £1,112, and after bank interest and other payments a balance of £970 was left, of which £949 had been applied to payment of dividend on preference shares. The Company had acquired the entire property and goodwill of the Keswick Electrical Company, and had come to an agreement with the Ambleside District Council to take over their provisional order. The amount available for dividend had been affected by the rise in the cost of coal.

On the motion of **Mr. Long**, seconded by **Mr. J. Raworth** (London), the statement of accounts was adopted.

Mr. Raworth, remarking on the non-payment of a dividend on the ordinary shares, said that most of the best electric supply companies had passed through that stage. Owing to the increased price of coal the directors contemplated raising the price of their light from 6d. to 7½d. per unit.

Mr. F. Fowkes, managing director, in reply to questions, said there was no connection between the Windermere Company and the British Electric Traction Company.—*Yorkshire Post.*

WIRRAL RAILWAY.

At the half-yearly meeting of shareholders in the Wirrall Railway Company on Monday,

Mr. T. H. Jackson, who presided, in proposing the adoption of the report, said that having obtained powers to work the line by electricity, the change would be proceeded with when a favourable opportunity presented itself. They hoped for good results from its adoption.

BLACKPOOL AND FLEETWOOD TRAMROAD.

The ordinary general meeting of this Company was held at the Company's offices, Fleetwood terminus, last week. The report, already noted by us, was adopted. A number of long speeches were made, and a vote of thanks was passed to the directors for the way they had conducted the Company's business.

PROVISIONAL PATENTS, 1900.

AUGUST 20.

14868. Improvements relating to the insulation of electrical conductors. William Alfred Phillips and Charles Eyre Kent, 323, High Holborn, London.

14877. An improved dynamo-electric machine and regulator therefor. Joseph Dentel and Maximilian Junka, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

14893. Improvements in electrical measuring instruments. Llewellyn Birchall Atkinson, 1, Queen Victoria-street, London.

14895. Improvements in electric ignition plugs for internal-combustion engines. Frederick Richard Simms, 4, South-street, Finsbury, London.

AUGUST 21.

14906. Improvements in or connected with sectional conductor street or road electric railways. John Milnes, 15, Water-street, Liverpool.

14924. Improvements in electric accumulators. Harry Rose, John Halifax, and Charles Henry Antrobus, 5, Hatton-garden, London.

14943. Improvements in switchboards for telephone stations. Milton Izatus Baird, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 22.

14971. Incandescent electric lamps. James Swinburne, 82, Victoria-street, Westminster, London.

14972. A new or improved arrangement for automatically lubricating the spindles of dynamos. William George Graham, 100, Wellington-street, Glasgow.

15001. Improvements in electric measuring instruments. Arthur Honig, 67, Sutherland-avenue, Paddington, London.

15019. Improvements relating to the recovery of tin and the simultaneous generation of electric energy. Robert Howe Gould, 45, Southampton-buildings, Chancery-lane, London.

Digitized by Google

15021. Improvements in the manufacture of carbon electrodes for arc lamps. Varsonophy Alexandroff, 24, Southampton-buildings, Chancery-lane, London.

AUGUST 23.

15095. Improvements in electrical demand indicators. The Reason Manufacturing Company, Limited, Norfolk House, Victoria-embankment, London. (Arthur Wright, high seas.)

AUGUST 24.

15123. A new or improved electrical arc lamp. Nettlefolds, Limited, and William Edward Symons, 7, Staple-inn, London.

AUGUST 25.

15146. A new or improved electrical hauling apparatus. Thomas Greensmith and Matthew Brown Wild, 70, Market-street, Manchester.

15187. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William J. Davis, jun., United States.) (Complete specification.)

15168. Improvements in commutators for electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (John T. H. Dempster, United States.) (Complete specification.)

15169. Improvements in rectifying alternating electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

15175. Improved apparatus for igniting by electricity combustible mixtures in internal-combustion motors and the like. Arthur George Bloxam, Birkbeck Bank-chambers, Chancery-lane, London. (Alfred Schoeller, Germany.)

15193. A new or improved method for adjusting electrodes. Russell John Reynolds, 99, Cannon-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Sept. 15.

1899.

17159. Electricity meters. Hookham.

19445. Electric lighting systems. Blondel, Weissmann, and Wydts.

20615. Electric safety apparatus for lifts and elevators. Bush and Jenkins.

20906. Trolley standards used on cars or wagons electrically propelled from an overhead wire. Munro, Wood, Brecknell, and Rogers.

23504. Receiving apparatus for Hertzian radiations or electromagnetic waves. Baviera.

1900.

10318. Electric storage batteries and conducting plates therefor. Fell. (Wiegand.)

10502 Telephone systems. Ritter.

11819. Instrument for measuring rotary field currents. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

13044. Electric railways in which transformers are carried on the train. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Aug. 11	804	767	+ 37	7,738	6,881
Birmingham Tramways Co.	,, 25	4,434	4,423	+ 11	146,735	139,507 *c*
Blackburn Corp'rat'n	—	—	—	—	—	—
Blackpool Corporatn.	,, 23	1,793	1,306	+ 487	17,681	13,769
Blackpool-Fleetwood	,, 25	1,845	2 090	- 245	11,605	11,990
Bradford City Trams	,, 26	454	410	+ 44	10,473	8,632
Bristol Tramways Co.	,, 24	3,453	3 692	- 239	—	—
Central London Ry.	,, 25	4,385	—	—	18,329 *e*	—
City & South London	,, 26	1,473	895	+ 578	12,008	7 662 *c*
Cork E. T. and L. Co.	,, 23	463	506	- 43	13.702	12,503
Dover Tramways ...	,, 25	324	346	- 22	6,834	6,488
Dublin U.T., elec. cars	,, 24	3,729	1,469	+2,260	—	—
Dublin S.D. Electric	,, 24	1,048	1.639	- 591	—	—
Glasgow Corporation	,, 25	8,866	9,337	- 871	—	—
Halifax Corporation	,, 25	809	810	- 1	16 704	13,061
Hull Corporat'n E.S.	—	1,297	—	—	26,077 *a*	— *a*
Liverpool Corporat'n	,, 18 *b*	9,461	7,649	- 1,812	250,616	222,021
Liverpool Overhead	,, 26	1,767	1,899	- 132	13,960 *c*	13,661
Sheffield Corporation	,, 26	2,507	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *d* Since July 5. *e* From July 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11½-12½
—— 40,001-100,000	—	—	11½-11¾
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6¼
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	¾-1
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2¼-2⅜
—— 4½ per cent. Debenture Stock	100	..	103-113
—— 4½ per cent. 2nd Debenture Stock	100	—	101-106
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	13-14
—— 5 per cent. Pref.	5	—	5½-5¾
Crompton and Co.	2	—	2¾ 4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	2	—	1⅞-2¼
—— 5 per cent. Debentures	5	—	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	91-96
—— 5 per cent. Second Deb. Stk., Prov. Crts. 70 p.c. pd.	—	..	66 72
Electric Construction	2	—	1⅞ 2¼
—— 7 per cent. Cumulative Pref.	2	..	2⅝ 3¼
—— 6 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-13½
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	—	31-32
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	35-39
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5½-6¼
Willans and Robinson, Ordinary, 1-80,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 80,001-80,000	5	—	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅞-1
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	9½-10½
Brompton and Kensington, Ordinary	5	—	7-8 xd
—— 7 per cent. Preference	5	—	8½-9½ xd
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	5-6¼
Charing Cross and Strand	5	..	9-10 xd
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾ xd
Chelsea Electricity Supply	5	—	6¼-7½
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	—	7½-8¼
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	100	..	123-128
County of London and Brush Provincial, Ordinary	10	—	8¼-9¼ xd
—— 6 per cent. Cum. Pref.	10	—	11-12 xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,600	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	—	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	2	—	1-1½
—— 6 per cent. Pref.	5	—	3¾-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	99-101
Metropolitan, Ordinary	10	—	14-15 xd
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-98
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1⅛-1⅜
—— £5 Shares	5	—	7½-7¾
—— £4½ Shares, New	4½	..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	—	5½-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	—	86-96
South London, Ordinary	2	—	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15
—— 7 per cent. Pref.	5	—	8-9
Westminster, Ordinary	5	—	12-13 xd
—— 20,001-109,437	2½	—	8¼-9½
Electric Railways.—			
Central London, Ordinary	10	..	9¾-10½
—— Pref. Half-Shares	5	..	4¾-5¼
—— ,, ,, deferred	5	..	4¾ 5¼
City and South London, Consolidated Ordinary	100	..	57-60
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13¼
Waterloo and City, Ordinary	100	—	91 94
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary	10	—	14½-15½
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	13-13
—— 5 per cent. Perpetual Debenture Stock	100	..	123-126
—— ,, ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	103-106
—— Prov. Cert., all paid	—	—	96-99
Isle of Man Electric Power, 6 per cent. Pref.	1	..	1/16-⅛
Kidderminster and District Lighting and Traction, Pref.	10	—	9½-10½
New General Traction, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. Pref.	5	—	4¾-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-19
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 25,667-40,000	10	—	11½-12¾
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4⅞
—— 6 per cent. Cum. First Pref.	10	—	15-16
—— 6 per cent. Cum. Second Pref.	10	—	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	—	4¾-5¼
—— 3½ per cent. Deb. Stock, Red.	100	—	97-100
Oriental Telephone and Electric Company	1	—	⅜-½

Digitized by Google

NOTES.

Wireless Telephony.—After wireless telegraphy, wireless telephony was bound to appear sooner or later, and we notice that it is announced that a system of wireless telephony has been discovered by Mr. Walker Moseley.

The New German Cable.—The new German-American cable between Emden and New York was opened on Friday, when the Emperor William sent a message to President McKinley and President McKinley replied. The cable was opened to the public service on Sept. 1, when the old route, from Emden *vid* Valencia (Ireland), was discontinued.

Electricity in Liverpool.—It is pleasing to notice that the demand in Liverpool for electrical energy is increasing to a very large extent. The chief cause of the increase is naturally the electric tramway system, but the demand for energy for other purposes has also become much larger. The great increase has naturally brought about some changes in the staff of the electricity works, and many of the officials have received well-deserved promotion.

A Piano Note Recorder.—An invention has, we learn, been completed by which such things as "lost chords" are to be prevented. Thus we notice in the *Globe* the announcement that Mr. Vaughan Neale has completed an electrical machine which is to register extempore compositions upon the piano. The arrangement can be attached to any ordinary piano, and it is reported that the machine has taken down a tarantella played at the rate of 2,000 notes a minute. The attachment, it is stated, does not interfere with the touch.

Sunderland Tramways.—The new electric tramways recently started by the Sunderland Corporation do not seem to have escaped the delays and stoppages which usually attend the opening of a new line. Thus, on Sunday last, in the afternoon, the current was suddenly cut off on two of the sections on the Christchurch-Roker route, and two or three of the cars were compelled to remain for about an hour at different places on the line. The service was naturally greatly disorganised, but at present no explanation is forthcoming as to the cause of the interruption.

Motorcar Speeds.—The inhabitants of Bournemouth have been greatly annoyed that motorcars should travel in that town at any speed above a walking pace. In consequence of their complaints, several drivers of motorcars were recently brought before the police court. The constables gave evidence as to measuring the distance travelled by the cars, and the time, which, when worked out, averaged 10 miles per hour. The traffic was fairly heavy at the spot where the measurements occurred, but the magistrates let the drivers off with only nominal fines, taking the view that none of the cases were serious.

French Translation.—In a note in our contemporary *L'Electricien* on the electric lighting stations in England, a number of figures are given as to the output, cost of machinery, and price per unit at various stations. Our French contemporary, however, does not yet seem to have mastered that strange conglomeration of "exceptions to the rule" which goes by the name of the English language, and while giving a working cost as 1·5 pence, when giving the total cost as 2·18 pence treats us to a double plural and calls it 2·18 pences. In yet another note, also, our contemporary gives the fare on the twopenny tube as two pences. Apart from this, however, the notes contain a large amount of useful information.

African Telegraphs.—The line of telegraph from the coast to the Lake Victoria Nyanza has recently been completed, and the advantages which it will confer on the inhabitants of Lower Egypt will be enormous. As is well known, the natives depend on the rise of the waters of the Nile for the irrigation of the land, and hitherto they have only known a very short time beforehand the condition of the waters. Now, however, that communication has been made from the sources of the Nile, the required information can be sent several months in advance, and the Egyptians can regulate their supplies. Messages, also, are now sent in a few days which previously took seven months to communicate.

Wireless Signalling.—Mr. J. Gardner, of Fleetwood, is stated to have invented a new automatic device for signalling at sea. The mechanism is said to consist of a specially-cut wheel, which controls a Morse key at the transmitting station. The dots and dashes are recorded on the tape in the usual way. At a trial made at Fleetwood a wire was erected on shore at the transmitting station, and a conductor of about the same height was attached to the mast of a vessel lying off the coast. The vessel was then towed out in the direction of the Morecambe Bay lightship. When about two miles out signals were sent and received. The record was taken up to the seven miles limit, the extremity of the zone provided for.

Edison Again.—Mr. T. A. Edison is credited with yet another great invention, this time it being announced that he has completed a machine for the generation of electrical power direct from coal without the use of engines or dynamos. Mr. Edison declares that his invention will practically do away with the use of steam, and make it possible by electricity to run ships across the Atlantic in four days. He also says that under his new system private electric lighting plants may be maintained in houses at small expense. We believe we have seen the same announcement in a slightly different form some considerable time since, but after going the rounds of the provincial Press no more was heard of the matter.

Liverpool Electric Tramways.—Last Saturday another portion of the electric tramways in Liverpool was opened for traffic, and through communication is now established between Seaforth and the suburbs of Waterloo and Great Crosby. The scheme was entrusted to the Overhead Railway Company to carry out, and work was commenced almost a year ago. The overhead trolley system is used, with side-pole construction for supporting the trolley wire. The cars are similar to those already in use in Liverpool, and the electricity is to be supplied from the Overhead Railway Company's station at Bramley Moore Dock. The fares charged on the route are remarkably low, and tickets will be issued to and from all stations on the Liverpool Overhead Railway. A luncheon was given by the chairman of the Waterloo District Council to the gentlemen connected with the construction of the line.

Hull Telephones.—The Hull telephone subscribers seem to have fallen on bad times. Thus we notice that on Monday last the members of the Hull Chamber of Commerce had brought before their notice what was described as the "defective telephonic system of Hull." One of the speakers said the system was simply abominable, especially when anyone wanted to speak out of the city. In many cases he had no sooner started to talk through the instrument than he was cut off. The Chairman (Mr. T. R. Ferens) also remarked that he had only used the trunk system once in six months. If he wanted anything quickly, he telegraphed. The telephone system was now a nuisance, and the trunk line, as now conducted, a failure. It was eventually decided

Digitized by Google

that the attention of the Post Office authorities and the National Telephone Company should be called to the defects in their systems and asked to remedy them.

The Healthful Tube.—The Central London Railway, or, as it is more familiarly called, the twopenny tube, has received a considerable amount of praise in various places, owing to its superiority in certain things. One is, however, rather startled when it is suggested that, instead of taking the sea breeze at Brighton, one should travel on the tube and get the same vigorous appetite which the ozone by the sea is supposed to produce. The *British Medical Journal*, however, quotes the case of a person who had suffered from anexoria for 18 months suddenly developing a ravenous appetite after a single journey on the new line. The satisfactory condition of affairs—from the patient's point of view—has since then been maintained by similar doses taken every two or three days. Tonics have become needless, and the price of the journeys forms a most profitable comparison with previous cost of medicines and doctors' bills. The twopenny tube, as a health resort, promises to rival Davos Platz.

High-Voltage Domestic Supply.—The Board of Trade rules have, during the last two or three years, been found to be exceedingly irksome in the matter of electric supply. Thus, referring to the fact that a deputation of representatives of several electric lighting companies lately waited on the President of the Board of Trade to obtain an alteration of the regulations regarding electric supply, *Feilden's Magazine* says: "It appears that the President of the Board of Trade has not been sufficiently impressed by the deputation which recently waited upon him on behalf of eight metropolitan electric lighting companies in order to convince him of the desirable necessity for an amendment of the regulations on the change in the pressure of supply to consumers. This is to be regretted, but still more is it to be regretted that any hard-and-fast rules regarding technical details were fixed by legislation at a time when electricity was as yet, with reference to many questions, in a purely experimental stage."

A Peculiar Tramway Accident.—An extraordinary accident occurred on Sunday last on the St. Helens and District Tramways system. Thus about noon one of the newer and larger cars was being taken from the sheds to the starting place at the junction of three large streets. The guard was new to the business and omitted to properly attend to the trolley, and consequently, as the car turned into Bridge-street, the trolley, being on the wrong wire, swung outwards, following a different course. The strain became very great, and the trolley left the wire. It came back with a crash, bringing down nearly all the wires at the junction, and interrupting practically the whole of the system. At the instant of the crash, apparently, a short occurred, while the arm on which an arc lamp is suspended at the corner of one of the streets was broken and the lamp shattered. At the works it was soon seen by the indicator that something was wrong, and the current was switched off, the cars on the Haydock, Denton's Green, Peasley Cross, and part of the Prescot sections being left standing still at various parts of the town. Breakdown gangs were immediately set to work, and the damage was repaired in the very short space of time of three hours.

A Ballistic Oscillometer.—The following is an abstract of a paper read by Messrs. A. and V. Guillet before the French Academy of Science. The abstract appears in the *Electrical World*, and reads as follows: "The authors start from the rule that when a coil supplied with a certain current oscillates in the inner part of a fixed coil supplied with the same current, the product of the current and the period of the oscillations is constant, therefore the number of oscillations during a certain time is proportional to the quantity of electricity supplied during that time; this rule is used in the counters of Vernon Boys and Blondlot. The energy cannot be measured in the same way; to measure it, not continuous current is supplied to the oscillating coil, but only a current that lasts for a moment. Let the coil oscillate around a fixed axle in a magnetic field, then it can be shown that if the magnetic field is constant a certain angle of oscillation corresponds to a certain quantity of electricity; if the magnetic field is proportional to the E.M.F., the angle of oscillation corresponds to a certain amount of energy. The first case is obtained with a permanent magnet, the second by means of a coil, in shunt, for producing the magnetic fields."

An Inexpensive Cooling Tower.—The *Electrical World* illustrates a cooling tower which has been used by the electric lighting company in Jersey City, but which, we are afraid, is not likely to find much demand in or around the large towns on this side. The apparatus in question is practically a cooling tower without any enclosing work, and the water is delivered at the top of an erection of scaffold poles, across which five platforms at different heights are placed. These platforms are made up of lattice woodwork, and break up the water as it falls down from one to the other, the water at the bottom being collected in a pond for use over again. Illustrations are given of the apparatus when working and when at rest. From the photo taken when the water is being discharged, we can see that in windy weather the spray would be carried for a great distance, which would cause a nuisance to the surrounding property owners. In fact, the general idea is not unlike that of the original condenser water-cooling apparatus at St. Pancras, the use of which had to be discontinued. In this case a galvanised iron structure with iron plates was built up round the chimney, but it used to shed ice in winter and spray in summer, which led to its disuse.

The Northampton Institute.—We have received a copy of the announcements of the Northampton Institute for the session 1900-1901. The book is much the same in appearance as in past years, but new illustrations have been introduced. The volume commences with a list of the staff, and with respect to the electrical engineering section we do not notice any special change, except that Mr. A. W. Martin, who was an assistant lecturer last year, has taken the place of Mr. A. Brooker as chief lecturer in the postal telegraph classes. As to the classes themselves, we learn that the only new feature of any importance is with respect to the engineering day classes. These are divided into three classes: mechanical, electrical, and horological engineering. In each the work consists of lectures, exercise classes, laboratory work, drawing office, and workshop practice. In the electrical engineering department, besides instruction in electric lighting and power distribution, electric traction and electro-chemistry will be dealt with. Before entering these classes, students have to pass an examination in general knowledge. The fee for students is £15 for the session. There are numerous other classes for all kinds of subjects, and there is also a social and recreative section, which includes music, swimming, athletics of all kinds, etc. Dr. R. Mullineux Walmsley, the principal, is much to be congratulated on the great success of the City Polytechnic in past years, and we are sure that in the session now about to commence the standard of work will be quite up to, if not higher, than in previous years.

Electric Railways.—The District and Metropolitan Railway Companies are waking up to the fact that for lines of railway between the City and suburbs steam is becoming out of date. Thus, when interviewed by the *St. James's Gazette* recently, Mr. Powell, the general

Digitized by Google

manager of the District Railway, is reported to have stated that as regarded the proposed new electric motive power to be applied to both the District and the Metropolitan underground lines, tenders had been invited from engineering firms for the reorganisation of the systems upon an electric motive basis. There were, however, so many details to be considered that firms were at present only making enquiries into the conditions. Tenders would not be ready for some few months, and after that it would be a considerable time before the matter was completed. There was nothing like the amount of work to get through, however, that the Central Electric had, as they had their tunnels, stations, and carriages made. With regard to the carriages, he thought the directors would favour the old form of doors to each compartment, and not the corridor system. Unlike the Central Electric, they would carry the luggage of the passengers. They were a railway, not a tramline. One of the reasons why the corridor system of carriages would not be adopted was that the public, and especially the women, were not educated up to it. They did not get out of the carriage fast enough with their luggage. There was little doubt that with the new system they would be able to do the through journeys very much quicker. An additional improvement, in our opinion, and probably of others who have travelled by the line, is that the very objectionable smell and smoke which at present exists in the tunnels, and even in the stations, will be done away with, and one will not feel half suffocated at the end of a journey.

The Energy of Cathode Rays.—At the recent meeting of the American Association for the Advancement of Science a very interesting paper was presented by Mr. W. G. Cady, dealing with the subject of "The Energy of the Cathode Rays." The paper, which is abstracted in the *Electrical World*, gives an account of investigations at the Physical Institute of the University of Berlin, made in order to determine the relation between the energy and other discharge phenomena of these rays. For this investigation the thermo-element, as used by Messrs. J. J. Thomson and O. Berg, was employed, as much more exact than the calorimeter. Observations were also made with bolometers. The bolometer formed one arm of a Wheatstone bridge. The paper is in reality an experimental test of the emission hypothesis which Prof. Merritt supported in his vice-presidential address. By that hypothesis, a relation exists between the energy of the cathode rays, potential of discharge, and amount of electricity transported by the rays, which is expressed by several equations, of which the crucial one is : $\frac{i\,V}{Q} = \frac{1-r}{1-r\,r'}$; where i is the intensity of the cathode current, V the potential of the cathode giving off a bundle of rays, Q the amount of heat given up to the conductor (ergs per second), r is the fraction of the rays reflected, and the ratio $r' : 1$ expresses the ratio in which rays lose their energy on reflection. The conclusion reached by comparing the limiting value of the ratio experimentally determined with this equation is in contradiction with results obtained by Merritt. Thus if $r = 1$ (Merritt), we still have $i\,V/Q = 1$; if in the limiting case $r' = 0$, then $i\,V/Q = 1 - r$. But Starke has found that platinum (the reflecting surface of Cady's bolometer) reflects about 40 per cent. of the rays. Assuming, therefore, that for the bolometer $r = 0{\cdot}4$, we find that when $i\,V/Q = 0{\cdot}83$, $r' = 0{\cdot}7$. The importance of this investigation on the vexed question of the nature of cathode rays is evident, since the result, if established, is incompatible with the emission or corpuscular theory.

Magnetisation and Elasticity.—The last of the papers upon "The Effect of Magnetisation upon the Modulus of Elasticity," by Mr. J. S. Stevens, appears in the August number of the *Physical Review*. In the previous papers he discussed the relation between magnetisation and the moduli of flexional and torsional elasticity. The two papers in the current issue deal with the elasticity of traction and compression. In the first case the apparatus consisted of a coil of wire wound on a brass tube, through which passed a stream of running water, in which was carried the wire to be tested. One end of the wire was fastened to a rigid support, and the other to a bent lever with a multiplying power of about 11. At the other end of the lever were attached weights giving a certain tension to the wire. The changes in length were communicated to another arm of the same lever, which multiplied the effect 110 times. The fore end of this lever moved under the field of a micrometer microscope. A thermometer with its bulb in the water completed the apparatus. The procedure consisted of setting the cross wires of the microscope on some point for zero, then turning on the current and noting the deflection of the end of the lever. The author then gives tables giving the current, zero readings, difference, and the change in length of the wire. From the tables he concludes that the modulus of elasticity of traction increases when the body is magnetised. The increase is fairly proportional to the magnetising force. With the same wire the change in the modulus varied with the stretching weight. With wires of different cross-sections stretched by the same load the change in modulus was greater in the smaller wire. In experimenting as to the elasticity of compression, a bar was firmly fastened at one end, and moved a lever arm when changing in length. The other arm of the lever moved under the field of a micrometer microscope. The compressing force was measured by a spring balance. The whole apparatus was bolted rigidly to the bed of a planer, so that there was little chance of friction or slipping. The knife-edges and bearings were of hardened steel, and variation of pressure was applied by moving the bed-plate of the planer. With respect to this experiment, the author states that within its limits magnetisation does not change the elastic modulus for compression. If it had been possible to apply a pressure nearer to that of the elastic limits of the metal, the results might have been different.

The Central London Railway.—Numerous letters have been sent to the *Times* concerning the Central London Railway, and the one or two serious stoppages which have occurred upon it. The stoppages one would naturally expect on an entirely new railway, and the Central London Railway Company are to be congratulated on having started the line with so few of them. The first of the letters was from a gentleman who had been stopped for half an hour at Marble Arch, and to this Sir Benjamin Baker replied explaining the means for getting the passengers away from the train in the event of a stoppage. Mr. R. W. Boyd is not, however, quite satisfied with Sir B. Baker's explanation, and submits one or two points for consideration. Thus, he says that Sir Benjamin tells the public that in the event of a prolonged stoppage gangways are provided for passengers, but these gangways lead, it appears to him, nowhere, unless the train is at station, at which point the main tube is enlarged. Gates are provided between the carriages, but these gates are hardly available for the use of passengers unassisted by the guard, while all side outlets are useless between the stations, as the train fits the tube closely. This close-fitting construction prevents escape from the train while in the main tube, and this seems to him to be an element of considerable danger. As to the lighting, a prolonged stoppage occurred with carriages full of people and the lights extinguished. The

Digitized by Google

carriages are supplied with some oil lamps in addition to electricity, but these he thinks are so few as to be of little use in a panic. Finally, to reduce the risk of accident, he suggests that it would be well to have a short, simple printed notice fixed in each carriage explaining what to do in case of accident or prolonged stoppage. Another gentleman, who would certainly seem of a rather timid disposition, describes very graphically his experience on Aug. 18, when a stoppage occurred between Holland-road and Notting Hill-gate. After being kept prisoners in the darkness for about two hours and a quarter the passengers had to walk back to Holland-park Station. Some nervous lady passengers, he states, were almost terrified into hysterics by vague fears of a horrible death caused by touching the electric rail, and the wanton action of the officials in refusing all explanations of the delay and keeping them imprisoned for so long must, he thinks, necessarily militate against the success of this new method of locomotion. The accident occurred apparently from a train running off the line at the points, an experience which he seems to think very often occurs to electric trains. He, however, has taken the right course to avoid any such delays by the Central London Railway in future, as he practically expresses his determination never to trust himself on it again.

Corridor v. Compartment Cars.—In comparing the relative advantages of English compartment cars and American long open cars, particularly in regard to the rapidity of filling and emptying, the New York *Commercial and Financial Chronicle* says that where the traffic is very large, as at the chief city stations, the many compartments of the English car undoubtedly enable more prompt ingress and egress on the part of passengers than the car with only end doors. But cars coming into a station filled with passengers are not usually promptly forwarded with another full car-load of passengers. This is particularly true in suburban service, in which the new Central London underground road is engaged. Each station has its proportion of passengers alighting and boarding the cars, and under these circumstances the quick handling of passengers with the compartment car, as at great terminal stations, is not maintained. There are a number of reasons for this which make the result quite obvious. With compartment cars the selection of a comfortable seat depends upon the choice made from the station platform. First, the particular class for which the ticket is good has to be found. Passengers examine each separate compartment until they find the seat they regard as the best—two operations which consume time. The assorting and distribution of passengers in the open American car is, however, accomplished after the passenger has entered the car and when the train may be in motion. Where compartment cars are used, this distribution must be done while the train is at a standstill at the station platform. These generous statements of the quicker handling of passengers at way stations and in the frequent stops of a rapid transit service, with the American open car having end doors, are amply verified by careful observations of the actual time consumed in the two services. One observer, Mr. R. H. Soule, a well-known American railroad officer and engineer, has recently published figures comparing the length of service stops on the Cape Government railroads in Africa and on the Illinois Central in its suburban service at Chicago. In each case 100 observations were taken. Roughly, Mr. Soule's figures show that the American train stops were but half as long as those on the African line, with its English rolling-stock. The actual figures, reduced to an average for the series of observations, were 22·39 seconds for each stop on the African road, while but 11·58 seconds were consumed on the average by the Illinois Central trains. This represents the view taken by the companies. The passengers, especially those in England, who are accustomed to the compartment system and its attendant comparative privacy, firstly miss the latter, and, furthermore, are not all favourably impressed with the constant interruptions, the inconvenience caused by people standing in the passages and front of the passengers already seated, etc. Another point is that the introduction of the one-class system in England is, when two different fares are charged, distinctly unfair to those paying the higher fare.

Spark Length.—In the *Physical Review* for August we notice a short contribution by Mr. W. J. Humphreys on spark length as modified by solid dielectrics. In the note the author states that whilst trying some experiments with an electrical influence machine he noticed that the spark length was greatly increased by the presence of solid dielectrics, such as glass or ebonite, near the positive pole. Several machines were experimented with, but the one commonly used was a two-plate Wimshurst machine with plates of ebonite 20in. in diameter, and furnished with metallic sectors. The apparatus used was two small Leyden jars with their outer coverings connected by a wire and their discharging balls connected, one to the positive side of the machine and the other to the negative side. The inner coatings of the jars were oppositely charged, and the distance between the discharging balls increased until sparks ceased to pass. When, however, the same potential difference being maintained, a glass rod was placed near the side of the positive pole facing the negative, a full spark passed. This did not happen with the rod near the negative pole. Various dielectrics were used, but with the same result, the increase in spark length being always well pronounced and sometimes doubling the ordinary length. Many combinations were tested, but in every case the results obtained were practically the same. In framing an hypothesis to explain the phenomena the author suggests that "the dielectric between two poles is most sensitive to electrical disturbances at points next the anode." To support this theory the author gives a number of facts—namely, that the spark length is increased by the presence of a glass rod next the anode, but not when the rod is in any other part of the field; the greater the increase in spark length, the nearer must the rod be brought to the pole. The greatest increase is obtained with a rod of a certain size—*i.e.*, the rod must not be too large or too small to produce the best results. When glass fibres are used, they must be brought very near the pole or quite in contact with it. The same phenomenon occurs when insulated conductors are used instead of glass or any other dielectric. In order to test this idea, the author experimented with dielectrics of widely differing inductive capacities, but otherwise approximately equal. The substances used were a thin-walled test tube empty, a similar tube partly filled with water, and a similar tube filled with metal. The results were not conclusive, the increase in spark length being nearly the same, with, perhaps, a slight advantage in favour of the tube containing water. The fact also that insulated metal rods act no better than glass rods does not, the author thinks, seem altogether in accordance with his assumption. These, however, were the only objections, which may not be fatal, and in further support of the hypothesis the author give the increase of spark length caused by a small spark drawn from the negative pole of two oppositely charged Leyden jars with the outer coatings connected, and also Faraday's experiments on spark lengths between spherical electrodes of different sizes. Mr. Humphreys states that

Digitized by Google

whatever may be the real action of solid dielectrics in increasing the spark length, it is a phenomenon of the anode, and to that extent indicates a greater sensitiveness of the air about this pole to electrical disturbances.

Municipalities and Public Service Companies. Mr. A. R. Foote has during the last few years been investigating the principles which should govern contracts between municipalities and public service corporations, such as tramway, electric lighting, etc., companies. This work appears as a series of Bills prepared by Mr. Foote at the request of the Ohio State Board of Commerce for presentation to the Ohio Legislature at its last session, and while action upon the Bills was deferred until the next session, it is expected that they will be taken up for consideration next winter. The essential provisions of these Bills, as given in a recent number of the *Street Railway Journal*, are as follows: (1) Bonds issued by a municipality for the establishment of a public service plant shall be secured only by mortgage of the plant itself and the franchises for operation. In other words, the general credit of the city shall not be placed behind these bonds, but they must stand or fall upon their own merits and earning power. (2) No public service owned by a municipality shall be sold for less than cost. If the service does not pay at the prices originally established, these prices must be increased. The general body of taxpayers must not be called upon to help pay for a service to a private user. (3) The true and entire cost of service, whether given by a private company or by the municipality, shall be determined by a State auditing department to be established, and shall include the full operating expenses; a sufficient provision for depreciation, for losses from fire, and for accidents of every kind; taxes paid (in the case of private companies) or relinquished (in the case of municipalities), these taxes including any special bargains concerning franchise taxes which may be made between municipality and company based on a payment of percentages on gross receipts; interest on the full amount of actual investment at the rate per cent. paid by the municipality on its bonded debt. (4) To the cost of service as above specified there should be added in the case of enterprises owned and operated by the municipality a provision for a sinking fund sufficient to pay off at maturity the bonds issued on investment account. (5) All surplus earnings over and above the true cost of service, as defined in paragraphs 3 and 4, are to be regarded as the true profits of the enterprise. (6) Out of these true profits, when earned by a private company, the latter may pay upon its true investment a rate per cent. double that paid by the municipality on its bonds. (7) If a private company adopts a system of profit-sharing with its employés, it shall be entitled to earn and pay to the employés the same rate per cent. upon the wages earned by them as the company earns on its investment. (8) All surplus profits, after making the distributions provided for in paragraphs 6 and 7, are to be divided equally between the municipality and the company. (9) The determination of the investment value to be used as a basis for the foregoing computations shall be determined originally by appraisement or by arbitration. Additions shall be made in a manner specified by the municipality. (10) The price for service to be paid by users shall be fixed by the municipal council for a period not less than five nor more than 25 years, and the prices so fixed shall be computed on the basis of cost, and must be such as to produce an annual revenue sufficient to fully pay all costs and to yield the company its authorised share of profit. These rules, which are very well drawn up, would, if adopted, probably prove of great use to the parties concerned in the contracts, and would doubtless save a very large amount of friction. It is, however, doubtful whether both municipalities and public companies could be brought to accept them as they are, and possibly, although the rules seem very fair all round, in practice many difficulties might be found in the working which did not appear in the first instance.

Electrical Stage Effects.—In most of the modern plays at the larger theatres electricity is used to produce particular and striking effects. We notice an instance of this in the *Scientific American*, which has an article respecting the production of "Bén Hur" at the Broadway Theatre, New York. In this play a chariot race takes place, and the stage is so fitted that two chariots, each with four horses, appear to be dashing along at a great pace. Finally, one chariot overturns the other and wins the race. A large part of the illusion depends upon the background, which gives the idea of positive motion, and the one employed in this instance embodies means for mounting and driving travelling aprons at the rear and sides of the stage, so as to prevent any break in the scene, this giving the audience the impression of change of scenery. At the rear of the stage is an endless apron, flanked on each side by smaller endless aprons, each of which is complete in itself, but are operated in unison. Upon these aprons are painted representations of the background of the scene; in this case representing the antique circus at Antioch filled with spectators. Directly below the chariots is the electric motor which actuates all three aprons of the panorama. It is a 5 h.p. Lundell motor, and is operated by an assistant, who stands at the switchboard and receives the signal of the stage manager by a flash of a coloured electric lamp. A twisted belt imparts motion to a vertical shaft upon which are three pulleys, one to receive the power from the countershaft and the others to transmit the power to the two ends to vertical shafts, which each carry a cylindrical drum, around which the aprons are passed. Their rotation causes the apron to travel continuously, and gear wheels are provided, which impart motion to the side aprons, so that they are all driven in the same direction, and to the spectator the three aprons appear to be a continuous, unbroken scene. In spite of the fact that the panorama is 96ft. wide and 25ft. high, the three panoramas are all rotated at a speed of 2,000ft. per minute by a 2-h.p. motor. As to the chariots themselves, the treadmills carrying them are placed immediately beneath the stage, and are covered by sections of planking, which are removed and carried out to the wings when the race is to take place. There are eight treadmills, one for each horse. The chariots are two in number and each is supposed to be drawn by four horses. The chariot of Ben Hur is not a trick chariot, but that of Messala is arranged to go to pieces when struck by Ben Hur. The chariot wheels do not rest upon the floor of the stage, but are supported upon metal yokes. The wheels are actuated by a small electric motor inside the body, and can be switched on by the drivers. Both chariots have these motors, and current is obtained by the aid of plugs which are inserted in the floor. The chariot of Messala is arranged so that at the critical moment when Ben Hur strikes it, by dropping a catch, powerful springs on the axle throw the wheels off and the body of the chariot drops upon a yoke which is provided with springs. To simulate the dust raised by the chariot wheels, a combination of powders is forced out underneath the horses' feet and behind the chariot wheels. This is accomplished by a blower in the cellar, driven by the same electric motor which actuates the belts. The scene can be fitted up with wonderful celerity, the whole requiring only about eight minutes to set.

Digitized by Google

TAUNTON ELECTRICITY WORKS.

(Concluded from page 298.)

Mr. Manville in his report, which is dated March 25, 1898, alludes to the early start made at Taunton in electric lighting, as plant was put down in 1895, and he expresses his opinion that in view of the then knowledge of electrical engineering, and also of the knowledge acquired at the time when the incandescent plant was laid down, that those responsible for the equipment of the station had not been wrong in their choice of a system.

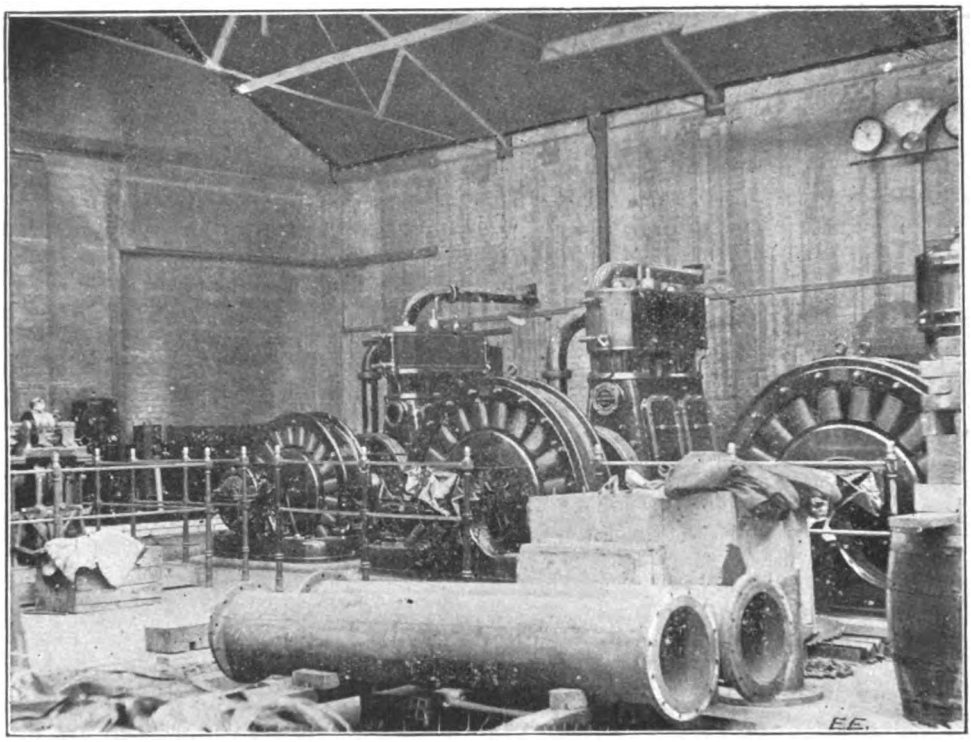


FIG. 4.—View of the Taunton Engine-Room under Process of Alteration.

At the time the report was written, however, the machinery which was to be recommended in 1897 was quite out of date. Mr. Manville regretted that extensions had been made which rendered the change over to a more modern system somewhat costly. The point arose that it was not possible under the Local Government Board regulations to obtain a loan for the whole of the proposed new expenditure, as the Board will not sanction loans for the renewal of plant, it being deemed that such renewals should come out of revenue. By a judicious arrangement made with the British Thomson-Houston Company, whose predecessors had supplied the original alternators, the consulting engineers succeeded in arranging that the new plant should be installed without a charge against the revenue. This was so because the Corporation had purchased the plant at a favourable price, and also had written off each year an amount for depreciation and for the sinking fund on the previous loan. The arrangements made in changing over were that the three largest alternators should be returned to the makers, who supplied instead two alternators of 75 kw. and one of 150 kw. output. These new machines have a frequency of 60 as against

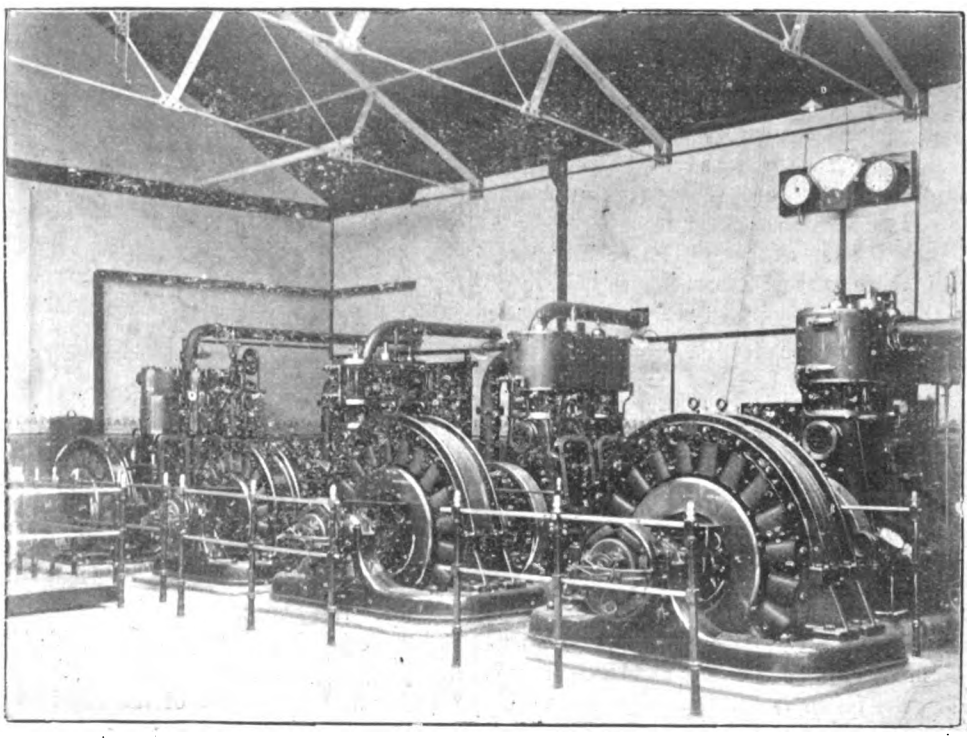


FIG. 5.—Taunton Engine-House Plant as Remodelled.

Digitized by Google

the old frequency of 125. The Belliss engine already used in the station for driving by means of belts was under the contract directly coupled to one of the 75 kw. machines. The other machine of same output was coupled up to a Willans engine, which was constructed out of the best parts of the two Willans engines on the works. This shows the great advantage of having standards in manufacture, as the parts of these engines, after having been subjected to severe working conditions during a number of years, were still able to be interchanged indiscriminately. In this way a really good engine could be built up out of the best parts of two engines which were not in a good state of repair. If the engines had not originally been made to templates and gauges, this would have been utterly impossible.

The great alteration in the appearance of the station from the substitution of these direct-coupled sets for the belt driving can be seen by contrasting Figs. 4 and 5 with Figs. 2 and 3 in our last issue. The photograph from which Fig. 4 was prepared was taken when the reconstruction was under way, and Fig. 5 shows the engine-room in its completed state. In the boiler-house an additional Babcock and Wilcox boiler was added, and a completely new range of steam and exhaust pipes was installed.

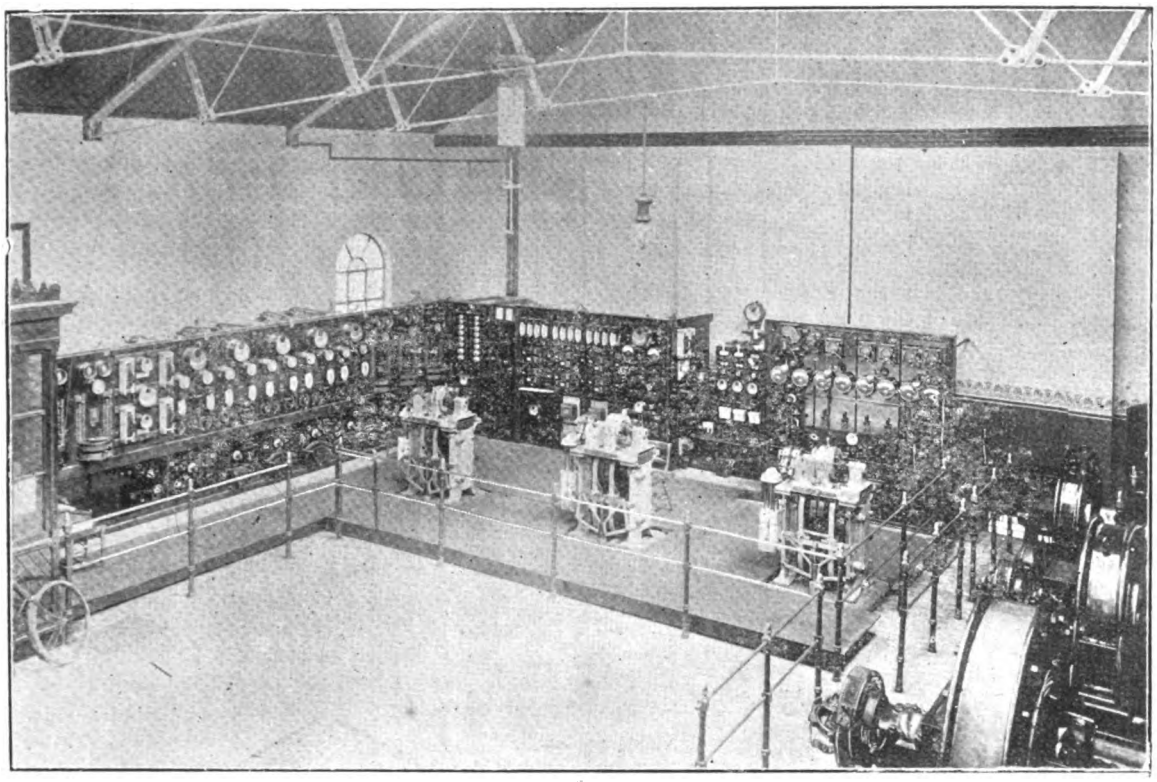


FIG 6.—Rectifiers and Switchboards.

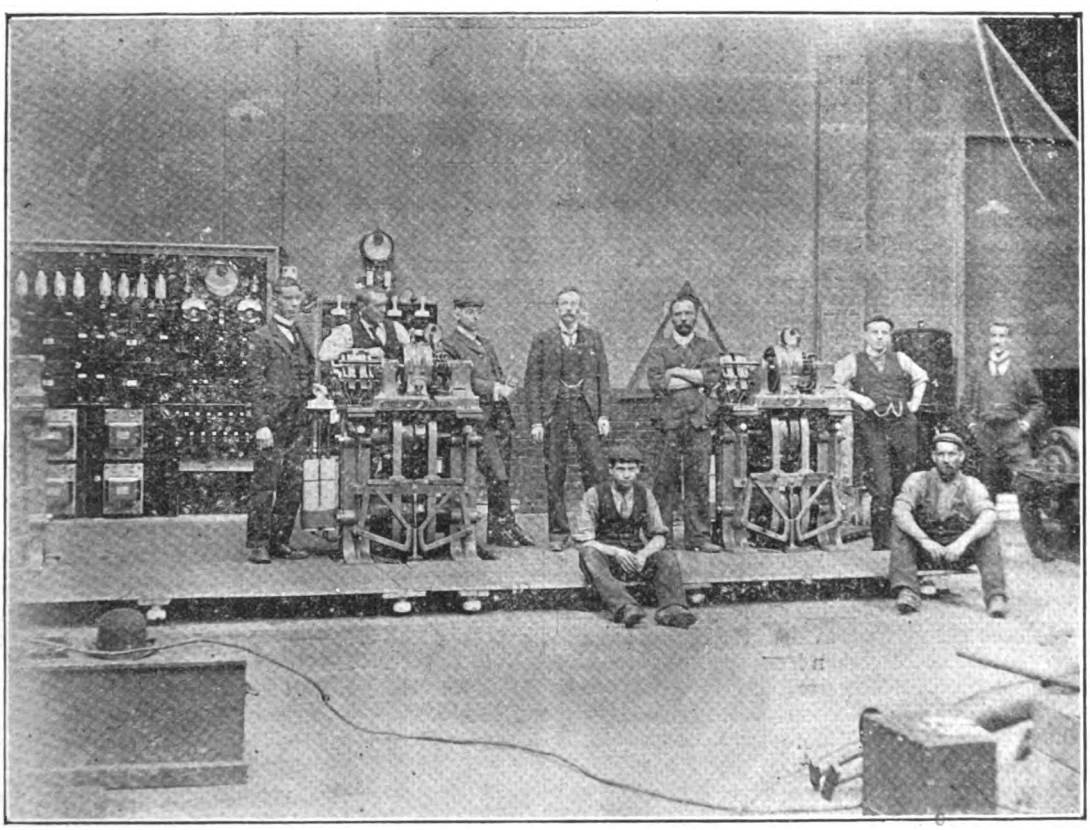


FIG 7.—Ferranti Rectifiers and Station Staff.

Digitized by Google

The next point in the report calling for notice is the changing over of the arc lighting system. This it was recommended should be done by introducing rectifiers, taking their supply from the high-voltage side of the alternate-current system. Here, again, an interesting comparison can be made between the old arc lighting plant, as illustrated in Fig. 2, and the new arc lighting plant, as seen in Fig. 6, in front of the switchboard, and which is again shown in Fig. 7, ornamented by the well-organised staff of the station. From this photograph it will be seen that the engineers at the Taunton electricity works are of as retiring a disposition as those in other parts of the country. The changing over of this arc lighting plant could not, however, be effected without a financial loss. The cost of the old plant was some £2,083, from which had to be deducted the depreciation and sinking fund, which brought the net value of the arc lighting plant on the Corporation books to £1,639. The actual value of the plant was only £500, and which is shown in Figs. 9 and 10, are wound with double-circuit dynamos and controlled by series-parallel controllers, so that they can be worked efficiently at widely varying speeds. Electric motors of the same type, but of a smaller size, are also used to drive the two boiler feed pumps, which were added at the same time as the condensing plant. These feed pumps are placed between the Babcock and Wilcox boilers and the Paxman "Economic" boilers, and are enclosed in a glazed room in order that the coal dust may not affect the workings of the bearings of the plant. There are now used for feeding the boilers two of these electrical pumps and one steam pump. The connections of steam and water pipes from these, and also the arrangements of the electrical conductors, provides against a complete breakdown of the boiler feed system from any one accident.

The mains at Taunton are worthy of notice from the fact that such a wide area is supplied as compared with

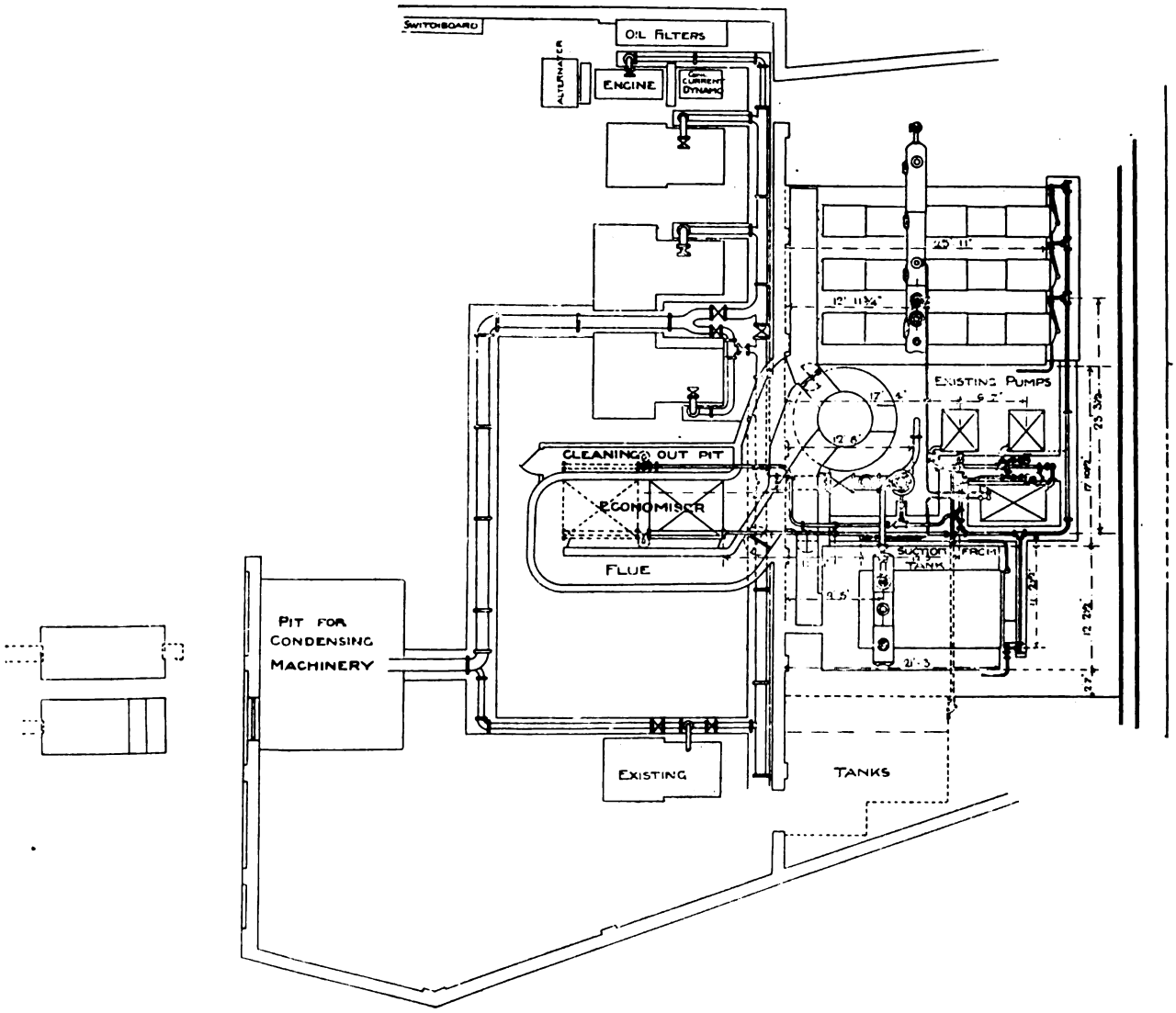


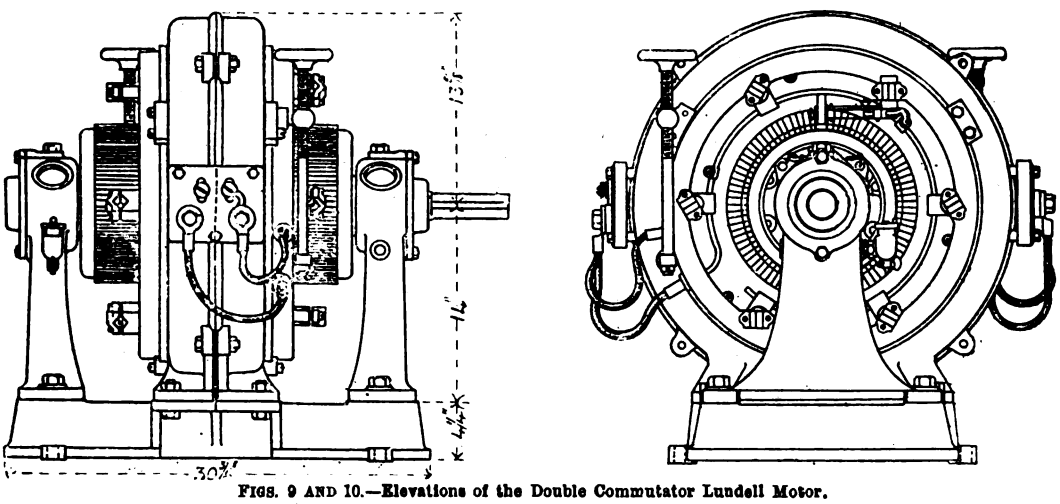
FIG. 8.—Plan of Taunton Electricity Works.

gave a loss of £1,139, which had to be provided out of revenue. The new rectifying plant was, however, installed, a loan of £550 being obtained from the Local Government Board for the purpose. This amount, together with the £500 obtained from the sale of the old plant, provided for the cost of the new, together with the £1,139 taken from revenue earned by the sale of electricity. The new arc lighting plant is able to supply 100 lamps alight at one time, leaving one rectifier as a spare, thus providing for 40 more lamps than could be supplied from the old plant. The great point, however, is that while the new arrangement is an exceedingly efficient one, the old one was the reverse. The result is shown by the coal-bill, to which we shall refer by-and-by. The complete plan of the works as reorganised is given in Fig. 8. A subsequent improvement to those mentioned above was the addition of the condensing plant, which is shown on this drawing, which consists of two jet condensers driven by two motors of the Lundell type. These motors, one of other towns in Great Britain of the same population. This wide-reaching supply shows that the Corporation has adopted the broad-minded policy of taking the mains to all probable consumers, and the result has quite justified the expenditure. Referring to the map of these mains (Fig. 11), the position of the central station is clearly marked. In this map we have denoted the routes of the high-tension mains by a single line, although, of course, in many cases more than one feeder is going down the road. Where low-tension distributing mains are being laid, we have cross-hatched the houses at either side of the street, so that the district served by these low-tension mains is clearly discernible. In other places the high-tension main is taken direct to a transformer on the consumer's premises. The main sub-station is situated under the municipal buildings, marked A, from which three $^{19}/_{14}$ triple-concentric feeders feed the ring main of $^{19}/_{14}$ concentric cable in the following streets: High-street, Fore-street (or round

Digitized by Google

the Parade), half of North-street, half of East-street. Mains branch off from this ring up the following streets: Mary-street, Paul-street, Hammet-street, Tower-street, and Castle-

main in the following streets: half of North-street, Bridge-street, North Town; also a feeder of $^{19}/_{14}$ runs back to the generating station, and supplies James-street and Cannon-



FIGS. 9 AND 10.—Elevations of the Double Commutator Lundell Motor.

green. Feeding points marked 1, 2, and 3. This sub-station has three 30-kw. transformers with earth shields, and the necessary double-pole high-tension and low-tension

street. Feeder points marked 4 and 5. In this sub-station are two 30-kw. transformers and a switchboard to control the same. The sub-station marked C on the map is situated

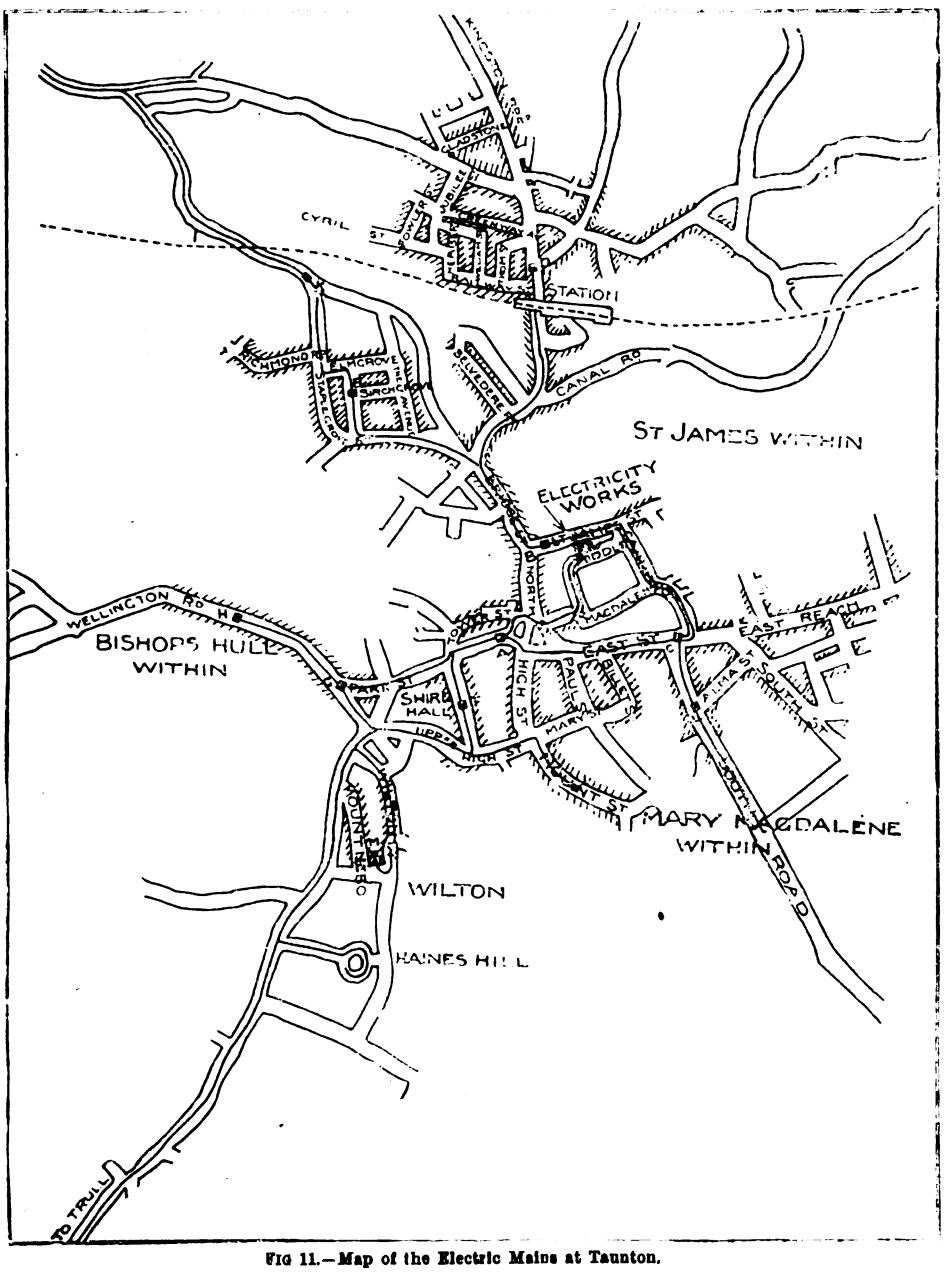


FIG 11.—Map of the Electric Mains at Taunton.

switches and fuses fixed on one board, with two ampere-meters and a voltmeter. The sub-station, marked B, in James-street has two feeders of $^{19}/_{14}$, which feed the ring

at the top of Tancred-street, and has five feeders of $^{19}/_{14}$ to the points marked 6, 7, 8, 9, and 10 on the ring of $^{19}{}_{14}$ supplying the several streets shown in Fig. 11. In

Digitized by Google

this sub-station there were two 30-kw. transformers and switchboard. The sub-station marked D is built under the pavement, and has been recently put down; consequently there are not yet many feeders in it, but pipes have been laid from Canal-road to Greenway-avenue, so that when the load increases on the sub-station feeders can easily be drawn through the pipes. In this station also there are two 30-kw. transformers and switchboard. The sub-station marked E, North Town, supplies a purely residential part of the town, and it has two 15-kw. transformers and switchboard in it. There are, besides the foregoing sub-stations, seven transformer pits which supply their own respective low-tension mains, with single transformers in them varying in size from 15 kw. to 1 kw. These are situated at the points marked F, G, H, I, K, L, and M. In every case where high-tension mains pass near one of the sub-stations, they are all taken into the same and tapped, so that it can be easy to give a supply in case of failure of any one feeder. On the switchboard in these sub-stations double-pole switches are provided, so that the load can be easily thrown over from one feeder to the other. In the transformer pits all the high-tension feeders are brought in through a box designed by the resident engineer, Mr. Thornhill, which contains Bates's high-tension fuses, and it is claimed that these high-tension fuses can be taken in or out, or the transformers switched off without doing any damage whatever to the gear or cables.

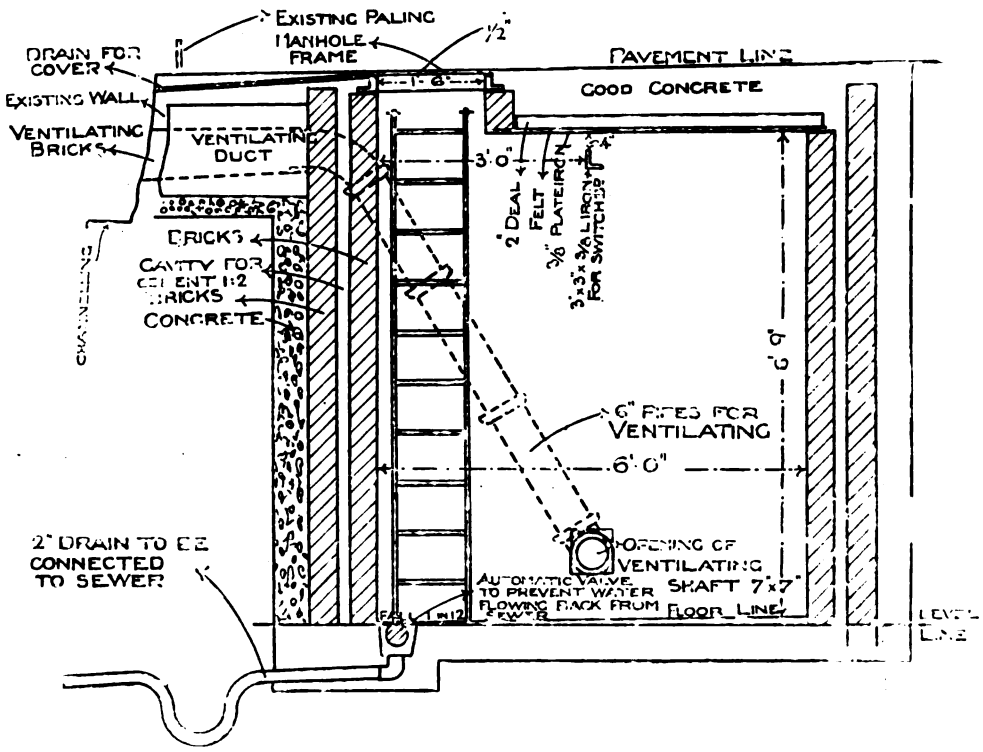


FIG. 12.—Section of Taunton Sub-Station.

An interesting feature in laying the distributing low-tension mains is that a house service box is provided for every fourth house at the time the mains are being laid. This throws on the original contractor the onus of making a good job of the service-box connections, and without doubt it is more easy for this to be done when the whole trench is opened up for laying the mains. The extra cost is not so much as one would expect, and it certainly facilitates the prompt connecting on of consumers. Fig. 12 is a section of one of the sub-stations, from which an idea of the ventilating and drainage arrangements adopted in Taunton for these sub-stations can be obtained.

FIG. 13.—Address Presented to Alderman Potter on the Opening of the Enterprise.

Digitized by Google

While the consulting engineers were reorganising the station, and the resident engineer was busy in keeping the supply in order in spite of the change over, it fell to the chairman of the Electric Lighting Committee to persuade his colleagues to spend the money, and also to provide the wherewith all for the undertaking. It is not fair to minimise the difficulty of this now that the undertaking has paid the one thousand and odd pounds out of revenue. The difficulty was in 1898 to persuade the rest of the members of the Corporation that this would be so; and we are pleased to see that when the new works were inaugurated last month the good work done by Alderman Potter was most suitably acknowledged by the presentation of an illuminated address and a service of plate. In Figs. 13 and 14 reproductions of photographs of both the address and the plate are given, which will give our readers some idea of the appreciation which is felt in Taunton of the good work done by Alderman Potter.

In a speech made at the opening ceremony, Alderman Potter referred to the fact that for a loan of practically £4,500 they had obtained a new plant with practically double the capacity of the old. They had also figures at their back to show that the change over from an obsolete plant to the new was financially right, in that it resulted in a great saving of coal. To illustrate this the following figures were given by Alderman Potter. In January, 1899, with the old plant the number of units generated in the station was 29,543, and the coal burned was 156 tons 13cwt. In January this year the units generated went up to 44,745, while the coal consumed was 156 tons 15cwt. This shows that for an increase of 50 per cent. in the units generated, the coal was only 2cwt. more. In view of the great rise in the price of coal, the change over was not made any too soon. The engineers are to be congratulated on the great coal economy effected with the new plant. As regards the progress of electric lighting at Taunton, it is interesting to note that when the Corporation took over the works there were only some 79 consumers connected to the mains, now there are nearly 600. In the same time the number of equivalent 8-c.p. lamps connected with the mains has increased from 1,840 up to nearly 17,000. Mr. Alderman Potter went on to say that many things had contributed to their success, not the least being the heads of the department themselves—Mr. Couzens, and now Mr. Thornhill. Notwithstanding what croakers might say as to the success of the undertaking, or men so steeped in financial ignorance as not to know that two and two made four, or so blinded by prejudice as not to see facts as clear as the noonday sun, it was a success, and a success unparalleled in the history of an electric light undertaking in any borough of its size in the kingdom. There was not another municipally conducted electric light undertaking in the kingdom of the size of Taunton that had ever produced such a satisfactory balance-sheet as that committee did last year.

We have to thank the consulting engineers, Alderman Potter, and Mr. Thornhill for the photographs, drawings, and information contained in this article.

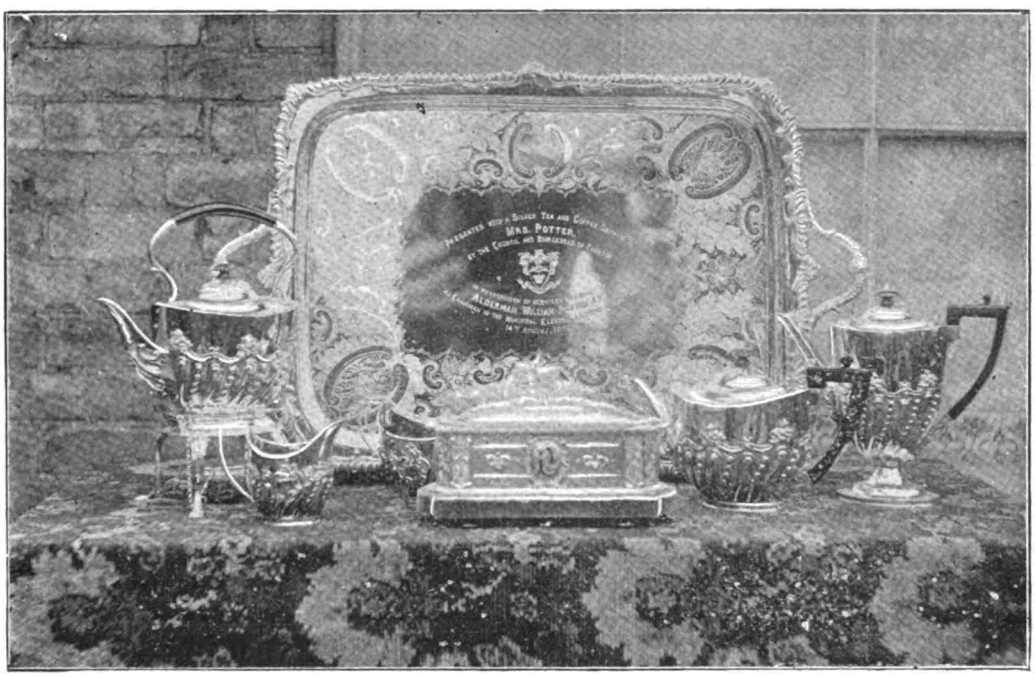


FIG. 14.—View of Plate Presented to Alderman Potter.

A COMBINATION INTEGRATING WATTMETER AND MAXIMUM-DEMAND INDICATOR.*

BY J. H. BARKER, M.I.E.E., A.M.I.C.E.

Before proceeding to describe the meter in question it is necessary to say a few words on maximum demand. It concerns engineers more especially, as every work they design or construct must be sufficiently strong to meet the greatest call which may ever be made upon it; their bridges strong enough to bear the heaviest train under the worst conditions of storm; their harbours deep enough to float the largest ship on the lowest tide. And of engineers, electricians suffer most: their plant must be sufficient to meet the maximum demand for light on any one night in the year. All their consumers need light at the same time, and Parliament says, rightly, they shall help themselves whenever they like. The result is shown in any supply station's daily record. A curve is given of that in Cambridge, taken on the heaviest day in the year, and on the same scale is shown the demand on the works if a regular amount could be generated every day. The actual requirement is 372 kw., the ideal 39 kw. (about one-ninth). Such an ideal is impossible until economic storage is more practicable than at present. However, the object of everyone in charge of a station should be to approach a little nearer the ideal state, for there is plenty of scope.

At present, electric lighting is undoubtedly more costly than gas. Consumers, as a rule, only light the more prominent parts of their houses and business premises electrically, which parts need light chiefly at the time of maximum demand, and for only one or two hours a day, using gas in basements, kitchens, and passages where light is needed for long hours, the very lights needed most by electricians to level up the hours of supply. It was evident that such lights could only be obtained if a reduced price were charged. But what is to be a fair charge? The late Dr. Hopkinson advocated a scheme that came very nearly to perfection in its idea; it was based on the fact that the

* Paper read before the British Association at Bradford.

Digitized by Google

cost of supplying each individual as regards capital outlay is proportional to his maximum demand for electricity, even though that maximum demand were only for a few minutes on one day in the year; this, therefore, should be taken as a basis for charging for the supply of current. It was further premised that unless a consumer used an amount of electricity equal to what he would have consumed were his maximum number of lamps burning for one hour per day, the supply authority could not be recouped at the statutory rate for their capital outlay and standing charges. Finally, when the consumer had received an amount of electricity equal to the above amount, he might be considered to have paid his share of interest on capital, and should be allowed to have his further supply at little more than the bare cost of production. To put this scheme into practice it is necessary to measure two quantities—the total amount of electricity used, and the maximum number of lamps or their equivalent ever lighted at one time. This system has been at work for some years with marked success, but it has been necessary to use two separate meters—one to integrate the total number of units consumed, and the second to record the maximum demand. Both meters absorb energy from the supply, to the detriment of the light. In conjunction with Prof. Ewing, the author has invented a meter which will combine the functions of the previous two. The external appearance is shown, and next is the explanation given to the consumer. The construction of the combined meter is shown; actual meters are on the table, and photographs are given on the screen. The maximum-demand device can be attached to meters of the magnetic brake type, a prominent example of which is the meter sold by the Thomson-Houston Company, Limited.

The meter is essentially a motor and a magnetic brake. The latter consists of a copper disc revolving in a horizontal plane between the poles of two permanent magnets; the magnets set up eddy currents in the disc and produce a drag which is proportional to the speed of the rotation. In carrying out the invention this drag is made use of. The two magnets are supported on a beam and suspended in such a manner that they tend to follow the rotation of the disc; a section of the suspension is shown. A steel wire enclosed within a tube is fixed at its upper end to a screw; at its lower extremity it is secured to the beam itself. The torsion of the steel wire acts as a spring and controls the distance through which the suspended system moves. The spring or other controlling force is made comparatively strong in order that the motion of the magnet poles may be so small as not to affect the rate of the meter, and also in order that the period of oscillation of the suspended system may be short. When a sudden increase takes place in the demand for current, and consequently in the rate of supply, the magnetic brake would tend to swing beyond the position proper to the new rate of supply if its period of oscillation were not short in relation to the time taken by the revolving parts of the meter to acquire their new velocity. This tendency is obviated by making the period of oscillation of the brake sufficiently short in relation to the time during which the disc is undergoing acceleration when the current is suddenly applied or suddenly increased. Further advantages of the strong controlling force, and consequently small movement of the brake, are that the brake may be pivoted eccentrically to the disc without causing its motion to affect the rate of the meter, and also that there is no necessity for the use of a dashpot or similar arrangement to check the oscillations, although such means may be used if desired. Again, the small motion of the brake assists in preventing disturbance of the indications through the direct effect of the motor coils in cases where continuous currents are used and the field of the motor is produced by currents in coils. The motion of the brake is multiplied and actuates the indicator as shown. A light ratchet and pawl is fixed at one end of the beam and retains the system at its point of maximum deflection. A lever with a sealing device passes through the outside of the case, and enables the meter inspector to reset the indicator at the end of each quarter or half year, as the case may be. In meters for measuring supply by continuous currents, care must be taken to arrange the magnetic brake so that the electric currents in the meter do not directly tend to displace it. For this purpose it is preferable to invert one of the two magnets forming the brake so that the pair shall constitute an astatic or nearly astatic system. When this is done, it may in some cases occur that the stray field from the magnets constituting the brake affects the field of the motor, and consequently disturbs the rate of the meter. This may be compensated for by several devices, such as introducing a separate compensating magnet to balance on the motor armature the field produced by the magnets of the brake, or using a shunt field coil in the motor for the same purpose. The scales for all sizes of meters are made the same, and the readings follow a straight-line law; the adjustment for rate is shown. The divisions of the scale are given in percentages of full load of the meter, and a table is fixed to the front of each case, giving at a glance the maximum demand corresponding to any reading, as well as the number of units which must be consumed before the lower rate is charged.

Next there is shown a meter adapted for use on a switchboard. It integrates the amount of current which has passed through any feeder or from any dynamo, and informs the attendant the quantity passing through at any moment, obviating the use of an ammeter, more properly speaking, a wattmeter. It differs from the ordinary meter, inasmuch as it has no ratchet and pawl, and is free to return to its zero position on the stoppage of current through the instrument.

There are many advantages claimed for this form of demand indicator: (*a*) it combines in one instrument the dual function of integrating and of recording the maximum demand; (*b*) as an indicator it absorbs no energy from the supply; (*c*) it contains no liquid or injurious acid; (*d*) it is not affected by any ordinary short-circuit; (*e*) it records alternating or direct current (in the case of alternating current it records true watts and not apparent watts, an important item in respect of supply to motors and arc lamps); (*f*) it is extremely accurate (a curve at varying loads is shown).

Mr. Reginald P. Wilson, of 66, Victoria-street, some few years ago devised a maximum-demand indicator embodying the same principle. A model of his meter is shown, and a diagram giving the working of the same. The difficulty in this form was that the swing of the suspended system was sufficient to carry the pointer beyond its correct reading if a larger amount of current than a very small fraction of its full load were switched on at any one time, and the meter was never in commercial use. The inventors of the Barker and Ewing meter were unaware of Wilson's patent until their own was in its final form. They have, however, acquired this patent.

ADDENDUM.

The following is a copy of the circular sent out with all meters fixed on consumers' premises by the Cambridge Electric Supply Company:

"*Explanation to Consumers.*

"The meter records on four small dials the total number of units of electricity consumed, in the same manner as a gasmeter. The indicating pointer shows on a scale the greatest rate at which electricity has been supplied corresponding to the largest number of lamps which have been lighted at once. The company calls this latter the maximum demand. If this largest number of lamps had been burning for one hour every day during the six months, they would have consumed a certain number of units, and for that number of units, or for any less number of units which may have been consumed, the company charges full price per unit. If the consumer has used a greater number of units, he is charged a lower rate for all the units used over and above the number which would have been used had the largest number of lamps lighted at one time burned for one hour every day during the six months."

Sick Clubs.—The whole of the men in the electric light department of the Eastbourne Town Council have been informed that unless they join the Corporation sick club they will not be entitled to any sick pay.

Digitized by Google

A NEW FORM OF CALORIMETER FOR MEASURING THE WETNESS OF STEAM.*

BY PROF. JOHN GOODMAN, M.I.C.E.

It is no uncommon thing at the present day for purchasers of steam-engines to specify the steam consumption per horse-power hour, and to add penalty clauses for a higher consumption than that specified, but it is quite impossible to accurately measure the *steam* consumption of the engine unless the amount of moisture in it be known. If the moisture be neglected, the makers of the engine run a great risk of being unduly penalised. Some Continental steam-engine makers who have a high reputation for economy in steam consumption owe an appreciable amount of that reputation to the fact that they always specify the steam consumption in terms of an equivalent amount of "dry steam," and British makers have, in some instances, lost orders through not appreciating this point, their engines giving practically the same result as the Continental engines when compared on the "dry steam" basis, but they do not show up to advantage when the results of the British engine are expressed as so many pounds of steam—probably wet—per horse-power hour, while the results of the Continental engine are reduced to pounds of "dry steam" per horse-power hour. With certain types of boilers which are not forced, and which are provided with well-clothed steam-pipes, the amount of moisture may not exceed 2 or 3 per cent.; but in very many instances the steam that reaches the engine is far wetter than this. Some types of boilers are greatly puffed by their makers for their apparent economy in evaporation, but their reputation is based on certain tests which have simply shown that a large weight of water has passed through the boiler per pound of fuel consumed. The water has been assumed to be all evaporated, but if the wetness of the steam had been measured a very different tale would have to be told, because much of the water leaves the boiler as priming water, and not as steam. The necessity of measuring the wetness of the steam may therefore be great in cases in which it is important to know accurately what a given engine or boiler is doing as regards steam.

The two most common methods in use which have any pretence to accuracy of measuring the wetness of steam are by (1) the throttling or wire-drawing calorimeter, in which the wetness is indirectly obtained by measuring the quantity of heat required to superheat the steam; (2) the continuous condensing calorimeter, in which a known weight of steam is mixed with a known weight of cold water, the wetness being calculated from the resulting temperature of the mixture.

The first-mentioned—viz., the wire-drawing calorimeter—has recently received a rude shock, which almost places it out of the field, for with this type of instrument the all-important factor—viz., the specific heat of superheated steam—was, until recently, assumed to be constant—viz., 0·48; but the recent experiments of Mr. Grindley, of Manchester, have shown that it is not even approximately constant: it varies from 0·4 to 0·68, and, unfortunately for users of wire-drawing calorimeters, it does not follow any simple or even any ascertained definite law. Thus, wetness determinations by such an instrument may be very misleading.

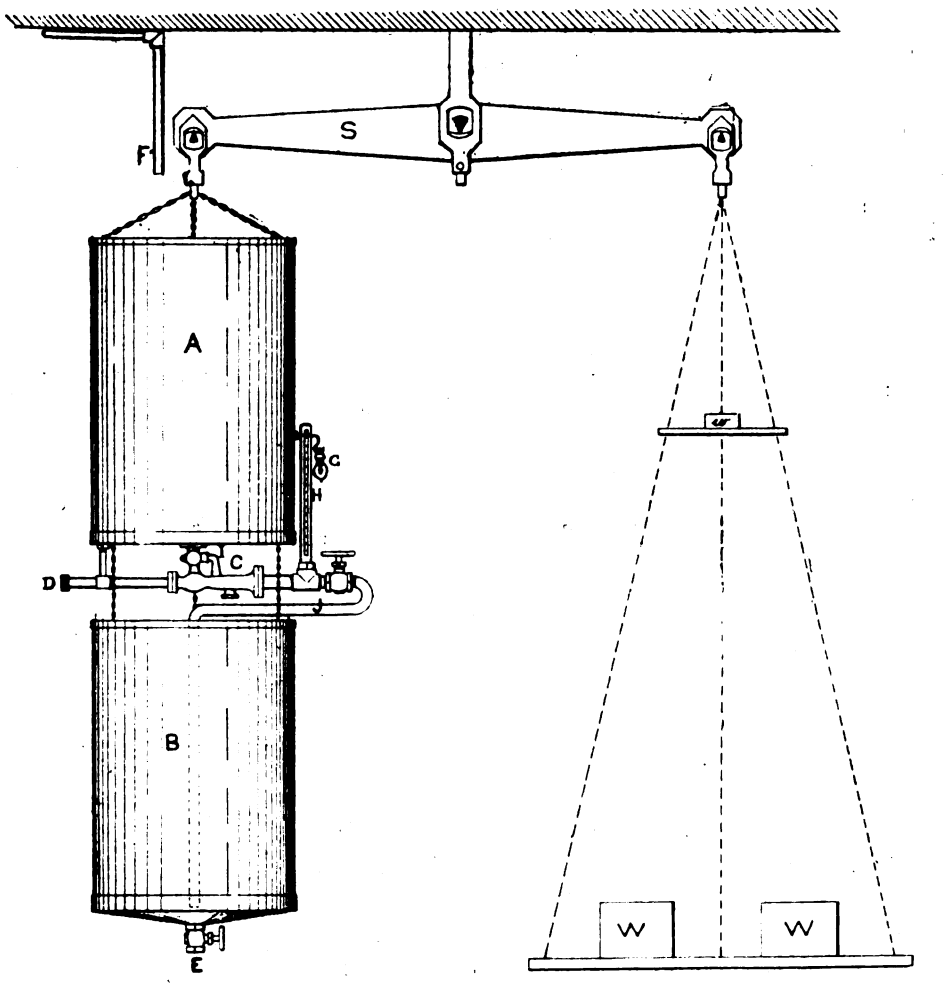


FIG. 1.

Several continuous condensing calorimeters have been used with success, but they are generally cumbersome and expensive, because they require two exceptionally good weighing machines. In the new form of instrument designed by the author, the weighing is done on one scale beam, thus making the instrument much more portable, cheaper, and more accurate, because a smaller difference in weight can be detected than in the case of instruments which depend on weighing machines. It consists of a scale beam, S, about 3ft. 6in. in length (Fig. 1), which will turn with $\frac{1}{100}$th of a pound when weighing 120lb. Two cylindrical tanks, A and B, 16in. diameter and 24in. high, are suspended by three light chains from the scale-beam

* Paper read before the British Association at Bradford.

Digitized by Google

hook. A small mixing injector, C, is attached to the bottom of the tank, A, through which the cold water from the top tank passes, and is there mixed with the steam, which is supplied by a removable flexible steam-pipe attached at D, which is thoroughly clothed for convenience in handling and for preventing radiation. The mixed steam and water pass a thermometer, H, with a naked bulb, on its way through the pipe, J, to the lower tank, B. An outlet cock, E, enables the lower tank, B, to be emptied at will. The bottom of this tank should be dished, in order to allow the water to drain out. A double scale pan is suspended from the other end of the scale beam; the small upper one is for steam weights and the lower one for water weights. The object of using the two pans is to prevent mistakes when weighing the two quantities separately.

The method of using the instrument is as follows: The tank A is filled with water from a pipe, F, until it just counterbalances the weight, W_1, in the large scale pan—usually two standard 56lb. weights. The temperature, t_1, of the water in A is then measured to the nearest one-tenth of a degree by a Kew certified thermometer. For very accurate tests it is better to allow the water to remain in A for some time before it is used in order to allow it to reach approximately the temperature of the room, or, if necessary, some warm water may be mixed with the cold for the same purpose. This precaution is for the sake of avoiding errors due to conduction and radiation. The incandescent lamp, G, is then suspended from a hook provided for the purpose, to enable the thermometer, H, to be seen clearly. The steam-pipe, D, after thoroughly blowing through, is then coupled up, and at a given signal both the steam-supply valve and the water-cock, I, on the injector are opened; the water from the tank A then runs into the injector and mixes with the steam; the mixture is delivered through the pipe, J, to the bottom of the tank B. The instant the above-mentioned valves are opened, an observer begins to take readings of the outlet temperature at H at every 10 or 15 seconds. For this purpose a centre-seconds watch is hung from a hook close to the thermometer. The experiment is continued until the tank A is nearly empty, which usually takes about five minutes. Then at a given signal both the steam and water valves are shut off at the same instant, the flexible steam-pipe is uncoupled, and the incandescent lamp removed. The whole apparatus is again balanced up by placing small weights, w, on the top scale pan, which represent the weight of steam that has been mixed with the water. They are left in position, and the tank B is emptied by means of the cock, E. When all the water has drained out, the apparatus is balanced up for the third time by the weights, W_2, on the large scale pan. The weight of the water which has been mixed with the steam is then $W = W_1 - W_2$.

The steam pressure having been noted during the test, we now have all the data we need for calculating the "dryness fraction," x, of the steam. If L be the latent heat of the steam, and t its temperature, and t_2 the mean outlet temperature as obtained from the thermometer, H, we have

$$(x\,L + t - t_2)\,w = W\,(t_2 - t_1),$$

whence

$$x = \frac{\frac{W}{w}(t_2 - t_1) + t_2 - t}{L}.$$

The possible sources of error in an instrument of this type are:

1. *Errors in Weighing the Quantities of Steam and Water.*—With care these need not exceed $\frac{1}{100}$th of a pound, or about 0·1 per cent. in the quality of the steam.

2. *Errors in Measuring the Temperature of the Water.*—The thermometers can be read to within one-tenth of a degree, and if the errors in reading be not greater than that, it will produce an error of about 0·13 per cent. in the final result. There is no difficulty in getting the initial temperature to this degree of accuracy, but the final or outlet temperature is not so certain, because it is very difficult to get a true reading at the instant of starting, as it takes a few seconds to get a steady flow from the injector. The error, however, cannot be serious, because there is only one uncertain reading out of about 30. It is for the sake of minimising this error that readings of the outlet thermometer are taken every 10 or 15 seconds. The mean of all the readings are taken as the t_2 in the formula given above. A rough check on the outlet temperature is obtained by taking the temperature in the bottom tank, B; it is too low on account of radiation and due to the water imparting some of its heat to the tank itself. The difference between the two methods, after the tank has got warmed up by the first experiment, varies from 0·6deg. to 1·0deg. F. If it be much more than that, it is a sure sign that some mistake has occurred in reading the thermometer, H. The object of placing the thermometer, H, close to the injector is to avoid radiation errors.

3. *Error in Measuring the Steam Pressure.*—This, of course, may be reduced to any extent we please by using a good form of pressure gauge. The final result will be in error to the extent of about 0·25 per cent. if the pressure be incorrectly obtained to the extent of 5lb. per square inch. The pressure gauge should preferably be placed in direct communication with the steam-pipe itself, rather than trust to the boiler pressure gauge.

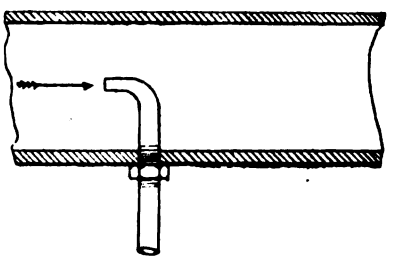


FIG. 2.

4. *Errors Due to Getting an Unfair Sample of Steam from the Steam-Pipe.*—It is believed that the above-mentioned errors of observation and of the instrument itself are very small and negligible as compared with the possible errors of sampling. There is a great difference of opinion as to how the steam should be sampled. Some take it by means of a bent nozzle (Fig. 2) facing the flowing steam, and made with such an area of opening that the speed of flow of the steam through it shall be equal to that of the steam in the main pipe from which the sample is taken. Others, however, prefer a horizontal perforated pipe passing diametrically across a horizontal main steam-pipe (Fig. 3). The author ventures to think that both are defective, because they make no attempt to catch the priming water, which necessarily runs along the bottom of a horizontal steam-pipe. It is evident that both of the above-mentioned methods of sampling only catch that moisture which exists in the steam as "Scotch mist" or fine rain. It is considered that a vertical perforated pipe (Fig. 4) passing upwards through the bottom of the pipe gives a far fairer sample. Care should be taken to have one hole so arranged that priming water running along the bottom of the pipe will be caught by the sampling pipe. It is practically impossible, however, to ensure a fair sample by means of a sampling pipe, and whichever method one adopts, it is largely a matter of opinion as to whether it is an approximately fair sample or not.

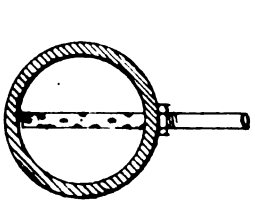


FIG. 3.

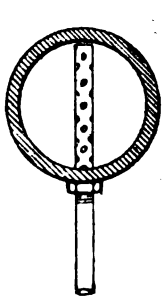


FIG. 4.

The following instance of a test may be of interest. Some stationary boilers were under test, and were known to be priming very seriously, because the engine-driver was obliged to keep his cylinder drain-cocks full open during the whole of the time he was running, although the steam-pipes were clothed and were not abnormally

Digitized by Google

long. A further proof that the steam was very wet was that water dripped, almost ran, out of every joint along the steam-pipe; no steam escaped, hence one cannot say that the joints were seriously at fault. Three sampling pipes were put in for testing the steam. In one case the sample was taken by a vertical sampling pipe at the low end of a nearly horizontal length of pipe near the steam-chest. The moisture present was over 40 per cent. Another vertical sampling pipe was put in a horizontal length of steam-pipe close to the boilers. The quantity of moisture was found to be 19 per cent.; a horizontal sampling pipe close to the last-named gave 2 per cent. The difference was, of course, due to the priming water not being caught at all in the horizontal sampling pipe. The very abnormal result obtained near the engine was probably due to water collecting in the main just where the sampling pipe was inserted. The instrument, weights, and thermometers were checked the next day and found to be correct; the instrument was also checked by coupling it up to a steam-pipe in the college, in which the wetness is known with a fair degree of accuracy from constant tests made whenever an engine trial is made. The author is of the opinion that steam calorimeters may be checked for accuracy by taking a sample of steam from a vertical steam-pipe immediately over a boiler from which no steam is flowing beyond that required for the sample. Such steam is certainly dry, and therefore the instrument should show $x = 1$.

The instrument described is not protected in any way, and the author will be glad to give the benefit of his experience to anyone contemplating the making of a similar instrument.

THE BRITISH ASSOCIATION.

Address to the Mathematical and Physical Section

BY JOSEPH LARMOR, M.A., D.SC., F.R.S., PRES.C P.S.,
PRESIDENT OF THE SECTION.

It is fitting that before entering upon the business of the section we should pause to take note of the losses which our department of science has recently sustained. The fame of Bertrand, apart from his official position as secretary of the French Academy of Sciences, was long ago universally established by his classical treatise on the infinitesimal calculus: it has been of late years sustained by the luminous exposition and searching criticism of his books on the theory of probability and thermodynamics and electricity. The debt which we owe to that other veteran, G. Wiedemann, both on account of his own researches, which take us back to the modern revival of experimental physics, and for his great and indispensable thesaurus of the science of electricity, cannot easily be overstated. By the death of Sophus Lie, following soon after his return to a chair in his native country Norway, we have lost one of the great constructive mathematicians of the century, who has in various directions fundamentally expanded the methods and conceptions of analysis by reverting to the fountain of direct geometrical intuition. In Italy the death of Beltrami has removed an investigator whose influence has been equally marked on the theories of transcendental geometry and on the progress of mathematical physics. In our own country we have lost in D. E. Hughes one of the great scientific inventors of the age; while we specially deplore the removal, in his early prime, of one who has recently been well known at these meetings, Thomas Preston, whose experimental investigations on the relations between magnetism and light, combined with his great powers of lucid exposition, marked out for him a brilliant future.

Perhaps the most important event of general scientific interest during the past year has been the definite undertaking of the great task of the international co-ordination of scientific literature; and it may be in some measure in the prolonged conferences that were necessitated by that object that the recently announced international federation of scientific academies has had its origin. In the important task of rendering accessible the stores of scientific knowledge, the British Association, and in particular this section of it, has played the part of pioneer. Our annual volumes have long been classical, through the splendid reports of the progress of the different branches of knowledge that have been from time to time contributed to them by the foremost British men of science; and our work in this direction has received the compliment of successful imitation by the sister associations on the Continent.

The usual conferences connected with our department of scientific activity have been this year notably augmented by the very successful international congresses of mathematicians and of physicists which met a few weeks ago in Paris. The three volumes of reports on the progress of physical science during the last 10 years, for which we are indebted to the initiative of the French Physical Society, will provide an admirable conspectus of the present trend of activity, and form a permanent record for the history of our subject.

Another very powerful auxiliary to progress is now being rapidly provided by the republication, in suitable form and within reasonable time, of the collected works of the masters of our science. We have quite recently received, in a large quarto volume, the mass of most important unpublished work that was left behind him by the late Prof. J. C. Adams; the zealous care of Prof. Sampson has worked up into order the more purely astronomical part of the volume; while the great undertaking, spread over many years, of the complete determination of the secular change of the magnetic condition of the earth, for which the practical preparations had been set on foot by Gauss himself, has been prepared for the press by Prof. W. G. Adams. By the publication of the first volume of Lord Rayleigh's papers a series of memoirs which have formed a main stimulus to the progress of mathematical physics in this country during the past 20 years has become generally accessible. The completed series will form a landmark for the end of the century that may be compared with Young's "Lectures on Natural Philosophy" for its beginning.

The recent reconstruction of the University of London, and the foundation of the University of Birmingham, will, it is to be hoped, give greater freedom to the work of our university colleges. The system of examinations has formed an admirable stimulus to the effective acquisition of that general knowledge which is a necessary part of all education. So long as the examiner recognises that his function is a responsible and influential one, which is to be taken seriously from the point of view of moulding the teaching in places where external guidance is helpful, test by examination will remain a most valuable means of extending the area of higher education. Except for workers in rapidly progressive branches of technical science, a broad education seems better adapted to the purposes of life than special training over a narrow range; and it is difficult to see how a reasonably elastic examination test can be considered as a hardship. But the case is changed when preparation for a specialised scientific profession, or mastery of the lines of attack in an unsolved problem, is the object. The general education has then been presumably finished; in expanding departments of knowledge, variety rather than uniformity of training should be the aim, and the genius of a great teacher should be allowed free play without external trammels. It would appear that in this country we have recently been liable to unduly mix up two methods. We have been starting students on the special and lengthy, though very instructive, processes which are known as original research at an age when their time would be more profitably employed in rapidly acquiring a broad basis of knowledge. As a result, we have been extending the examination test from the general knowledge to which it is admirably suited into the specialised activity which is best left to the stimulus of personal interest. Informal contact with competent advisers, themselves imbued with the scientific spirit, who can point the way towards direct appreciation of the works of the masters of the science, is far more effective than detailed instruction at second hand, as regards growing subjects that have not yet taken on an authoritative form of exposition. Fortunately, there seems to be now no lack of such teachers to meet the requirements of the technical colleges that are being established throughout the country.

The famous treatise which opened the modern era by treating magnetism and electricity on a scientific basis appeared just 300 years ago. The author, William Gilbert, M.D., of Colchester, passed from the grammar school of his native town to St. John's College, Cambridge; soon after taking his first degree, in 1560, he become a Fellow of the college, and seems to have remained in residence and taken part in its affairs for about 10 years. All through his subsequent career, both at Colchester and afterwards at London, where he attained the highest position in his profession, he was an exact and diligent explorer, first of chemical and then of magnetic and electric phenomena. In the words of the historian Hallam, writing in 1839, "in his Latin treatise on the magnet he not only collected all the knowledge which others had possessed, but he became at once the father of experimental philosophy in this island," and no demur would be raised if Hallam's restriction to this country were removed. Working nearly a century before the time when the astronomical discoveries of Newton had originated the idea of attraction at a distance, he established a complete formulation of the interaction of magnets by what we now call the exploration of their fields of force. His analysis of the facts of magnetic influence, and incidentally of the points in which it differs from electric influence, is virtually the one which Faraday reintroduced. A cardinal advance was achieved at a time when the Copernican astronomy had still largely to make

Digitized by Google

its way, by assigning the behaviour of the compass and the dip needle to the fact that the earth itself is a great magnet, by whose field of influence they are controlled. His book passed through many editions on the Continent within 40 years; it won the high praise of Galileo. Gilbert has been called "the father of modern electricity" by Priestley, and the "Galileo of magnetism" by Poggendorff.

When the British Association last met at Bradford in 1873, the modern theory which largely reverts to Gilbert's way of formulation, and refers electric and magnetic phenomena to the activity of the æther instead of attractions at a distance, was of recent growth: it had received its classical exposition only two years before by the publication of Clerk Maxwell's treatise. The new doctrine was already widely received in England on its own independent merits. On the Continent it was engaging the strenuous attention of Helmholtz, whose series of memoirs, deeply probing the new ideas in their relation to the prevalent and fairly successful theories of direct action across space, had begun to appear in 1870. During many years the search for crucial experiments that would go beyond the results equally explained by both views met with small success; it was not until 1887 that Hertz, by the discovery of the æthereal radiation of long wave-length emitted from electric oscillators, verified the hypothesis of Faraday and Maxwell, and initiated a new era in the practical development of physical science. The experimental field thus opened up was soon fully occupied both in this country and abroad; and the borderland between the sciences of optics and electricity is now being rapidly explored. The extension of experimental knowledge was simultaneous with increased attention to directness of explanation; the expositions of Heaviside and Hertz and other writers fixed attention, in a manner already briefly exemplified by Maxwell himself, on the inherent simplicity of the completed æthereal scheme, when once the theoretical scaffolding employed in its construction and dynamical consolidation is removed; while Poynting's beautiful corollary specifying the path of the transmission of energy through the æther has brought the theory into simple relations with the applications of electro-dynamics.

Equally striking has been the great mastery obtained during the last 20 years over the practical manipulation of electric power. The installation of electric wires as the nerves connecting different regions of the earth had attained the rank of accomplished fact so long ago as 1857, when the first Atlantic cable was laid. It was largely the theoretical and practical difficulties, many of them unforeseen, encountered in carrying that great undertaking to a successful issue that necessitated the elaboration by Lord Kelvin and his coadjutors of convenient methods and instruments for the exact measurement of electric quantities, and thus prepared the foundation for the more recent practical developments in other directions. On the other hand, the methods of theoretical explanation have been in turn improved and simplified through the new ways of considering the phenomena which have been evolved in the course of practical advances on a large scale, such as the improvement of dynamo armatures, the conception and utilisation of magnetic circuits, and the transmission of power by alternating currents. In our time the relations of civilised life have been already perhaps more profoundly altered than ever before, owing to the establishment of practically instantaneous electric communication between all parts of the world. The employment of the same subtle agency is now rapidly superseding the artificial reciprocating engines and other contrivances for the manipulation of mechanical power that were introduced with the employment of steam. The possibilities of transmitting power to great distances at enormous tension, and therefore with very slight waste, along lines merely suspended in the air, are being practically realised; and the advantages thence derived are increased manifold by the almost automatic manner in which the electric power can be transformed into mechanical rotation at the very point where it is desired to apply it. The energy is transmitted at such lightning speed that at a given instant only an exceedingly minute portion of it is in actual transit. When the tension of the alternations is high, the amount of electricity that has to oscillate backwards and forwards on the guiding wires is proportionately diminished, and the frictional waste reduced. At the terminals the direct transmission from one armature of the motor to the other, across the intervening empty space, at once takes us beyond the province of the pushing and rubbing contacts that are unavoidable in mechanical transmission; while the perfect symmetry and reversibility of the arrangement by which power is delivered from a rotatory alternator at one end, guided by the wires to another place many miles away, where it is absorbed by another alternator with precise reversal of the initial stages, makes this process of distribution of energy resemble the automatic operations of nature rather than the imperfect material connections previously in use. We are here dealing primarily with the flawless continuous medium which is the transmitter of radiant energy across the celestial spaces; the part played by the coarsely constituted material conductor is only that of a more or less imperfect guide which directs the current of æthereal energy. The wonderful nature of this theoretically perfect, though of course practically only approximate, method of abolishing limitations of locality with regard to mechanical power is not diminished by the circumstance that its principle must have been in some manner present to the mind of the first person who fully realised the character of the reversibility of a Gramme armature.

In theoretical knowledge a new domain, to which the theory as expounded 20 years ago had little to say, has recently been acquired through the experimental scrutiny of the electric discharge in rarefied gaseous media. The very varied electric phenomena of vacuum tubes, whose electrolytic character was first practically established by Schuster, have been largely reduced to order through the employment of the high exhaustions introduced and first utilised by Crookes. Their study under these circumstances, in which the material molecules are so sparsely distributed as but rarely to interfere with each other, has conduced to enlarged knowledge and verification of the fundamental relations in which the individual molecules stand to all electric phenomena, culminating recently in the actual determination, by J. J. Thomson and others following in his track, of the masses and velocities of the particles that carry the electric discharge across the exhausted space. The recent investigations of the circumstances of the electric dissociation produced in the atmosphere and in other gases by ultra-violet light, the Röntgen radiation, and other agencies, constitute one of the most striking developments in experimental molecular physics since Graham determined the molecular relations of gaseous diffusion and transpiration more than half a century ago. This advance in experimental knowledge of molecular phenomena, assisted by the discovery of the precise and rational effect of magnetism on the spectrum, has brought into prominence a modification or rather development of Maxwell's exposition of electric theory, which was dictated primarily by the requirements of the abstract theory itself; the atoms or ions are now definitely introduced as the carriers of those electric charges which interact across the æther, and so produce the electric fields whose transformations were the main subject of the original theory.

We are thus inevitably led, in electric and æthereal theory, as in the chemistry and dynamics of the gaseous state, which is the department of abstract physics next in order of simplicity, to the consideration of the individual molecules of matter. The theoretical problems which had come clearly into view a quarter of a century ago, under Maxwell's lead, whether in the exact dynamical relations of æthereal transmission or in the more fortuitous domain of the statistics of interacting molecules, are those around which attention is still mainly concentrated; but as the result of the progress in each, they are now tending towards consolidation into one subject. I propose—leaving further review of the scientific aspect of the recent enormous development of the applications of physical science for hands more competent to deal with the practical side of that subject—to offer some remarks on the scope and validity of this molecular order of ideas, to which the trend of physical explanation and development is now setting in so pronounced a manner.

If it is necessary to offer an apology for detaining the attention of the section on so abstract a topic, I can plead its intrinsic philosophical importance. The hesitation so long felt on the Continent in regard to discarding the highly developed theories which analysed all physical actions into direct attractions between the separate elements of the bodies concerned, in favour of a new method in which our ideas are carried into regions deeper than the phenomena, has now given place to eager discussion of the potentialities of the new standpoint. There has even appeared a disposition to consider that the Newtonian dynamical principles, which have formed the basis of physical explanation for nearly two centuries, must be replaced in these deeper subjects by a method of direct description of the mere course of phenomena, apart from any attempt to establish causal relations; the initiation of this method being traced, like that of the Newtonian dynamics itself, to this country. The question has arisen as to how far the new methods of æthereal physics are to be considered as an independent departure, how far they form the natural development of existing dynamical science. In England, whence the innovation came, it is the more conservative position that has all along been occupied. Maxwell was himself trained in the school of physics established in this country by Sir George Stokes and Lord Kelvin, in which the dominating idea has been that of the strictly dynamical foundation of all physical action. Although the pupil's imagination bridged over dynamical chasms, across which the master was not always able to follow, yet the most striking feature of Maxwell's scheme was still the dynamical framework into which it was built. The more advanced reformers have now thrown overboard the apparatus of potential functions which Maxwell found necessary for the dynamical consolidation of his theory, retaining only the final result as a verified descriptive basis for the phenomena. In this way all difficulties relating to dynamical development and, indeed, consistency are avoided, but the question remains as to how much is thereby lost. In practical electromagnetics the transmission of power is now the most prominent phenomenon;

Digitized by Google

if formal dynamics is put aside in the general theory, its guidance must here be replaced by some more empirical and tentative method of describing the course of the transmission and transformation of mechanical energy in the system.

The direct recognition in some form, either explicitly or tacitly, of the part played by the æther has become indispensable to the development and exposition of general physics ever since the discoveries of Hertz left no further room for doubt that this physical scheme of Maxwell was not merely a brilliant speculation, but constituted, in spite of outstanding gaps and difficulties, a real formulation of the underlying unity in physical dynamics. The domain of abstract physics is, in fact, roughly divisible into two regions. In one of them we are mainly concerned with interactions between one portion of matter and another portion occupying a different position in space; such interactions have very uniform and comparatively simple relations; and the reason is traceable to the simple and uniform constitution of the intervening medium in which they have their seat. The other province is that in which the distribution of the material molecules comes into account. Setting aside the ordinary dynamics of matter in bulk, which is founded on the uniformity of the properties of the bodies concerned and their experimental determination, we must assign to this region all phenomena which are concerned with the uncoordinated motions of the molecules, including the range of thermal and in part of radiant actions; the only possible basis for detailed theory is the statistical dynamics of the distribution of the molecules. The far more deep-seated and mysterious processes which are involved in changes in the constitution of the individual molecules themselves are mainly outside the province of physics, which is competent to reason only about permanent material systems; they must be left to the sciences of chemistry and physiology. Yet the chemist proclaims that he can determine only the results of his reactions and the physical conditions under which they occur; the character of the bonds which hold atoms in their chemical combinations is at present unknown, although a large domain of very precise knowledge relating, in some diagrammatic manner, to the topography of the more complex molecules has been attained. The vast structure which chemical science has in this way raised on the narrow foundation of the atomic theory is, perhaps, the most wonderful existing illustration both of the rationality of natural processes and of the analytical powers of the human mind. In a word, the complication of the material world is referable to the vast range of structure and of states of aggregation in the material atoms; while the possibility of a science of physics is largely due to the simplicity of constitution of the universal medium through which the individual atoms interact on each other.

The reference of the uniformity in the interactions at a distance between material bodies to the part played by the æther is a step towards the elimination of extraneous and random hypotheses about laws of attraction between atoms. It also places that medium on a different basis from matter, in that its mode of activity is simple and regular, whereas intimate material interactions must be of illimitable complexity. This gives strong ground for the view that we should not be tempted towards explaining the simple group of relations which have been found to define the activity of the æther by treating them as mechanical consequences of concealed structure in that medium; we should rather rest satisfied with having attained to their exact dynamical correlation, just as geometry explores or correlates, without explaining, the descriptive and metric properties of space. On the other hand, a view is upheld which considers the pressures and thrusts of the engineer, and the strains and stresses in the material structures by which he transmits them from one place to another, to be the archetype of the processes by which all mechanical effect is transmitted in nature. This doctrine implies an expectation that we may ultimately discover something analogous to structure in the celestial spaces, by means of which the transmission of physical effect will be brought into line with the transmission of mechanical effect by material framework.

At a time when the only definitely ascertained function of the ether was the undulatory propagation of radiant energy across space, Lord Kelvin pointed out that, by reason of the very great velocity of propagation, the density of the radiant energy in the medium at any place must be extremely small in comparison with the amount of energy that is transmitted in a second of time. This easily led him to the very striking conclusion that, on the hypothesis that the æther is like material elastic media, it is not necessary to assume its density to be more than 10^{-18} of that of water, or its optical rigidity to be more than $10\ 10^{-8}$ of that of steel or glass. Thus far the æther would be merely an impalpable material atmosphere for the transference of energy by radiation, at extremely small densities, but with very great speed, while ordinary matter would be the seat of practically all this energy. But this way of explaining the absence of sensible influence of the æther on the phenomena of material dynamics lost much of its basis as soon as it was recognised that the same medium must be the receptacle of very high densities of energy in the electric fields around currents and magnets. (We can here only allude to Lord Kelvin's recent most interesting mechanical illustrations of a solid æther interacting with material molecules and with itself by attraction at a distance: unlike the generalised dynamical methods expounded in the text, which can leave the intimate structure of the material molecule outside the problem, a definite working constitution is there assigned to the molecular nucleus. It is pointed out in a continuation that is to appear in the *Phil. Mag.* for September that a density of æther of the order of only 10^{-9}, which would not appreciably affect the inertia of matter, would involve rigidity comparable with that of steel, and thus permit transmission of magnetic forces by stress. This solid æther is, however, as usual, taken to be freely permeable to the molecules of matter.) The other mode of explanation is to consider the æther to be of the very essence of all physical actions, and to correlate the absence of obvious mechanical evidence of its intervention with its regularity and universality.

On this plan of making the æther the essential factor in the transformation of energy as well as its transmission across spaces, the material atom must be some kind of permanent nucleus that retains around itself an æthereal field of physical influence, such as, for example, a field of strain. We can recognise the atom only through its interactions with other atoms that are so far away from it as to be practically independent systems; thus our direct knowledge of the atom will be confined to this field of force which belongs to it. Just as the exploration of the distant field of magnetic influence of a steel magnet, itself concealed from view, cannot tell us anything about the magnet except the amount and direction of its moment, so a practically complete knowledge of the field of physical influence of an atom might be expressible in terms of the numerical values of a limited number of physical moments associated with it without any revelation as to its essential structure or constitution being involved. This will at any rate be the case for ultimate atoms if, as is most likely, the distances at which they are kept apart are large compared with the diameters of the atomic nuclei; it, in fact, forms our only chance for penetrating to definite dynamical views of molecular structure. So long as we cannot isolate a single molecule, but must deal observationally with an innumerable distribution of them, even this kind of knowledge will be largely confined to average values. But the last half century has witnessed the successful application of a new instrument of research, which has removed in various directions the limitations that had previously been placed on the knowledge to which it was possible for human effort to look forward. The spectroscope has created a new astronomy by revealing the constitutions and the unseen internal motions of the stars. Its power lies in the fact that it does take hold of the internal relations of the individual molecule of matter, and provide a very definite and detailed, though far from complete, analysis of the vibratory motions that are going on in it; these vibrations being in their normal state characteristic of its dynamical constitution, and in their deviations from the normal giving indications of the velocity of its movement and the physical state of its environment. Maxwell long ago laid emphasis on the fact that a physical atomic theory is not competent even to contemplate the vast mass of potentialities and correlations of the past and the future, that biological theory has to consider as latent in a single organic germ containing at most only a few million molecules. On our present view we can accept his position that the properties of such a body cannot be those of a "purely material system," provided, however, we restrict this phase to apply to physical properties as here defined. But an exhaustive discovery of the intimate nature of the atom is beyond the scope of physics; questions as to whether it must not necessarily involve in itself some image of the complexity of the organic structures of which it can form a correlated part must remain a subject of speculation outside the domain of that science. It might be held that this conception of discrete atoms and continuous æther really stands, like those of space and time, in intimate relation with our modes of mental apprehension, into which any consistent picture of the external world must of necessity be fitted. In any case it would involve abandonment of all the successful traditions of our subject if we ceased to hold that our analysis can be formulated in a consistent and complete manner, so far as it goes, without being necessarily an exhaustive account of phenomena that are beyond our range of experiment. Such phenomena may be more closely defined as those connected with the processes of intimate combination of the molecules: they include the activities of organic beings which all seem to depend on change of molecular structure.

(To be continued.)

Correction.—In the first part of the description of Sunderland's new electric tramways, which appeared in our issue of the 31st ult., the British Thomson-Houston Company were inadvertently mentioned as the contractors for the overhead equipment of the lines. Later on in the article, however, due credit was given to Messrs. Dick, Kerr, and Co. for the whole of this section of the work. It may be mentioned that Messrs. Dick, Kerr, and Co. also supplied the cars, which were built and fully equipped at Preston.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	325	Correspondence	343
Taunton Electricity Works,	330	St. Pancras	346
A Combination Integrating Wattmeter and Maximum-Demand Indicator	335	On the Effects of Strain on the Thermo-Electric Qualities of Metals.—Part II.	349
A New Form of Calorimeter for Measuring the Wetness of Steam	337	Questions and Answers	350
The British Association: Address to the Mathematical and Physical Section	339	Companies' Meetings and Reports	353
The Design of Railway Carriages	342	Contracts for Electrical Supplies	353
The Bradford Meeting of the British Association	343	Traction Notes	355
International Association of Municipal Electricians	346	Lighting Notes	356
		Provisional Patents	359
		Specifications Accepted	360
		Traffic Returns	360
		Companies' Stock and Share List	360

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E C Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and not), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

THE DESIGN OF RAILWAY CARRIAGES.

An inspection of the designs of railway carriages which have been built in recent years for our various steam railways, discloses the fact that the main object kept in view is to provide accommodation for as large a number of passengers as possible in a given space. In consequence of this dominant idea being carried too far in certain cases, the passengers using the railway carriages in question have to undergo each day a large amount of personal inconvenience. For instance, carriages are to be found on a number of our suburban lines in which the space between the seats is not sufficient, so that the knees of passengers upon the opposite sides are almost always in contact. As a result, the operation of leaving a full carriage is one which demands the skill and strength of an athlete. When these are wanting, it is even doubtful if a robust passenger will ever succeed in getting out unless others on one side of the carriage first step out on to the platform. The railway companies using these carriages, of course, succeed in carrying rather more people per given length of train than they otherwise would do; they also succeed in delaying at every station the departure of the train beyond the time at which it should leave. In fact, the whole travelling population on that line are delayed a few minutes each morning and evening in order to save a few feet in the length of the train. This objection is not to be found on our great main-line trains, where the comfort of the passenger is considered. But here, again, the question of ingress and egress is not always considered as it should be. If one takes, for instance, the corridor carriages which are attached to certain well-known express trains, to which entrance can only be obtained from the ends of the carriage when the platform is on one side: when such a carriage gets to its destination this corridor is immediately blocked by porters trying to fight their way in and by porters and passengers trying to get out with luggage. As, however, the extra time taken to get the people out is not large compared with the time spent in the train, it is not such a serious matter as in the case of a train service where the length of time taken on a journey is seriously affected by the time the trains are waiting at intermediate stations. The question arises as to what is the best type of vehicle for lines such as the underground and the new electric railways which are being constructed in various parts of London. In looking into the question, it would be well to study the difference in the carriages on the Central London Railway and on the Metropolitan District Railway. This latter line has adopted throughout the old transverse compartments, which, having one door on each side, give a large number of points at which the passengers can leave or enter the train. With the carriages used on the Central London Railway, the platforms between two long carriages are the only points at which access can be obtained to the same. On each of these platforms an attendant is stationed, which involves more travelling servants than are employed on the District line. The result gained, however, is much superior. There is a good space on the platform between the carriages

Digitized by Google

to hold the passengers as they come on; and again, the design of the carriages themselves obviates the objections referred to above, both in the compartment and in the corridor types of carriages. In the carriages in the Central London Railway seating accommodation at either end is arranged in two rows along the sides of the carriage, so as to leave ample space between for people entering and leaving. The result is that when the train begins to slow up, those passengers who wish to get off naturally walk towards the end platform, and there is ample space for them to stand at the end of the carriage in the broad passage between those longitudinal row of seats. We have not at present reliable figures as to actual time saved by this construction of carriages and by the provision of a few well-controlled points of egress, as compared with the many doors (which all have to be closed by the guard) of the old compartment system. The impression, however, gained from journeys on the two lines is that the Central London trains do not stay more than half the time in the stations that the Metropolitan District ones do. Of course, the same consideration holds with regard to the driving of tramcars, but, owing to the more limited speed, the conditions for safeguarding the passengers are not so rigid. Our conclusion as a whole is that while electric traction can do much, as shown last week, to improve the communication between each of the great towns and their suburbs, the electrical engineer in designing his line must not be bound to the designs of rolling-stock which have been used for years with steam railways.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—In your correspondence column for last week there appears a letter under the above heading, concerning which I should be glad if you would permit me to say a few words. Your correspondent, Mr. Dunton, has in a most weak and uncalled-for attempt to show slipshod language in a certain text-book, fallen ignominiously himself into the very pit which he, in such a patronising way, would have others to carefully avoid. The paragraph to which he takes exception reads as follows: "When a conductor is mechanically moved in a field transversely to the lines of force traversing that field, a certain E.M.F. is determined which sets up a current in the wire if its two ends are connected." After quoting the above perfectly correct and properly worded statement, Mr. Dunton, in a roundabout manner, describes the case of a rectangular coil of wire having its plane parallel to a uniform magnetic field, and moving transversely across that field; and then, after asserting, what is most obviously true, that there will be no current generated in the coil under these conditions, he evidently thinks that he has proved his case.

The reason why there will be no current generated in the coil under the conditions referred to is, that in each of the two parallel wires of the rectangle which is cutting the lines of the uniform field, there is impressed an E.M.F. equal in amount and opposed to each other through the neutral sides of the rectangle. It is the equivalent, in fact, of putting two cells of equal E.M.F. in opposition to one another, and has nothing at all to do with the change in the number of lines passing through the coil, and of which, like the snakes in Ireland, there are none. The example in no way detracts from the statement quoted from Messrs. Slingo and Brooker's text-book, which no more implies or suggests that the wire connecting the ends of the conductor referred to should have an equal and opposite E.M.F. impressed on it than it implies that an opposing cell should be connected up in the circuit. Remembering that the so-called "lines of force" are simply graphical means of representing the direction or "grain" of the medium or state known as a magnetic field, it is evident that the E.M.F. impressed on a conductor, whether it be in the shape of a rectangle or not, is dependent on the density of that field and the rate at which the conductor cuts it at right angles to its direction. It is not only *slipshod*, but emphatically *wrong*, to say that "as long as the rectangle still faces north and south *there will be no E.M.F. whatever*, because there will be no change in the number of lines passing through it." An E.M.F. *is* impressed on the two vertical sides referred to, but being equal and opposite no current results. But suppose that one of the vertical sides was moving in a weaker field than the other, there would in this case still be no change in the number of lines passing through the coil, and yet a current depending upon the difference between the two impressed E.M.F.'s would result. Your correspondent has found a veritable "mare's nest."—Yours, etc.,

F. JOHNSTON.

Beechcroft, Holywood, co. Down, Sept. 2, 1900.

CORRECTION.

SIR,—In reference to the article, "Indian Electricity," in your issue of Aug. 31, p. 289, we should like to point out that, in conjunction with Messrs. Siemens, we are supplying three direct-coupled sets for the lighting at Simla. We think in this instance the insertion of Messrs. Willans's name is an error.—Yours, etc.,

JOHN BELLISS,
(For Belliss and Morcom, Limited).

THE BRADFORD MEETING OF THE BRITISH ASSOCIATION.

The meeting at Bradford of the British Association for the Advancement of Science was opened by the presidential address by Prof. Sir William Turner, M.B., D.C.L., LL.D., D.Sc., F.R.S., which was delivered on Wednesday evening last in the St. George's Hall before a most distinguished audience.

The PRESIDENT referred to the fact that it was 27 years since the British Association had met in Bradford. At the first meeting the town had not been raised to the dignity of a city. That meeting was a very successful one, and he hoped that the present one would be equally successful. At their last meeting in Bradford, a distinguished chemist, Prof. A. W. Williamson, had presided, while at the present meeting the association had elected him to the presidential chair, and his life work had been the study of biographical science. Sir William Turner proceeded to discuss the methods of studying such a subject. Thus Edward Gibbon had told us that diligence and accuracy are the only merits which an historical writer can ascribe to himself. While these were fundamental qualities necessary for historical research, they were even more necessary to scientific research. By the application of these qualities new facts were discovered and tabulated, and a wider and more intimate knowledge of the processes of nature was acquired. Besides diligence and accuracy, a well-balanced mind and the exercise of prolonged thought and reflection were needed to obtain the true significance of a series of connected facts and observations. The president referred to the qualifications of William Harvey for scientific research as a typical example. He proceeded to review the great improvements which had been made in this century in the means of observation, and compared the disadvantages under which experimenters laboured even in the year 1830. It was exceedingly difficult, for instance, for a biologist of the present day to realise the conditions under which his predecessors of only 50 years ago worked. The president then reviewed the cell theory, first introduced with respect to vegetable matter in

Digitized by Google

1831 by Robert Brown, and proceeded to discuss the structure of cells and their multiplication. The following portions of the address were devoted to the phenomena known as karyokinesis and to the consideration of cell plasm. This led Sir William Turner to the consideration of the functions of cells and of nerve cells, the consideration of which has occupied the attention of biologists greatly of recent years. In the concluding portions of the address the all-important subject of bacteria was discussed, the president concluding by some notes on the Darwinian theory. The address was concluded in the following words:

"We know not as regards time when the fiat went forth, 'Let there be life, and there was life.' All we can say is that it must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval. Prior to its genesis our earth consisted of barren rock and desolate ocean. When matter became endowed with life, with the capacity of self-maintenance and of resisting external disintegrating forces, the face of nature began to undergo a momentous change. Living organisms multiplied, the land became covered with vegetation, and multitudinous varieties of plants, from the humble fungus and moss to the stately palm and oak, beautified its surface, and fitted it to sustain higher kinds of living beings. Animal forms appeared, in the first instance simple in structure, to be followed by others more complex, until the mammalian type was produced. The ocean also became peopled with plant and animal organisms, from the microscopic diatom to the huge leviathan. Plants and animals acted and reacted on each other, on the atmosphere which surrounded them, and on the earth on which they dwelt, the surface of which became modified in character and aspect. At last man came into existence. His nerve energy, in addition to regulating the processes in his economy which he possesses in common with animals, was endowed with higher powers. When translated into psychical activity it has enabled him throughout the ages to progress from the condition of a rude savage to an advanced stage of civilisation; to produce works in literature, art, and the moral sciences which have exerted, and must continue to exert, a lasting influence on the development of his higher being; to make discoveries in physical science; to acquire a knowledge of the structure of the earth, of the ocean in its changing aspects, of the atmosphere and the stellar universe, of the chemical composition and physical properties of matter in its various forms, and to analyse, comprehend, and subdue the forces of nature. By the application of these discoveries to his own purposes man has, to a large extent, overcome time and space; he has studded the ocean with steamships, girdled the earth with the electric wire, tunnelled the lofty Alps, spanned the Forth with a bridge of steel, invented machines and founded industries of all kinds for the promotion of his own material welfare, elaborated systems of government fitted for the management of great communities, formulated economic principles, obtained an insight into the laws of health, the causes of infective diseases, and the means of controlling and preventing them. When we reflect that many of the most important discoveries in abstract science and in its applications have been made during the present century, and, indeed, since the British Association held its first meeting in the ancient capital of your county 69 years ago, we may look forward with confidence to the future. Every advance in science provides a fresh platform from which a new start can be made. The human intellect is still in process of evolution. The power of application and of concentration of thought for the elucidation of scientific problems is by no means exhausted. In science is no hereditary aristocracy. The army of workers is recruited from all classes. The natural ambition of even the private in the ranks to maintain and increase the reputation of the branch of knowledge which he cultivates affords an ample guarantee that the march of science is ever onwards, and justifies us in proclaiming for the next century, as in the one fast ebbing to a close, that great is science, and it will prevail."

On Thursday the various sections were opened by presidential addresses. We commence elsewhere in this issue the text of the presidential address delivered by Dr. J. Larmor, M.A., F.R.S., before the Mathematical and Physical Section.

The president this year in the Mechanical Section is Sir Alexander R. Binnie, and we are compelled by the limited space at our disposal to give only an abstract of his address.

Sir ALEXANDER BINNIE commented on the fact that many of his distinguished predecessors in the chair had devoted their address to the general progress of engineering knowledge, or to some particular parts of the same. He proposed, therefore, to consider how and under what circumstances the advancement made during the present century, or even during the Queen's reign, became possible, as civil engineers were accustomed to define their position as being "the art of directing the great sources of power in nature for the use and convenience of man." Consequently their success or otherwise will depend on the estimate they may form of nature as a whole, and of those great sources of power which it places at their disposal. Undoubtedly in the history of the world there has never been a period when the study of nature has been so open and free from all prejudices of any kind whatever, as it has been during the past century; nor, perhaps, with but few exceptions, has there ever been in any age or country a time when nature and her laws have been investigated with so pure and steadfast an aim after actual truth, without the mind being prejudiced by authority or preconceived ideas derived from those great departments of human thought which deal more particularly with matters of faith, morals, and religion. Sir Alexander Binnie proceeded to show that this equanimity of mind in which one could now approach scientific subjects had hardly been possible in the past. The inductive method of study could not, however, be attributed solely to Bacon, as in the teachings of Socrates and Aristotle there were continual references to the importance of enquiry, observation, and induction. The president also referred to the work of Hipparchus and Ptolemy, and to the splendid work done by the Alexandrian philosophers. Numerous quotations were given from various old writers to illustrate the president's points, and the author then skipped a few centuries and started his *résumé* again from the revival of learning. To illustrate the progress which has been made since then, he exhibited a chart extending from the time of Edward IV. to the present year. This chart contains an enormous amount of useful statistics, and gives in a clear form data which indicates the progress of science and the arts, as well as all those social events which mark the increase of civilisation. Through Sir Alexander Binnie's description of the chart and of the progress of the various arts we do not propose to go in detail, but must quote his remarks on the progress of electrical science. He attributed to Davy, Faraday, and Tyndall the birth of our electro-chemical ideas of the present day, while the progress of electrical science was associated with names commencing with William Gilbert, in the sixteenth century, and extending down to the discoveries of Hertz of the present day. He pointed out that from the time of Volta, Ampère, and Oersted the rapid progress which electrical science has made has been due in no small measure to the manner in which its experiments have been treated, on strictly mathematical lines, by the master minds of such men as Maxwell and Kelvin, until at last we arrive at the demonstration, long foretold, of the wave theory, which renders wireless telegraphy an accomplished fact. Light to the engineer has at all times been of supreme importance, and as we scan the names on the chart from Galileo, Descartes, Huyghens, Gregory, Newton, up to Roemer's discovery of its velocity, through Halley, Herschel, and the illustrious Thomas Young, who perfected the undulatory theory, until at last we eventually come to those mysterious Fraunhofer lines, noticed also by Wollaston, and which were interpreted by Bunsen and Kirchhoff in 1860, since which period they have been applied as an aid to chemistry in the analyses of terrestrial and celestial bodies. In the theory of heat we have the experiments of Cavendish and Priestley investigated by Count Rumford, illustrated by Tyndall, and bearing fruit in Joule's mechanical equivalent. Perhaps none of the allied sciences appears so distant from our own profession as that of physiology.

Digitized by Google

The address was concluded in the following words, in which the author answered the question with which his address began: "Modern scientific thought is due to an enquiry into nature and her works, irrespective of all preconceived theories, and the breaking away from the authority which other departments of human thought and faith have in former ages imposed upon some of the earlier enquirers into science. Faith in religion has been defined as 'the substance of things hoped for, the evidence of things not seen,' which is quite apart altogether from the other and wider faith with which the scientific enquirer contemplates that vast, that stupendous, that beautiful universe which has been revealed to him by the teaching of his predecessors, and which inspires him with those hopes to which I have just alluded. On the teaching of the ancients Bacon remarks: 'The opinion which men entertain of antiquity is a very idle thing, and almost incongruous to the world; for the old age and length of days of the world should in reality be accounted antiquity, and ought to be attributed to our own times, not to the youth of the world which is enjoyed among the ancients, for that age, though with respect to us it be ancient and greater, yet with regard to the world it was new and less.' This idea is perhaps more and more beautifully expressed by Tennyson in the words, 'I, the heir of all the ages in the foremost files of time.' And in another respect, taking Bacon's teaching which he so often reiterates, as being a search after fruits, we must not imagine that the fruits of which he speaks are necessarily to be gathered in by the worker himself, for the pursuit of true science is often hindered by the too greedy effort to grasp the sordid rewards of the present, and, alas! Bacon himself will ever stand as a most painful example of the depth of degradation to which even the highest minds may fall. We must learn from nature what she is continually teaching, that her efforts are directed not solely for the benefit of the individual, but for the welfare and the advancement of the race. The fruits and the rewards which grow from a study of nature, and a truly scientific effort to expound her laws, are of a higher and a wider scope. And in contemplating the work of the great men of the past with whose names we have been so freely dealing, looking at the present attitude of the scientific mind, and our share in the application and directing of those great sources of power in nature, we may say:

"No more a wind-borne leaf upon the waves
Of time and chance, but one to whom is given,
To help the mighty purpose of the world,
To straighten crooked paths, to smooth the hills
Of sin and sorrow, that on some bright day
The great wheels of the world may run their course
Without one jar or check."

The following is the programme, as far as can be ascertained, in Section A, which section deals with mathematical and physical science:

THURSDAY, SEPT. 6.

On this day (yesterday) the president (Prof. J. Larmor, M.A., F.R.S.) read his presidential address at 10 a.m. The following papers were then read and discussed:

"Notes on M. Cremien's Experiment," by Prof. G. F. Fitzgerald, F.R.S.

"The Creeping of Liquids and on the Surface Tension of Mixtures," by Dr. F. T. Trouton, F.R.S.

"The Method of Investigating Correspondences between Spectra," by Mr. H. Ramage.

"The Report of the Committee on Radiation in a Magnetic Field," by Prof. G. F. Fitzgerald.

"An Experiment on Simultaneous Contrast," by G. J. Burch, F.R.S.

"A Quartz Calcite Symmetrical Doublet," by J. W. Gifford.

While the papers for to-day and the following day of the meeting are not quite settled for Section A, the list below gives a number that are accepted:

"The Fixation of Molecular Energy, and the Relation of Radiation to Temperature under their Thermodynamic Aspect," by Dr. J. Larmor, F.R.S; "The Apparent Emission of Cathode Rays from an Electrode at Zero Potential," by Mr. C. E. S. Phillips; "The Similarity of and the Effect of Electrical Stimulus on Inorganic and Living Substances," by Prof. J. C. Bose; "The Production of an Artificial Light of the same Character as Daylight," by Messrs. A. Dufton and W. M. Gardner; "Note on an Improved Standard Resistance Coil," by Mr. R. S. Whipple; "A Form of Wheatstone Bridge," by Mr. E. H. Griffiths, F.R.S.; "The Telautograph," by Sir William Preece, F.R.S.; "Note on the Propagation of Electric Waves along Parallel Wires," by Prof. W. B. Morton; "The Rainfall of the Northern Counties of England," by Mr. John Hopkinson; "The Weather of the North Atlantic Ocean in the Winter of 1898-9," by Captain Campbell Hepworth; "Report on Seismological Observations"; "Determination of Successive High Primes," by Lieut.-Colonel Allan Cunningham and H. J. Woodall; "On a Central-Differsnce Interpolation Formula," by Prof. J. D. Everett, F.R.S.; "On Newton's Contribution to Central-Difference Interpolation," by Prof. J. D. Everett, F.R.S.; "The Vector Potential of Electric Currents in a Field where Disturbances are Propagated with Finite Velocity," by Mr. S. H. Burbury, F.R.S.; "The Use of Multiple Space in Applied Mathematics," by Mr. H. S. Carslaw; "Report on Electrolysis and Electro-Chemistry;" "Report on Electrical Standards"; "Municipal Trading," by A. Priestman; "Trade Fluctuations," by John B. C. Kershaw; "Recent Changes Affecting the Legal and Financial Position of Local Authorities in England," by F. W. Hirst, B.A.; and "Municipal Buildings for the Overcrowded," by Auberon Herbert.

The arrangement of subjects is to be as below:

FRIDAY, SEPT. 7.

At 10.30 a.m. the president of the astronomical department of the section will deliver his address, after which the section will divide into two departments. In the physical department mathematical papers will be read and discussed, while the astronomical department will have papers on astronomy before it.

SATURDAY, SEPT. 8.

On this day papers on electrical subjects will be taken.

MONDAY, SEPT. 10.

The section will again meet and divide up into two departments, one taking mathematical papers and the other papers on meterology.

TUESDAY, SEPT. 11.

The physical department will consider papers on ions, while the astronomical department will also meet.

WEDNESDAY, SEPT. 12.

Electrical papers will be taken.

MECHANICAL SECTION.

In Section G a programme of papers was prepared some months ago, which we have published before and reproduce again now. Thus yesterday the following papers were read: "Bradford Waterworks," by Mr. James Watson; and "The Disposal of House Refuse in Bradford," by Mr. John McTaggart.

To-day (Friday) the papers will be: "Resistance of Road Vehicles to Traction," by Prof. Hele Shaw, F.R.S.; "Recent Tramway Construction, with Special Reference to the Denerbe System," by Mr. W. H. H. Dawson; "The Coal and Iron Ore Fields of Shansi and Honan, and Railway Construction in China," by Mr. J. H. Glass; "The Use of Expanded Metal in Concrete," by Mr. A. T. Walmisley; and "Power Generation—Comparative Cost by the Steam-Engine, Water-Turbine, and Gas-Engine," by Mr. J. B. C. Kershaw.

On Saturday, Sept. 8, Prof. R. Beaumont is to read a paper on "The Application of Photography to Textile Designing."

On Monday, Sept. 10, the report of the Small Screw-Gauge Committee will be read by Mr. W. A. Price, and the following papers: "Measurement of the Tractive Force, Resistance, and Acceleration of Trains," by Mr. A. Mallock; "The Liverpool and Manchester Electric Railway," by Sir W. H. Preece, F.R.S.; "The Design and Location of Electric Generating Stations," by Mr. A. H. Gibbings; "A Maximum Demand Meter," by Mr. J. H. Barker; "An Account of a New Form of Self-Registering Rain-Gauge," by Mr. J. W. Binnie; and "The Automobile for Electric Street Traction," by Mr. J. G. W. Aldridge.

On Tuesday, Sept. 11, the papers will be: "A New

Digitized by Google

Form of Calorimeter for Measuring the Wetness of Steam," by Prof. J. Goodman; "The Internal Architecture of Steel," by Prof. Arnold; "Shop Buildings," by Mr. E. E. Clark; and "Steam Raising and Smokeless Combustion," by Mr. H. R. Armitage.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.

We have received the following communication from the Executive Committee of the International Association of Municipal Electricians, whose headquarters are in Pittsburg, Pa.:

The fifth annual meeting of the International Association of Municipal Electricians, to be held in Pittsburg, Sept. 25, 26, and 27, will be the most profitable and interesting assemblage that has occurred in the history of the association. Pittsburg, "the workshop of the world," as it has been justly called, has the leading electric manufacturing works in America, employing daily over 4,500 persons, and this of itself ensures the delegates and their friends a world of interest, to say nothing of the thousands of other works and industries of all kinds located there. The committee having in charge the work of arranging for the meeting are straining every effort to make the convention a success in every sense of the word. Mr. Morris W. Mead, the chairman of the Executive Committee, and who is superintendent of the Pittsburg Bureau of Electricity, is giving every attention in his power to pushing the work of arranging for the meeting. He is ably assisted by Mr. Elmer G. Loomis, chairman of the committee on arrangements, and other members of that committee. Mr. Loomis is superintendent of the Bureau of Electricity of Allegheny, Pa.

Mr. Mead attended a meeting of the committee on arrangements, held at Newell's Hotel on Aug. 24, at which he stated that at least 300 delegates, accompanied by their wives and daughters, will attend the convention. The committee arranged for the reception of the visiting delegates and their friends when they arrive in the city, and if the delegates will notify Mr. Mead or Mr. Loomis at what time and upon what trains they will reach the city, members of the committee will be at the depôts to meet them and escort them to their hotels. It was decided at the meeting to form a Ladies' Reception Committee, with Mrs. H. P. Ecker at the head. This committee will arrange for the reception and entertainment of the wives and daughters of the delegates, meet them at the depôt, escort them to their hotels, and provide for their comfort during their stay in the city. Mr. Mead informed the committee that he had arranged with the American Bell Telephone Company and the Pittsburg Central District and Printing Telegraph Company for the free use of those companies' telephones to the delegates and their friends during their sojourn in Pittsburg, and also with the Western Union and Postal Telegraph and Cable Companies for the free services of their wires during that time. He also stated that it is expected that the railroad companies would arrange to issue to the delegates and their friends a one and a third fare from all points on the certificate plan, and that arrangements have been made at leading hotels for the accommodation of all guests at reasonable rates. By way of entertainment on the evening of the first day of the convention (Sept. 25), a trolley ride on special cars of the Consolidated Traction Company, the United Traction Company, the Monongahela Traction Company, and the Pittsburg and Birmingham Street Railway Company has been arranged. The route laid out over the lines of these companies is many miles in length, and passes through the most beautiful, picturesque, and historic scenes in the States. The lines traverse lofty hills, shady glens, and mile after mile of costly and magnificent residences; shady glens skirt acres upon acres of the finest parks in the world, and along mills, factories, and workshops, the value of whose manufactured products aggregate nearly 400,000,000dol. annually. During this trip luncheon will be served at Kennywood Park, one of the most beautiful places for the purpose on the route laid out. In fact, everything possible to make this ride one of the most enjoyable events of the meeting has been planned and will be carried out to the letter. Another meeting of the committee was held the following week, at which arrangements were completed for a carriage ride on the afternoon of the 26th over the beautiful boulevards of the East End, and theatre parties in the evening. An excursion and banquet on the steamer "Mayflower" on the afternoon and evening of the 27th on the Ohio and Monongahela rivers have also been arranged.

Mr. Mead is daily receiving dozens of letters from superintendents of municipal electrical bureaus, city electricians, and others interested in electrical affairs from all over the United States, in which they state their intentions of attending the convention, and enquire as to matters pertaining to it. The Western Pennsylvania Exposition of Industrial Arts will open at the time of the meeting, and special arrangements will be made for the delegates to attend in a body.

ST. PANCRAS.

The Electricity and Public Lighting Committee's report and the annual report of the chairman of the St. Pancras Electric Lighting Committee were presented to the Vestry on Sept. 5, and from these we extract as follows:

The committee have accepted applications from various sources for current to the equivalent to 365 amperes at the Regent's Park, and to 223 amperes at the King's-road station. They also recommended an extension of mains in Stanhope-street. In connection with the extension at the Regent's Park station, it is necessary that facilities be acquired to enable the mains from the new switchboard being carried through into Stanhope-street—the most direct and economical route is through 41, Stanhope-street. The owner refusing to grant a wayleave, the committee recommended that his freehold interest be acquired for the sum of £1,100.

The committee unanimously passed the following resolutions: "That the best thanks be accorded to Dr. Walter Smith for his able and interesting report, and for the manner in which he has presided over the meetings of the committee. That the committee desire to record their appreciation of the services rendered by Mr. G. A. Hodgkinson, the deputy-chairman and chairman of the Gas Sub-Committee, and also by Mr. Thornton Rutter and Mr. Jonathan Edgar, as chairmen of the Stations and Mains and Audit Sub-Committees respectively. That the committee also desire to record their satisfaction of the manner in which the work of the department has been carried on by Mr. S. W. Baynes, the chief electrical engineer, and Mr. A. E. Pycraft, the chief clerk, and the officers of engineering and clerical staffs respectively."

Abstract of Chairman's Report.

Gentlemen,—I have the honour of presenting to you the tenth annual report dealing with the work of the electricity and public lighting department from May, 1899, to September, 1900, during which time great advance has been made in the undertaking, which has necessitated many important extensions being carried out; and owing to the difficulty in obtaining the new plant much anxiety was caused your committee and the staff during the past year. New consumers have been connected to the mains representing an extra demand for supply to 11,305 16-c.p. incandescent lamps, 106 arc lamps, 25 motors, equal to 89 h.p. The accounts for the year 1899 recently presented to you show the very satisfactory revenue of £44,880. 7s., an increase over the previous year of £6,624. 6s. 8l., notwithstanding the concessions made during the year under the indicator system, by which the large sum of £6,536. 16s. 6d. was allowed off accounts as rebates to consumers. As the net result of the year's trading, after paying instalments (£3,374. 6s. 4d.) of loans and interest (£7,321. 8s.), there remained a net profit of £6,841. 19s. 11d., and with the sum of £1,892. 9s. 7d. brought forward from 1898, a sum of £8,734. 9s. 6d. remained for disposal. The surplus of £8,734. 9s. 6d. has been distributed as follows:

Written off for depreciation on accumulators	£1,000	0	0
" " " meters and switches...	600	0	0
Contribution to lighting rate.....	2 000	0	0
To reserve fund.....	4,000	0	0
Carried forward to next year's account	1,134	9	6

During the past year extensive alterations and extensions have been carried out at the Regent's Park station, and are now nearing completion, the additional plant consisting of four 850-h.p. engines and dynamos, six 500-h.p. dry-back marine boilers, condensing plant, feed-water heaters, new switchboard for private lighting, and new switchboard for public lighting, for which tenders have been accepted to the amount of £44 692. In consequence of the necessity of retaining some of the small engines that have been replaced by the larger ones, it has been

Digitized by Google

UNITS SOLD, PRICE REALISED, AND COST FROM 1892 TO 1899.

Number of units sold.	Average price per unit realised.	Average cost of production per unit.	Average cost for interest and capital per unit.	Total cost per unit.	Profit per unit	Loss per unit.
	d.	d.	d.	d.	d.	d.
435,519	6	4 6	2·28	6 88	—	0·88
594,893	6	3 5	1 8	5 3	0 7	—
719 484	5·6	3 2	1·8	5 0	0 6	—
849,987	5·3	3 5	1·6	5·1	0·2	—
1,201,229	5·4	3·8	2 0	5 8	—	0·4
1,520,354	5·2	2·9	1·3	4·2	1 0	—
1,996,877	4·59	2 94	1 15	4 09	0 5	—
2,477,508	4 35	2·64	1·05	3·69	0·66	—

ANALYSIS OF COSTS, IN PENCE PER UNIT SOLD, FROM 1892 TO 1899.

Coal.	Oil, waste, etc.	Wages.	Maintenance and repairs, including carbon.	Rents, rates, and taxes.	Management.	Other expenses.	Total.
d.	d.	d.	d.	d.	d.	d.	d.
1·63	·24	1·30	·24	—	·72	·36	4 60
1·26	·17	·72	·92	—	·34	·09	3·50
·99	·15	·71	·80	·10	·35	·11	3·21
·95	·10	·67	1·18	·10	·36	·13	3·49
·99	·17	·72	1 07	·12	·53	·20	3 80
·84	·09	·63	·92	·09	·24	·09	2·89
·84	·07	·60	1 04	·07	·19	·12	2 93
·93	·09	·43	·72	·12	·22	·13	2·64

COMPARISON OF ST. PANCRAS COSTS WITH OTHER LONDON UNDERTAKINGS FOR 1899.

—	Coal, etc.	Oil, waste, etc.	Wages	Maintenance etc.	Rates, rents, etc.	Management, etc.	Total
	d.	d.	d.	d.	d.	d.	d.
Charing Cross.	·86	·06	·30	·35	·22	·39	2·18
Chelsea	·70	·12	·43	·45	·32	·48	2·50
City of London	1 23	·13	·28	·72	·29	·55	3·20
Kensington ..	·64	·09	·26	·35	·40	·56	2 80
Metropolitan..	1·64	·17	·26	·50	·11	·57	3 25
St. James	·54	·06	·24	·36	·17	·58	1 95
Westminster..	·67	·08	·22	·26	·21	·59	2·03
St. Pancras ..	·93	09	·43	·72	·12	·35	2·64
Hampstead ..	1·24	·15	·32	·23	·06	·36	2·36
Islington	1 02	·24	·59	·20	·15	·38	2 58
Shoreditch ...	1 0	·11	·37	·28	·04	·25	2 05
Hammersmith	·78	·13	·45	·07	·15	·31	1·89

TABLE OF CAPITAL EXPENDITURE.

—	Capital expenditure.	Units sold.	Capital expenditure per unit sold.
	£ s. d.		s. d.
1892	88,913 17 2	435,519	4 1
1893	96,085 6 8	594,893	3 2½
1894	109,931 14 4	719,484	3 0½
1895	113 889 2 1	849,987	2 8½
1896	187,135 10 6	1,201,229	3 1
1897	210,680 18 4	1,520,354	2 9
1898	241,993 16 6	1,996,877	2 5
1899	288,146 12 0	2,477,508	2 3

PROGRESS TABLE OF UNDERTAKING FROM DECEMBER, 1892, TO DECEMBER, 1899.

Number of units sold.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Total number of consumers connected	172	238	349	447	672	808	984	1,184
Total number of 8-c.p. lamp connections	19,980	28,702	31 084	38,390	53,846	64,500	76.248	110,462
Number of units sold per kilowatt of maximum load in station	1,567	1,518	1,515	1,439	1,263	1,460	1,565	1,575
Capacity of plant in kilowatts	1,040	1,040	1,100	1,174	1,534	1,850	2,090	2,590
Number of 8-c.p. lamps connected per inhabited house	·8	1·1	1·29	1·59	2 23	2 67	3·16	4·58
Number of units sold per inhabited house	18·8	24 7	29 57	35 29	49·7	63·12	82·91	102·86

THE MAXIMUM LOAD POINT.

—	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Amperes.	Amperes.	Amperes.	Amperes.	Amperes.	Amperes	Amperes.	Amperes.	Amperes.	Amperes	Amperes.	Amperes.
1892	2,230	2,195	1,750	1,545	1.485	1 570	1 490	1,930	3,300	3 440	3,970	3,860
1893	2,720	2,600	2 690	2 100	2,270	2 190	2 040	2 310	2 380	2,800	2,935	3 600
1894	3,190	3 090	2 960	2 785	2 660	2,650	2,610	2,730	3,240	3,680	4,100	4,290
1895	3,930	3,640	4,080	3 620	3 320	3,000	3 160	3,420	4,060	4 540	4,930	5,380
1896	5 450	5,610	5,210	5 225	4 620	4,280	4,370	4,760	6 220	6,660	7,400	8,610
1897	7.990	7,400	5,830	6 760	6 380	5.310	5,090	5,940	7,060	8,270	9,250	9,420
1898	9 340	8,540	8,110	8,380	8 220	6,940	7,600	7.600	8,780	10,340	11,210	11,530
1899	12,010	11,410	10,945	11,150	10,110	8 710	8,340	9,440	11,400	11,980	13,470	14,060

RETURN SHOWING THE LIGHTING RATE FROM 1874 UP TO 1900, AND THE NUMBER OF GAS LAMPS DISPLACED, ETC., SINCE THE INTRODUCTION OF ELECTRIC LIGHTING.

Year.	Lighting rate.	Produce of lighting rate.	Number of gas lamps.	Charge for gas.	Repairs and maintenance of gas lamps, etc.	Wages (gas).	Salaries (gas).	Number of gas lamps displaced by arc lamps.	Number of arc lamps.	Charge for arc lamps at 6d. per unit (g).	Total for gas and electric lamps.
	d.	£		£	£	£	£			£	£
1874	4½	21,130	3 296	15,428	(Lighting of	parish	done by	contract with	gas com	pany).	17,218
1875	Average	meter sys	tem intro	duced.							
1876	3	15,521	3,351	10 711	729	2,424	147	—	—	—	14.011
1890	2½	15,044	4,284	8,925	2 097	3.528	160	—	—	—	14,710
1891	2	12 332	4.480	9,325	1,200	3,613	160	—	—	—	14,298
1892	2½	15 438	4 503	9,113	737	3.509	160	187	26	2,040	15,559
1893	2½	15,454	4,281	8.704	357 (e)	3.389	160	479	86	4,941	17,551
1894	3	18,643	4,312	8,839 (c)	390	3 402	87	546	95	4,426	17,144
1895	3	18,736	4,325	8,995	288	3,400	88	561	97	3 568 (h)	16,339
1896	2½	16,279 (a)	4 310	8,931	282	3.531	100	561	97	3 826	16,670
1897	2½	16,498	4,541	8 846	466	3,775 (f)	188	561	97	3,704	16,979
1898	2½	16 566	4,100	8,241	465	3 794	131	1,057	197	5,978 (i)	18,478
1899	2½	16 547	3,831	7,520	369	3,291	155	1,173	228	6,639	17,819
1900 (k)	1	8,300 (b)	3,409	3 513 (d)	254	1,607	—	1,602	357	4,257 (j)	9,631

(a) Contribution of £1,000 received from electricity department in aid of lighting rate. (b) Contribution of £2,000 ditto. (c) Price increased 1d. per 1,000 cubic feet. (d) Increase of 3d. per 1,000 cubic feet in June quarter; a notification has been received of a further increase of 4d. from July 1, 1900. (e) Charges for reinstating by works department first made. (f) Wages of lamplighters increased from 21s. 6d. to 24s. per week. (g) Inclusive of all capital charges, repairs, maintenance, and interest and instalments of loans. (h) Price reduced to 5d. per unit. (i) Price reduced to 4d. per unit from June. (j) Price reduced from July 1, 1900, to 3d. per unit. (k) Half-year ending June. *Note.*—One arc lamp displaces on an average 4·5 gas lamps, but the standard of light is about 11 times greater.

Digitized by Google

found necessary to lengthen the engine-house by removing the test-room and smiths' shop, which will allow space for two engines, and also ensure more thorough ventilation to the engine-house generally. The new chimney shaft, which has also been completed during the past year, has now been in use for some months, and is working very satisfactorily.

The following tables show the progress of the undertaking from its commencement:

TABLE OF REVENUE AND EXPENDITURE FROM DECEMBER, 1892, TO DECEMBER 1899.

Revenue.	Trading expenditure.	Repayment of capital and interest.	Deficit.	Profit.
£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
11,003 2 6	8,427 8 6	4,119 0 2	1,543 6 2	—
15,021 19 5	8,809 19 5	4,654 5 5	—	1,557 14 7
16,931 16 7	9,698 15 3	5,479 3 2	—	1,753 18 2
18,921 17 5	12,346 2 1	5,640 10 9	—	935 4 7
27,089 16 5	19,151 15 3	9,888 0 4	1,949 19 2	—
33,347 19 11	18,347 1 3	8,482 18 11	—	6,517 19 9
38,256 0 4	24,489 14 11	9,591 3 0	—	4,175 2 5
44,880 7 0	27,230 11 3	10,807 15 10	—	6,841 19 11
205,452 19 7	128,501 7 11	58,662 17 7	3,493 5 4	21,781 19 5

The surplus of £18,288. 14s. 1d. has been distributed as follows:

Items of preliminary expenses written off capital account	£554	4	7
Amount written off for depreciation on accumulators	1,000	0	0
Ditto, meters	600	0	0
Contribution to lighting rate in lieu of further reduction in price	3 000	0	0
Reserve fund	12,000	0	0
Carried forward to account for 1900	1,134	9	6
	£18,288	14	1

In consequence of the great demand on the King's-road station, and the fact of the whole of the plant being in use without even a single stand-by, the attention of your committee has been seriously occupied by considering as to how the station can be increased, and the chief electrical engineer was instructed to prepare plans showing proposed extensions, with the result that negotiations were commenced to try and acquire the houses facing Great College-street, but owing to the great number of interests to be acquired, and the large amount asked for same, it was thought advisable to first acquire the freehold. The Ecclesiastical Commissioners were approached, and after several conferences they agreed to accept £7,500 for the whole of their interests, which, on the recommendation of your committee, the Vestry agreed to purchase; but in consequence of the present Vestry being shortly dissolved, it was thought advisable that the further consideration of the extension should be postponed until after the new corporation comes into existence, the engineer having been instructed in the meantime to consider as to the action to be adopted.

The work of the department having greatly increased, it was found necessary to find extra accommodation for both the clerical staff and also the large staff now under the distributing engineer. This has been met by converting the upper part of the new gas shop into offices for the distributing engineer and staff, and a meter-testing room, which has enabled the two rooms that have been rented for the past two years at 106, Great College-street to be given up, but as the work advances it will be necessary to consider as to providing still further office accommodation, which can probably be done when the extensions to King's-road station are taken in hand. There has also been erected during the past year a new stores shed at the back of the Pratt-street offices.

Owing to your committee having decided during the last year or two to carry out most of the extensions of mains by our own workmen without the aid of contractors, the outdoor staff has considerably increased, but I cannot allow the opportunity pass without testifying as to the very satisfactory, economical, and expeditious manner in which the work has been done under the able superintendence of Mr. W. A. Brown, our distributing engineer.

A large trunk main has been laid between the two stations at a cost of £5,550. Sanction has also been given to lay additional feeders to supply the Clearing House and Somers Town district at an estimated cost of £3,000. During the past year and half, 152 additional arc lamps have been erected in 43 thoroughfares, and besides the foregoing there are 227 lamps in 23 other thoroughfares. The lighting of Prince of Wales-road, Malden-road, and Queen's-crescent by the enclosed type of arc lamp not being satisfactory, your committee called upon the contractors to replace them by the Brockie-Pell open-type arc lamp, since which no complaints have been received, and they appear to be burning satisfactorily. Nearly the whole of the arc lamps sanctioned having now been completed, your committee have ordered a list to be prepared as to which of the streets should be next taken in hand, which, in view of the large increase of the price of gas, your committee are of opinion should be proceeded with.

In consequence of the war in South Africa and other causes, great difficulty has been experienced during the past year in obtaining supplies of smokeless steam coal, and in consequence numerous complaints have been received of the smoke nuisance, which have also been intensified by the difficulty of obtaining efficient stokers. Tenders have been accepted for smokeless coal at an increased price of 50 to 75 per cent. on previous year's contracts.

In consequence of the war in South Africa, four workmen employed by the department, who were reservists, were called up for service to proceed to the front, and in accordance with the resolution of the Vestry the wives of the men are receiving half-pay.

During the past year the alterations of the boundaries of the parish have been considered by your committee in connection with the electric lighting area, and I have attended several conferences with other members of your committee at the Board of Trade offices, and the matter is still pending a settlement.

In December, 1898, your committee reported to the Vestry that applications had been received from intending consumers whose premises are situated at the border line of the parishes of St. Pancras and that of Islington—Brecknock-road and York-road. The Board of Trade stated, in reply to a communication sent them on the subject, that it is a case for arrangement between the two Vestries. Acting on this, a communication was sent to Islington Vestry inviting them to appoint a small committee to confer with your committee, with the object of promoting a reciprocal agreement. A conference was duly held, and your committee subsequently received a letter from the Vestry of Islington, stating that as St. Pancras has no power to lay mains outside its statutory area, the Vestry of Islington is not empowered to grant it permission to do so. These views your committee did not concur in, and considered the action of the Vestry of Islington vexatious, but considering the conditions nothing further could be done in the matter until after the new boundaries of the parish come into existence.

Owing to the great success of the electricity undertaking your committee considered the time had arrived to considerably reduce the price for supply, believing that the installation was undertaken not so much to make a large profit as to benefit the inhabitants of the parish generally, by giving them a fine, clear, and economical light, and the Vestry, on your committee's recommendation, agreed to the following reduction in prices from June last—viz.: (1) for supply to consumers not using the maximum demand indicator, from 6d. to 5d. per unit; (2) the price to consumers using the maximum demand indicator, from 6d. per unit for the first 1½ hours, all after at 3d. per unit, to 6d. per unit for the first hour, all after at 2d. per unit; (3) supply for motor power, heating, etc., from 3d. to 2d. per unit; (4) church and chapels, from 5d. to 4d. per unit; (5) hospitals, from 6d. to 4d. per unit, or by maximum demand rates; (6) public street-lighting and municipal buildings, from 4d. to 3d. per unit. As a result of the above great reductions the price of electricity is now cheaper than gas.

PRESENT PRICE CHARGED FOR SUPPLY BY METROPOLITAN COMPANIES AND LOCAL AUTHORITIES.

Companies.	Private lighting.	Power and heat.	Public lighting.
Metropolitan ...	6d.-4d.	4d.	—
Charing Cross ...	6d.-4d.	4d.-2d.	—
City of London	4½d.	2d.	—
Crystal Palace ...	7d.-6d.	5d.	—
Kensington	6d.-5d.	4d.	—
Notting Hill.....	6d.	6d.	—
St. James's	6d.-4d.	3d.	—
Westminster.....	6d.-4d.	3d.	—
Local authorities.			
Islington	7d. first hour, 4d. surplus	3½d.	3½d.
Hampstead	6d. two hours, 2½d. surplus	6d. first hour, 2d. surplus	£19 per lamp
St. Pancras	6d. first hour, 2d. surplus	2d.	3d.
Hammersmith ...	6d.-4d.	2½d.	—
Shoreditch.....	5d. two hours	2d.	5d. to 3½d., plus cost of maintenance

A table recently published shows the average number of hours per day various classes of consumers use their demand, from a practical experience of 1,800 consumers:

Shops	2 68
Private houses	2·36
Hotels and clubs	4·63
Public houses	4·18
Offices	2·27
Theatres	2 47
Hospitals and baths	1 65
Churches, chapels, and schools	0·79
Street-lighting	9·73
Miscellaneous	2·03

WALTER SMITH, M.D., Chairman.

Digitized by Google

ON THE EFFECTS OF STRAIN ON THE THERMO-ELECTRIC QUALITIES OF METALS.—PART II.*

BY MAGNUS MACLEAN, M.A., D SC.

(*Concluded from page 312.*)

§ 14. For the soft copper wire (Table IX. below) the readings were in the same direction for weights on and off up to a permanent elongation of 1 per cent. After a permanent elongation of 4 72 per cent. the current with weight on was 0·00103 mikroampere per degree from stretched to unstretched through the hot junction, while with the weight off the current was 0·00075 mikroampere per degree from unstretched to stretched through the hot junction. For iron wire the current was in the same direction for weights on and off up to a permanent elongation of 0·35 per cent.; but after a permanent elongation of 3·41 per cent. the current with weight on was 0·00461 mikroampere per degree from unstretched to stretched through the hot junction, and with weight off 0 0069 mikroampere per degree from stretched to unstretched through the hot junction.

* Paper read before the Royal Society.

§ 15. In "Mathematical and Physical Papers," vol. ii, p. 270, § 109, Kelvin says: "I have thus arrived at the remarkable conclusion that when a permanent elongation is left after the withdrawal of a longitudinal force which has been applied to an iron or copper wire, the residual thermo-electric effect is the reverse of the thermo-electric effect which is induced by the force, and which subsists as long as the force acts." It seems (§ 14) that for small longitudinal strain in copper or in iron the direction of the current through the hot junction is the same, whether the force which produced the permanent strain is on or off; (2) that as the permanent elongation is increased by increased longitudinal forces, a stage is reached which gives zero current when the forces are removed; and (3) that for greater longitudinal forces and permanent elongations the direction of the current is opposite with the pulling forces off and on. It seems, in fact, that the permanent elongation must exceed a definite limit to produce reverse thermo-electric effects with the longitudinal force on and removed. I hope to further investigate this point, and to report the results to the society.

§ 16. The galvanometer used for the investigation of

TABLE V.—Electrotype Copper. Current from Stretched to Unstretched. Temperature difference = 87deg. C. Total resistance in circuit = 15·56 ohms.

Total weight in grammes.	Percentage temporary elongation.	Percentage permanent elongation	Current in mikroampere per degree with weight on.	Thermo-electric difference in mikrovolt per degree.
250	0 06	—	0 00020	0 00311
500	0·1	—	0·000267	0 00415
750	0 137	—	0 000567	0·00882
1,000	0·18	0·036	0·000934	0 01452
1,250	0·21	0 057	0 001200	0 01867
1,500	0·264	0 072	0·00137	0.02127
1,750	0·318	0 104	0·001866	0·02905
2,000	0 348	0·144	0 002	0 03113

TABLE VI.—Commercial Copper Wire. Current from Stretched to Unstretched. Temperature difference = 88deg. C. Total resistance in circuit = 16·66 ohms.

250	0·05	—	0·00119	0 02
500	0·1	—	0 00142	0·0236
750	0·14	—	0 00138	0·0231
1,000	0·19	—	0 00148	0 0247
1,250	0 23	0·024	0·00152	0·0253
1,500	0·28	0·058	0 00161	0 0269
1,750	0·32	0 083	0 00175	0 0291
2,000	0·37	0·112	0 00191	0·0318

TABLE VII.—Copper for Alloy. Current from Stretched to Unstretched. Temperature difference = 87deg. C. Total resistance in circuit = 15·62 ohms.

250	0·08	—	0 000333	0 00521
500	0·145	0·041	0·000533	0·00833
750	0 176	0 059	0 000600	0·00937
1,000	0 215	0·076	0 000833	0·01302
1,250	0 256	0·105	0 001167	0·01823
1,500	0 285	0·118	0 001324	0·02031
1,750	0·340	0·142	0·001433	0 02239
2,000	0·402	0·170	0·001600	0·02500

TABLE VIII.—Glover's Hard Copper. Current from Stretched to Unstretched. Temperature difference = 86deg.·5 C. Total resistance in circuit = 15·59 ohms.

250	—	—	0 000335	0·005226
500	0·006	—	0 000469	0·007316
750	0·014	—	0·001106	0 01725
1,000	0 019	0·006	0·001241	0·01934
1,250	0 0285	0·0135	0·001375	0·02143

TABLE IX.—Glover's Soft Copper. Current from Stretched to Unstretched. Temperature difference = 87deg. C. Total resistance in circuit = 15·56 ohms.

300	—	—	0·00020	0 003113
500	0 14	0·03	0·00083	0 01296
750	0·28	0·105	0·00123	0 01919
1,000	1·18	1·00	0·00143	0 02225
1,200	4 84	4·72	0·00103	0·01608

TABLE X.—Reostene Wire. Current from Unstretched to Stretched. Temperature difference = 86deg.·5 C. Total resistance in circuit = 43·39 ohms.

Total weight in grammes.	Percentage temporary elongation.	Percentage permanent elongation	Current in mikroampere per degree with weight on.	Thermo-electric difference in mikrovolt per degree.
250	0 037	—	0·002682	0·1163
500	0·085	—	0 003521	0·1528
750	0·152	0·037	0·003521	0·1528
1,000	0 220	0·073	0 003588	0·1557
1,250	0·257	0·104	0 003721	0·1614
1,500	0·318	0·134	0·003957	0·1717
1,750	0·417	0 201	0·004526	0·1963

TABLE XI.—Platinoid Wire. Current from Stretched to Unstretched. Temperature difference = 86deg. C. Total resistance in circuit = 29·89 ohms.

250	0 035	—	0·003541	0 1058
500	0 071	—	0·003979	0·1190
750	0·101	—	0·004451	0·1330
1,000	0·130	0·025	0·005125	0·1532
1,250	0·16	0·03	0·005631	0·1683
1,500	0·19	0 035	0·007285	0·2177

TABLE XII.—German-Silver Wire. Current from Stretched to Unstretched. Temperature difference = 86deg. C. Total resistance in circuit = 26·85 ohms.

250	—	—	0·002529	0 0679
500	0·08	—	0 002360	0·0634
750	0·105	—	0·002474	0·0661
1,000	0·13	—	0 003020	0 0813
1,250	0·18	0·051	0 003710	0·0996
1,500	0·35	0·162	0 003946	0·1059
1,750	0·80	0·588	0 004552	0·1222

TABLE XIII.—Manganin Wire. Current from Stretched to Unstretched. Temperature difference = 86deg. Total resistance in circuit = 30 ohms.

250	—	—	0·001888	0·05655
500	0·145	0 012	0·002124	0 06372
750	0·260	0·072	0·002090	0·06272
1,000	0·327	0·120	0 002259	0·06778
1,250	0 382	0·151	0 002158	0·06474
1,500	0·427	0·166	0·002158	0 06474
1,750	0·484	0·193	0·002192	0 06575

TABLE XIV.—Iron Wire. Current from Unstretched to Stretched. Temperature difference = 85deg. Total resistance in circuit = 19·20 ohms.

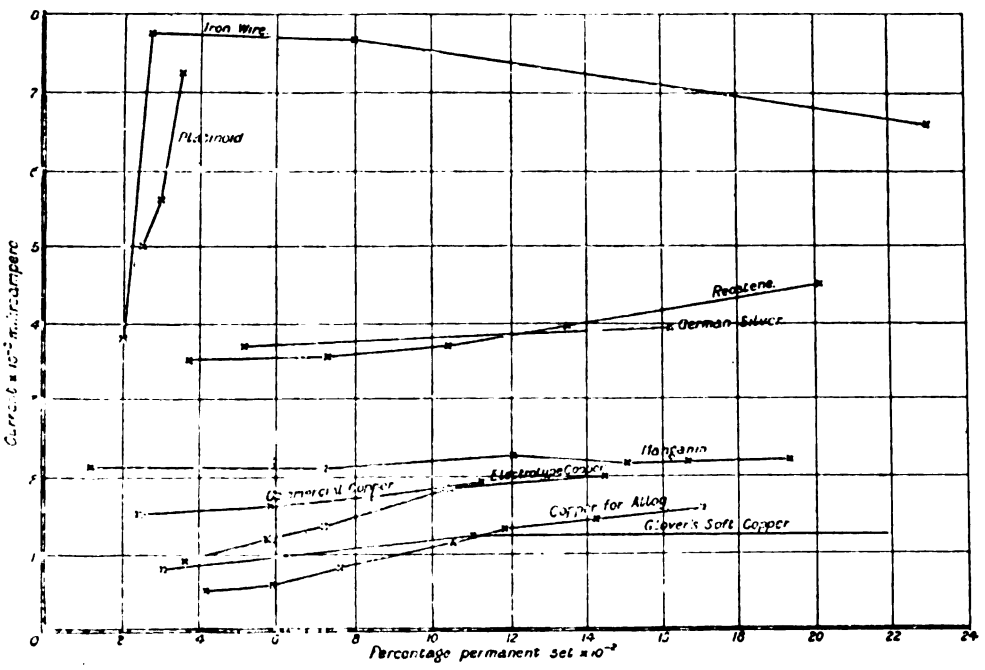
250	—	—	0 0000727	0 000912
500	—	—	0·000131	0·006216
750	0 023	—	0·000131	0 006216
1,000	0 03	0·02	0·003813	0 07192
1,250	0 06	0·027	0·007816	0 09485
1,500	0·19	0 08	0·007736	0·09430
1,750	0·39	0·23	0 006602	0·08696
2,000	—	3 41	0·00461	0 07576

Digitized by Google

these temporary and permanent strains was one of the Kelvin recorder pattern—namely, a movable coil between the poles of a strong permanent magnet of circular form. The coil had 81 turns and a resistance of 14·94 ohms at 17·5deg. C. Its constant was determined in the usual way, and found to be 0·029 mikroampere per division of the scale.

§ 17. To find the stress-strain diagram, experiments were performed on a specimen of each wire in the following manner: Two pieces of the wire were passed through two small holes in a metal plate and soldered at the back of the plate. The plate was fixed to a horizontal support at a convenient height. One of the wires had a half-millimetre scale near its lower end, and a weight hanging on it to keep the wire straight. The other wire had a scale-pan and a pointer in the manner generally used in laboratories for finding the Young's modulus of materials. By putting weights into the scale-pan and taking them out, and noting the readings of the pointer on the scale, the temporary and permanent elongation in the wire for different weights were found. The numbers are given in the second and third columns of Tables V. to XIV. The currents in the fourth columns are calculated from the deflections of the galvanometer when the stated weights are on the wire, and the thermo-electric differences in the fifth column are found by multiplying the currents in the fourth column by the total resistance in the circuit in each case.

§ 18. The numbers in the tables are plotted in curves



with percentage permanent elongation as abscissæ, and thermo-electric differences as ordinates. The thermo-electric difference between free platinoid and strained platinoid rises rapidly with the permanent elongation of the strained wire. For manganin and lead, both commercial and pure, it is very nearly constant up to a permanent set of $\frac{1}{5}$ per cent. Mr. Alexander Wood, Thomson experimental scholar in the physical laboratory, the University, Glasgow, has rendered valuable help in the experimental work and in the calculations.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

305. Explain how to test the Aron new model watt-hour meters for alternating current at ordinary periodicity, if possible, with direct current.—A. S.

306. When running a dynamo and cells in parallel, if the voltage of both are the same, the current will be equally divided. Now, if the voltage of the cells drops one-eighth of a volt, will the whole of the current be supplied from the dynamo, presuming its capacity to be great enough and its regulating qualities perfect?—A. G.

ANSWERS.

Question No. 298.—I have a slow-revolution large-unit engine driving a dynamo. The speed of the dynamo is not uniform enough, and I wish to know where to look for and how to remedy this defect.

Best Answer to No. 298 (*awarded* 10*s.*).—The defect referred to in the question may arise from a number of individual causes or a combination of such causes, and to locate the actual one it is necessary to investigate separately all parts of the plant likely to detrimentally affect the speed of the dynamo. Commencing, therefore, at the dynamo itself, and assuming that it is indirectly driven by means of belts or ropes, it is evident that the ropes or belts may slip over the driven pulleys. If this occurs, and the slip is beyond the ordinary limits of practice, it may cause undue alteration of the speed of the dynamo, as the amount of the slip would be a variable and uncertain quantity. The slipping of the belts or ropes may arise either from them being too small for the power transmitted, or the pulleys may be wrongly proportioned, or the drive too short. Assuming, however, that there is no undue loss of speed from the drive, or that the dynamo is a directly-driven one, we limit the causes of the fluctuation of the speed to the engine proper. The load on the dynamo may be regular or irregular in character, and if the latter the investigation of the cause of the absence of uniformity of speed is rather more complex.

Considering first the simpler case, that of a regular dynamo load for a fairly lengthy interval, it is evident that the governor, which is the first important detail of the engine we should examine for variation of the speed, is not at fault for the following reasons: An early cut-off, consequent upon expansive working of the steam, combined with momentum of the moving parts of the engine, such as the piston, connecting rod, etc., result in the twisting effort of the shaft varying from a maximum to a minimum, and this tends to variation of the speed. To counteract this, energy is stored up in the flywheel when the twisting effort is in excess, and is given out again when

Digitized by Google

the twisting effort is below the average resisting effort. It is evident, then, with the dynamo load constant and variation of the speed, that the flywheel is not heavy enough. Further, the fluctuation of speed in this case will occur every stroke, and will be periodic in character. The only course open, therefore, to improve the running is to put in a heavier flywheel. As a temporary measure, the valves might be readjusted to cut off the steam later in the stroke, for this would give more uniform pressure on the piston and a better turning effort, though probably at the expense of the economy.

In the case of an irregular dynamo load, the fluctuation of speed may arise either from defective governing or too light a flywheel, or both these causes acting concurrently. The governor may not be sufficiently sensitive, or it may be too sensitive and not powerful enough. In the latter event there would be "hunting," and this would be readily detected. The usual method of overcoming hunting when it arises from hyper-sensitiveness is to attach a dash-pot to the governor. If the governor is not sensitive enough and does not respond readily to slight changes of speed, it will probably be found necessary to replace it by one more nearly isochronous. If the expansion gear or the throttle valve requires considerable force to move it, the governor may not be powerful enough, and this, again, would lead to irregular running. The only satisfactory way to obtain good governing under these conditions is to resort to the "relay" system. In this system the governor acts on some independent power, which in turn actuates the valve gear. Good governing, however, cannot be obtained unless there is sufficient flywheel weight, as the governor only has control over the engine during the admission of steam, and this is often for only a very short period of the stroke. Thus during the remainder of the stroke the controlling force is the flywheel. In fact, the panacea for all the evils of irregular running is a heavy flywheel. With rope driving the speed of the engine does not usually vary very much, and the reason for this is that the rope drum is by construction necessarily heavy, and there is, therefore, plenty of flywheel weight. Should there be any doubt as to whether or not the flywheel is heavy enough, indicator diagrams should be taken, and an actual twisting effort diagram, taking into consideration the momentum of the moving parts, constructed. The difference between the twisting effort and the average resistance at any position of the stroke can then be compared with the reserve of momentum of the flywheel.

In the above considerations we have not noticed the case in which the variation may arise from bad setting of the valves and irregular boiler pressure, because in these cases there is very little difficulty in locating the cause.—E. T. T.

Answer to No. 298 (*awarded* 5*s*.).—It is not stated whether the speed variation is periodic during each revolution, or irregular, from time to time. In the latter case the fault may be due to bad governors. First ascertain that they are clean and working freely. See if there is any slackness or loose part in the linkwork controlling the valves. If all is correct, run the engine light and adjust governors to normal speed, with stop valve full open. Then run engine on full load (artificial). The drop in speed should not exceed 3 per cent. If more, and if irreducible by different setting of the valves, the governors are no good for the speed required, and should be changed. Note whether any hunting goes on. This may occur if governing is by throttle, owing to the valve being brought into action too quickly. Adjust so that steam is admitted more freely. If Corliss gear is used, pay attention to the trip gear and dash-pots—the latter often need an adjustment if air or oil be used as a buffer.

It may be that the governors only act on the high-pressure cylinder. If this is so, and there is a fixed cut-off on the low-pressure side, a sudden change of load on the engine would vary the speed in spite of the governors. This is because the charge of steam admitted on one stroke to the high-pressure cylinder has to do work on the succeeding stroke in the low-pressure cylinder, and the power developed may be in excess of or insufficient for the power required at that instant. The remedy is to have a receiver between the high and low pressure cylinders, and a separate governor operating the admission of steam into the low-pressure cylinder.

A periodic variation in each revolution is due to unequal turning moment on the dynamo shaft. There have been cases when the cranks of the high and low pressure sides of a compound engine have been placed at 180deg. to each other instead of 90deg. The variation in turning moment is in this case very great. If possible, without too much expense, this should be altered, and an intermediate receiver put in between high and low pressure cylinders.

An insufficiently heavy flywheel may be responsible for irregular turning, particularly at light loads on an engine governing by variable cut-off. The remedy is obviously to increase the weight of the flywheel. In very bad cases it is worth while to have a spring coupling, similar in construction to Ayrton and Perry's transmission dynamometer, placed between the coupling flanges of the engine and dynamo, and a flywheel mounted on the dynamo shaft. The flywheel tends to secure even turning, while the expansion and contraction of the springs takes up the irregularities in the turning moment not overcome by the engine flywheel.—J. A. S.

Answer to No. 298 (*awarded* 5*s*.).—It would have been of considerable service towards a comprehensive reply to this question if some details of the irregularities of the speed of the dynamo had been given; for it is now open to doubt whether by "the speed of the dynamo is not uniform enough," is meant the fact that after any considerable alteration in load the speed either increases or decreases somewhat and then gradually returns to the normal, or it may be that at full load the speed is under the normal for half or light loads; the explanations of the two phenomena are probably widely divergent.

If the speed fluctuates with any alteration in the load, the fault must be sought in the engine, and it will doubtless be found that the governor is too sluggish in its action, or that the lead of the valve requires adjustment. I should, however, advise the first attention to be paid to the governor. As we are told the engine is a slow-revolution one, the dynamo is evidently not direct coupled, but the power is transmitted to it either by means of ropes or belts. Here, then, may be a source of the lack of uniformity, and the first thing to be done should be to place a tachometer on the engine and see whether its speed be constant or if it fluctuates with that of the dynamo. Many electrical engineers appear to have only a very elementary knowledge of the principles of mechanical engineering, and appear to think that as long as the ratios of pulleys are correct everything has been done that is necessary for good driving, and hence you will often find 1¼in. and 1½in. ropes round a pulley 18in. or even less in diameter, and astonishment expressed because the ropes soon wear out, or because a great amount of slip occurs. Some time ago I was called in to account for the great drop in voltage between full load and no load in a 15 kw. dynamo driven off a mill engine. There was no question of the engine speed not being constant, but I found that the dynamo speed fell 150 revolutions per minute at full load below the normal. Upon investigation I found the power was transmitted from the line shaft to the countershaft by means of an *8in. double belt* running over 32in. and 16in. pulleys, and was informed that formerly there had been a light belt, but as it was thought the slip occurred here, *to improve matters*, the light belt was replaced by a heavy one. Unfortunately, the available space on the line shaft was very limited, as it ran near a wall, and I was only able to get in a 48in. driving pulley and 24in. driven one, but this alteration, together with the substitution of the original light belt, improved the drive sufficiently to maintain an approximately constant voltage. Hence I should direct my first attention to the ropes or belts; if, however, the variation of the speed occurs proportionately in the engine, the fault must be sought there. It is possible that the governors are at fault, or the engine is too small for its work, the valves may be wrongly set, or, what is quite as likely, judging from past experience, the steam or exhaust pipes may be of too small a diameter to convey the steam. If, there-

Digitized by Google

fore, the want of uniformity occurs in the engine, and is not due to slip in the ropes, I should advise "T." to take indicator diagrams at light, half, and full loads, when he should readily discover the fault, or if he is unable to do so himself, and will publish the diagrams, doubtless many of your readers would be able and willing to assist him.—M.

Question No. 299.—When the load is suddenly taken off an engine in ordinary cases it will race away, but in the case of an engine and dynamo coupled a dead short pulls the engine up instantly. Please explain this fully.

Best Answer to No. 299 (*awarded* 10*s.*).—The pressure of steam in the cylinder of an engine acting upon the piston is, of course, the force which tends to produce motion. In a compound engine it is the sum of the effect in each cylinder. Averaged up for a single stroke, this force may be said to vary as the mean effective pressure in the two cylinders. To reduce this mean effective pressure is to reduce the effort which the engine is capable of making, and may be brought about in two ways: one, by reducing the initial pressure in the cylinder by throttling the steam; and the other, by cutting off the supply of steam earlier in the stroke, and thus allowing it to expand to a lower final pressure. In the reverse way, of course, the effort of the engine may be increased. Now, when an engine is employed to drive a dynamo on load, it is upon overcoming the resistance to motion that the armature displays with reference to the field magnets that the power of the engine is almost entirely spent, and this resistance, other things being constant, is proportional to the current passing through the armature. With a given mean effective pressure in the cylinders and a given current in the armature, a certain fixed speed of revolution results, but it is evident that if the load on the dynamo vary, the mean effective pressure remaining constant, an alteration must take place in this speed, which could not be tolerated in ordinary electrical practice. To obviate these variations, a governor is fixed upon the engine, which varies the mean effective pressure as the load changes; in the majority of cases, however, it is necessary for a change in speed to take place before the governor comes into play, and thus it is evident that a slight irregularity of running would result were it not for the fact that a second governor is employed, in the form of a flywheel, which, by reason of its inertia, acts as a damper upon these momentary irregularities if suitably designed for the purpose. A governor of a good type, and suited to its work, will hold the speed of the engines within certain narrow limits for all values of current from 0 to a considerable percentage of overload, but it will plainly be seen that there is a certain limit beyond which it cannot go. If it is a throttle governor, it cannot admit more than full-pressure steam into the high-pressure cylinder, and if the current is so great that this is insufficient to keep speed the engine will slow up. With a cut-off governor the maximum effect would be to allow the steam to enter the cylinder throughout the whole stroke (though, for various reasons, very few governors do this), and a similar slowing up will result if this is insufficient.

Now, referring to one half of the question: with a dead short on the armature circuit, an almost incredibly high current results, depending in amount upon the voltage, armature resistance and self-induction, duration of short, etc., and the resistance to motion on the part of the armature may be so increased not only to absorb, almost instantaneously, the energy stored up in the flywheel (which comes first into play as a regulator whilst the governor is acting), but to be far and away beyond the maximum effort that the engine can make however governed, and one can well imagine the engine pulling up.

With regard to the other half of the question—as to racing away when the load is suddenly removed—this would only occur to a slight extent if the governor were working properly and the flywheel suitably designed. Should it be only a momentary race, it means probably that a heavier flywheel is needed, or that the governor is acting sluggishly; but with a permanent race it means that the governor is not properly set, or else is incapable of closing sufficiently within the required limits of speed. The test for a reliable governor is to run the engine upon full load and then suddenly switch all load off, and note both momentary and permanent rise in speed.

It may be mentioned, by the way, that a cut-off governor, acting at extremely light loads, really acts as a throttle governor, because the cut-off takes place before the admission valve is fully opened, so that the cylinder does not have a chance to receive full main pressure.—W. G. M.

Answer to No. 299 (*awarded* 5*s.*).—There is a great difference in the question of an engine suddenly losing its load and a dead short on a direct-coupled set. Take the case of an engine losing its load suddenly: before the governor can cut off the extra steam which the engine has been taking, the engine is thrown into a state where steam is only required at part of stroke, using considerably less steam than before. This extra steam admitted to the engine causes it to rush forward, assisted by the inertia of the moving parts, until the governor again gets control. It is in this case where a shaft governor is preferred before a belt-driven governor, the former being quicker in its action on the cut off.

Now take the case of a dead short on the dynamo of a direct-coupled set. In a shunt machine the dynamo would lose its excitation, and after the first pause would give up generating current, and the engine would work on with no load. Suppose the dynamo to be compound wound, then it would try to burn out the short-circuit, with probably disastrous results to the armature, and as this would not take place before a large current, above the normal output of machine, is generated, the engine, which is designed with due regard to the output of the generator, would be taxed above its power and would slow down. The conductors on an armature regulate the output of the dynamo, and if the conductors are liberally designed, it is the engine which fails to take up the load.

The limitations of a direct set will be seen from the following: $C = \frac{E}{R}$. The volts, E, remain constant, but when a short occurs, the resistance, R, is reduced, thus increasing the current, C. Now $\frac{C \times E}{750}$ = horse-power. E has remained constant, but C is increased, so that the horse-power is more when a short is on the mains.

$$\text{Horse-power of any engine} = \frac{PLAN}{33{,}000}.$$

The length of stroke, L, and area of piston, A, and the pressure, P, cannot be altered at maximum load, so that N is the only factor which can increase; but the more current a dynamo generates, the greater the torque opposing the armature from revolving, and in this way the machine is pulled up. When the dynamo looses the load, this testing torque disappears and the engine races.—F. M. M.

Answer to No. 299 (*awarded* 5*s.*).—When the load is suddenly taken off, the engine races, because the governors are not sensitive enough, taking so many seconds or minutes, as the case may be, to reduce the amount of steam admitted into the cylinders, thereby keeping the speed constant when the load is reduced. It is a totally different case when a dead short occurs and the engine is pulled up. The resistance of the external circuit is reduced, and, therefore, following the well-known law of $C = \frac{E}{R'}$ there will be a larger current passing out of the generator causing the load on the engine to increase. The governors being slow to open the throttle valve, and when it is full open the engine not being large enough to take the increased amount of power needed, the result will be that the speed of the engine will decrease. If suitable fuses were put in the external circuit, the dead short would cause the fuses to blow, thereby decreasing the load on the engine.—C. G.

Question No. 300.—In designing a polyphase installation, what circumstances would guide you in selecting the number of phases and the frequency to be adopted?

Best Answer to No. 300 (*awarded* 10*s.*).—In designing a polyphase installation the first consideration would be which system is easiest to work combined with cheapness

Digitized by Google

Another consideration is whether the system is for a combined motor and lighting load, and it is safe to assume the load of the combined nature is meant in the question. The two-phase system is the simplest system to work motors and lights off the same mains. With three-phase working the uneven loading of the circuits is objectionable, and not only have the circuits to be balanced in the three branches, but the kind of load must be similar—it will not do to have an inductive load on one branch and non-inductive loads on the others. Another advantage in favour of two-phase working is the fact that two circuits of the two-phase system may be electrically disconnected, either always or during tests. This facilitates detection of troubles and gives greater security. Prof. Forbes prefers this two-phase system to the three-phase, especially where no earth return can be used. The three-phase system uses only three-quarters the copper in line wire, but this is counterbalanced by the complications used with this system. In conclusion, the merits as to which is the best system is open to argument, some favouring one system and some the other.

In selecting the frequency to be used when power only is required, a low frequency is adopted, but for lights a higher frequency is used, as a lower frequency would introduce complications into the lighting circuits too costly to justify this low frequency. On power circuits a high frequency means trouble with generators, motors, and the line. The frequency for lighting in England is from 80 to 100; power at Niagara, 25; power in Europe, 40 to 60. At 50 the fluttering of enclosed arcs is inappreciable at a few yards when arc is enclosed in an opalescent globe. A frequency of 60 will be found the best to adopt.—F. M. M.

Answer to No. 300 (*awarded* 5*s.*).—In selecting the number of phases in a polyphase installation, Prof. Forbes strongly advocates a two-phased system with the middle earthed, as having the advantage that the two circuits may be electrically disconnected either always or else during tests. If any consumer's plant uses only one-phase, two-phase or three-phase mesh must be used. Three-phase mesh subjects the transformers to 17 times the electric pressure experienced by three-phase star or two-phase, each earthed at the centre of the electric system. The chief circumstances for consideration are: Is the installation for transmission only, or for both transmission and distribution? Is the installation for purposes of light or power, or both? The same consideration should act as a guide in selecting frequency. The present tendency seems to point to a standard of 50 periods.—A. S.

COMPANIES' MEETINGS AND REPORTS.

CHLORIDE ELECTRICAL STORAGE SYNDICATE.

The annual general meeting of the shareholders of the Chloride Electrical Storage Syndicate, Limited, was held at the works and registered office, Clifton Junction, near Manchester, on Tuesday, the 28th ult., the chairman of the Company (Mr. F. H. Bowman) presiding.

The directors, in their report for the year ending June 30, 1900, stated that during the year the business of the Syndicate had continued to increase in a very satisfactory manner, the amount of orders received and goods manufactured being considerably greater than in any previous year. The capability of production at the works had been taxed to the utmost to meet the demand, and a large volume of orders had either gone by the Syndicate or been refused by it owing to its inability to execute them within a reasonable period. To meet the continually increasing demand considerable extension of the works and plant was becoming an imperative necessity, as also additional working capital. Negotiations had been entered upon for acquiring additional land adjoining the Syndicate's works. The balance-sheet showed that the profits for the year, after providing for debenture interest, amounted to £8,649. 15*s.* 5d., which the directors considered satisfactory, when the large increase in the cost of raw material and the conditions of production which have obtained during the year under review were taken into consideration. These, together with the execution of contracts arranged in 1897 and 1898 previous to the advance in prices, have seriously militated against the year's profit. After writing off from several accounts £4,391. 2*s.* 1d. (an amount which the directors thought necessary) there remained a balance of £4,258. 13*s.* 4d., to which was added £7,026. 10*s.* 5d. brought forward from last year, making £11,285. 3*s.* 9d. The directors proposed to carry forward the balance, out of which a dividend might be paid at their discretion. The retiring director under the articles of association was Mr. John Shepherd Baker, and the auditors Messrs. Parkinson, Mather, and Co.

The report and accounts were received and adopted, and the retiring director (Mr. J. S. Baker) and the auditors re-elected. Votes of thanks were passed to the chairman and directors and also to Mr. Grindle (the general manager), the secretary, and the staff.

MARCONI'S WIRELESS TELEGRAPH.

At a meeting of Marconi's Wireless Telegraph Company, held on Wednesday at the offices, Finch-lane, to enable the directors to announce an issue of 25,000 new shares of £3 each, a rosy picture of the progress of the new invention was presented by the chairman, Major Flood Page. A provisional agreement had been entered into with a firm of brokers, who would guarantee 12,500 of those shares at £3 each, and take at that price such of them as were not applied for, in consideration of a commission of 5*s.* per share on the 12,500 shares and their having a call at £3. 10*s.* up to March 31, 1901, on such of the remaining 12,500 as should not be taken up by the shareholders. That was a bona fide offer from a firm of considerable position, and showed the estimate they put on the value of those £1 shares.

Arrangements have been made with the Admiralty for the Company to fit 28 ships and four land stations with the new system. A naval officer has been experimenting, but could not get beyond what the chairman described as the "comparative failure" of speaking across 25 miles, while the Company is to provide instruments capable of communicating at 90 miles.

We take the above from the *Daily News*, to whose representative, it is stated, Signor Marconi confided that he regards 150 miles as already well within the range of his instruments, and is about to carry out experiments over 200 miles.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Lincoln.—The Town Council invite tenders for wattmeters and demand meters. Tenders by Sept. 14.

Hamburg.—Two 30-ton electric cranes are required. Enquiries may be made at the Town Hall. Tenders by Sept. 10.

Hampstead.—The Vestry invite tenders for various plant for their central station, Lithos-road, Finchley-road. Tenders by Sept. 27.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the lighting of the town by electricity for 30 years by Nov. 2 (concession).

Plumstead.—The Vestry invite tenders for the supply and erection of various plant and machinery for electricity works. Tenders by Sept. 19.

Perth.—The Commissioners invite tenders for meters (direct-current) and cut-outs. Tenders by Sept. 15. Details in our advertisement columns.

Nottingham.—The City Council invites tenders for the construction and erection of a new power station at St. Ann's Well-road. Tenders by Sept. 21.

Philippopolis (Bulgaria).—The Town Council invite tenders for erection and working of electric lighting and working of tramways. Tenders by Nov. 4 (concession).

Oldham.—The Electric Light Committee invite tenders for the supply, delivery, and erection of boilers. Tenders by Sept. 11. Full details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of a 200-kw. steam dynamo for their electricity works. Tenders by Sept. 8. Details in our advertisement columns.

Southampton.—The Harbour Board invite tenders from crane builders for one 30cwt. portable electric wharf crane. Tenders by Sept. 10. Details in our advertisement columns.

Hammersmith.—The Vestry invite tenders for two single-phase alternate-current motors, coupled to two centrifugal pumps, with accessories. Tenders by Sept. 12. Full details in our advertisement columns.

Horton (Surrey).—The Asylums Committee of the London County Council invite tenders for the installation of boilers, engines, dynamos, etc., at the Horton Estate, Epsom, Surrey. Tenders by Sept. 22.

Christiania (Norway).—Tenders are invited for 100 Morse apparatus, 100 Morse keys, 100 galvanometers, and 100 lightning conductors. Tenders to the Telegraph Department, Jernbane-torvet 8/9, by Sept. 12.

Hull.—The Electric Lighting Committee invite tenders for steam and water pipes, feed pump, water softener, etc., at their Sculcoates-lane generating station. Tenders by Sept. 27. Full details in our advertisement columns.

Southampton.—The Guardians invite tenders for the erection and completion of electrical plant and installation for the lighting of the new workhouse infirmary, Shirley Warren. Tenders by Sept. 11. Details in our advertisement columns.

Tunbridge Wells.—The Corporation invite tenders for the supply and delivery of high and low tension cables. Specification and full particulars can be obtained from Mr. Horace Boot, borough electrical engineer. Tenders by Sept. 20.

Digitized by Google

Preston.—The Guardians invite tenders for an electric light installation at Fulwood Workhouse, near Preston. Tenders by Sept. 10. Details in our advertisement columns.

Wrexham.—Tenders are invited for three electric motors and all accessories, working at 500 volts, to drive centrifugal pumps. Also one dynamo, capable of supplying energy for the above motors, together or singly. Details in our advertisement columns.

Greenock.—The Police Board invite tenders for traction plant as follows: water-tube boilers, two steam dynamos (high-speed enclosed engines), boosters, switchboard, steam and exhaust pipes, etc. Tenders by Sept. 10. Details in our advertisement columns.

Poplar.—The Managers of the Poplar and Stepney Sick Asylum District invite tenders from firms willing to perform sundry work in connection with the new telephonic installation at the sick asylum. Tenders by Sept. 10. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of two steel boilers for heating purposes, cast-iron pipes, etc.; rubber rings, bolts and nuts, steel stanchions, etc.; 100 car trucks. Tenders by 18th inst. Details in our advertisement columns.

Croydon.—The Town Council invite tenders for the construction of an underground electricity sub-station at Parchmore-road, Thornton Heath. Plans, etc., may be obtained at the Borough Electrical Engineer's Office, Factory-lane, Croydon. Tenders by 8th inst.

Hackney.—The Electric Lighting Committee invite tenders for condensing plant, cooling apparatus, pipework and valves, feed pumps, switchboard and boosters, public arc lamps, meters, travelling crane, and workshop equipment. Tenders by Sept. 12 Full particulars in our advertisement columns.

Walthamstow.—The Council invite tenders for the supply, delivery, and erection of electric lighting plant and apparatus, consisting of gas plant, gas engines, dynamos, switchboard, booster, balancer, and measuring instruments. Tenders by Sept. 25. Details in our advertisement columns.

Dundalk.—Tenders are invited by the Urban District Council for a transfer of their electric lighting order for the purpose of supplying electricity for public and private lighting and energy for manufacturing purposes within the urban district of Dundalk. Tenders by Sept. 18. Details in our advertisement columns.

Eastbourne.—The Corporation invite tenders for the supply and erection of a water-tube boiler, with fittings, feed pump, etc., a 400-kw. steam alternator, with exciter (vertical enclosed high-speed engine), and main switchboard and connections. Tenders by Oct. 4. Particulars appear in our advertisement columns.

London, E.C.—The Commissioners of H.M. Works and Public Buildings invite tenders for the enlargement of Block E of the telegraph factory at Mount Pleasant, E.C. Drawings, specification, and a copy of the conditions and form of contract may be seen on application to Mr. J. Wager, at H.M. Office of Works, etc. Tenders by Sept. 18.

Middleton and Castleton (Lancs.).—The British Electric Traction Company invite tenders for the construction of light railways in Middleton and Castleton, near Manchester (length in all about seven miles). Drawings may be seen at the offices of the Engineer to the Company, Lennox House, Norfolk-street, Strand. Tenders by 15th inst.

Salford.—Tenders are invited for the supply and delivery of the following materials for the ensuing 12 months: high and low tension single and concentric cables, and house fuse-boxes, meters, and meter boards. Full particulars from Mr. F. A. Wilkinson, borough electrical engineer (pro tem.), Electricity Works, Walmesley-road, Salford. Tenders by Sept. 10.

London, S.W.—The London County Council invite tenders for the supply within 12 weeks of the order being given of the mains required in connection with the electric light installation for the Victoria embankment and Westminster Bridge. Particulars may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 24th inst.

Sunderland.—The Corporation invite tenders for the supply of (A) triple-expansion, high-speed, direct-current steam dynamos; (B) Lancashire boilers; (C) feed pumps. The several specifications and forms of tender can be obtained on application to the borough electrical engineer, Mr. J. F. C. Snell, A.M.I.C.E., Dunning-street, Sunderland. Tenders by 21st inst.

Aberdeen.—The Electric Lighting Committee invite tenders for supply of (1) two 200-kw. direct-coupled continuous-current generators and one 120-kw. balancing set; (2) one 420-kw. direct-coupled continuous-current generator. Specification and form of tender can be obtained from Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen. Tenders by Sept. 29.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and laying of electricity supply mains and accessories. Specifications and form of tender may be inspected at the office of the city engineer, Mr. Spencer Harty, M.I.C.E., City Hall, Dublin, and at the offices of Mr. R. Hammond, consulting engineer to the Corporation, 64, Victoria-street, S.W. Tenders by Oct. 4.

Mexborough.—The Council invite tenders for the supply and erection of a Lancashire boiler; two 50 kw. steam dynamos, balancer and boosters, feed-water heater, and feed pump; switchboard and connections; storage battery; mains; a five-ton hand travelling crane; and for adapting public street lamps from gas to incandescent electric. Tenders by Sept. 15. Details in our advertisement columns.

Blackpool.—The Tramway Committee invite tenders for the construction of a single and double line of tramways in Waterloo-road, Whitegate-drive, Raikes-road, Church-street, Abingdon-street, Talbot-road, and Central drive. The respective lengths will be about one mile single and 2½ miles double. The contract will include the laying of rails, points, etc., excavating, concreting, paving, etc. The Corporation will provide all the materials. Drawings may be seen and specifications and bills of quantities obtained on application to Mr. J. Wolstenholme, borough engineer, Town Hall, Blackpool. Tenders by 17th inst.

RESULTS OF TENDERS.

Salford.—The Electricity Committee have decided to recommend the acceptance of the tender of Messrs. W. T. Glover and Co., at £159 6s., for cables, etc.

Sydney.—The Railway Commissioners have placed with the Edward P. Allis Company a contract to furnish the engines for the Sydney tramways extensions.

Edinburgh.—The contract for an automatic coal-handling machine for the city electric light works has been placed with the New Conveyor Company, Smethwick, Birmingham.

Accrington.—The Corporation have accepted the tender of Messrs. Maund and Leed, 120, Lord-street, Southport, for the wiring of their electricity works, Argyle-street, at £215.

Aberdeen.—The following tenders are recommended for acceptance: A. Spark, Aberdeen, house main fuse-boxes; Ferranti, Limited, meters; British Insulated Wire Company, cables.

Blackpool.—The Hart Accumulator Company, Marshgate-lane, Stratford, have secured the contract for the supply of storage batteries required by the Corporation for the extension of their tramway system.

Rochdale.—The General Purposes Committee have accepted the tender of Mr. G. L. Adamson, 116, Yorkshire-street, for the wirings and fittings required in connection with the electric lighting of the town hall.

Melbourne.—W. T. Henley's Telegraph Works Company, Limited, have obtained an order from the Government for the supply of three miles of lead-covered, dry-core, paper-insulated, 26-pair telephone cable at £705.

Cardiff.—The Electric Committee have received, amongst others, the following tenders for steam pipes, heater, and pump for the works in Eldon-road: Messrs. Danks, £2 500; Messrs. Lace and Son, Cardiff £1,379*; British Insulated Wire Company, for street cable.* *Recommended for acceptance.

Bradford.—The Guardians have accepted the following tenders for lighting the workhouse: No. 1 section, C. A. Parsons and Co., £900; (3) Electrical Power Storage Company, £1,025; (4) G. A. Steinthal, £308; (5) G. F. Cook and Co., £613; for steam separator and steam trap, C. A. Parsons and Co., £20.

Leeds.—The Guardians have accepted the tender of Mr. Albert Dickinson, Upper Mill hill, Leeds, at £219. 10s., for the installation of electric light to the Poor-Law Offices, East-parade, Leeds. Messrs. Clayton, Sons and Co, Limited, Leeds, have secured a contract for four Lancashire steel boilers for the generating station at Crown Point.

Newcastle.—The Tramway Committee have accepted the following tenders: Mr. J. J. Robson, of Newcastle, for the new extension of the electric tramways in the west end of the city, for £26 505; Mr. Nuttall, of Manchester, for the east end of the city, for £26,072; and Messrs. Mather and Platt, extra pumping plant for the power station, £1,470.

Warrington.—The Museum, Library, Arts and Technical Instruction Committee have accepted the tenders of the National Electric Wiring Company for installation of electric light in the museum and library at a cost of £153. 4s. 1d., and of the Warrington and District Electric Light and Power Company for installation of electric light at the school of art at a cost of £53. 10s. 6d.

London, S.W.—The following tenders have been received for wiring the Town Hall, Walham Green, for the electric light, for the Vestry of Fulham:

C. Cooper and Co.	£493	10	0
Concentric and General Contract Company	637	0	0
National Electric Wiring Company	649	0	0
G. E. Taylor and Co.	671	10	0
F. Troy and Co.	695	0	0
T. L. Hellyar	725	4	0
D. Hulett and Co.	750	0	0
J. Bolding and Son, Limited	899	10	0
W. Douglas and Sons	1,249	6	0

Cleethorpes.—The Great Grimsby Tramways Company have received the following tenders in connection with the erection of electric power station, chimney shaft, car-sheds, workshops, etc., in Pelham road:

Power station.

Thompson and Sons	£7,967
Frere and Co.	7,800
Hewins and Goodhand	7,500
H. Marrow	6,522
Wilkinson and Houghton, Grimsby (accepted)	6,310

Depot.

Thompson and Sons	6 059
Frere and Co.	5 845
Hewins and Goodhand	5,440
H. Marrow	4,951
Wilkinson and Houghton (accepted)	5,003

Digitized by Google

Limerick.—The following are the lowest tenders received by the Borough Council in connection with the proposed electric installation for the city: plant, the Alliance Company, £12,157; lamps, the Schuckert Company, £335; cables, the Western Electric Company, £4 285. 4*. 8l.—total, £16,797. 10*. 8l. If the Corporation decided to accept one contractor for the whole work, Messrs. Porte and Sykes offer to do it at £17,000; Messrs. Porte and Sykes offer to supply Schuckert lamps and Glover's cables.

BUSINESS NOTES.

TRACTION.

Great Orme's Head.—A new mountain tramway to the summit of the Great Orme's Head has been sanctioned, and will be commenced almost immediately.

Leeds.—The Town Council on Wednesday decided to apply for parliamentary powers to construct several branch tramways as auxiliary lines to relieve the congestion in Boar lane.

Crewe.—The Council have endorsed the recommendation of the Electric Light Committee to go in for a scheme of electric tramways, to be worked in connection with the electric lighting station.

Halifax.—The Tramways Committee have received letters from the Queensbury and Shelf District Councils urging them to carry out the extension of tramways to their respective places "at the very earliest opportunity."

Bradford.—The new electric tramway along Thornton-road and Listerhills to Lidget Green has been inspected by Mr. A. P. Trotter, of the Board of Trade, and is now open for traffic. This adds another 1½ miles to the Corporation's system.

Wrexham.—The transfer of the property of the old Wrexham tramway company to the new company has taken place legally and effectively as from Aug. 8. The new company have taken over everything that belonged to the old company.

Aberdeen.—The Tramways Committee have been asked to report as to the advisability of applying for authority in the next session of Parliament to construct a tramway (double line) commencing at Market-street and terminating in Poynernook-road.

Nottingham.—We understand that it is confidently hoped by the officials responsible for the tramways now under construction that a start will be made some time during October, although great difficulty is being experienced in obtaining the necessary materials.

Hull.—William Long, a young man, pleaded guilty at Hull to embezzling 1d. while acting as a conductor on one of the electric trams of the city. He was sent to gaol for two months, with hard labour. On the same day six months was meted out to a clerk convicted of embezzling £6,000.

Army Motorcars.—Experiments will be made during the autumn manœuvres of the French army with a view of substituting mechanical for animal traction. By using motorcars it is expected that the transport will be much more rapid, while the forage problem will also be solved.

Newcastle.—As about 115 cars will be required to work the tramways, and 100 cars have been purchased already, the Tramways Committee on Tuesday agreed to purchase 35 more, so that there will be 20 additional cars for use during the midsummer holidays and on other special occasions.

Accidents.—Another alarming accident occurred in Paris last Sunday between an electric and a horse-drawn car. Three people were so seriously injured that they were removed to the Hospital Saint Louis. This makes the eighth tram or automobile accident during the past week, causing four deaths with injuries of more or less gravity.

Preston.—The Mayor, Aldermen Davies, Walmsley, and Pearson, Councillors T. Dewhurst, Copland, Margerison, Greenwood, Hamilton, Andrew, Hubberstey, and J. Foster have been appointed a special committee to consider the best way of giving effect to the powers as to tramways given by the Preston Corporation Act, 1900. They have been authorised to obtain the advice of such electrical or other engineer as they deem necessary.

Tramway Provisional Orders.—The Board of Trade has issued its report on proceedings under the Tramways Act. During the session of 1900 there were 36 applications for provisional orders under the Tramways Act—the largest number since 1881—and of these no fewer than 11 were from Lancashire. The aggregate length of the proposed lines was 59 miles of double line and 99 miles of single line, the estimated cost of construction amounting to £1,626,307.

Croydon Tramways Co.—At the ordinary half-yearly meeting of this Company, held on the 3rd inst. at Winchester House, Mr. T. K. Freeman presiding, it was resolved that, pursuant to the provisions of the Croydon Tramways and Improvements Act, 1900, the Company be wound up voluntarily. A resolution was also passed appointing Messrs. T. K. Freeman, W. Langley-Smith, W. P. Paige, and W. Feast as liquidators of the Company at a remuneration of £400.

Beddgelert Light Railway.—At a special meeting of the Portmadoc Urban District Council on Friday last Mr. Bennett, of Messrs. Bennett and Ward Thomas, consulting electrical engineers to a Manchester syndicate which intends applying for a light railway order for a line from Portmadoc to Beddgelert, attended in regard to the enquiry made whether the Council would entertain the question and, further, support the syndicate in applying for an electric light provisional order for the town. Replying to a member, Mr. Bennett said that at Pwllheli the syndicate had come to terms with the Corporation to supply public lighting at 4d. per unit and private lighting at 6d. per unit. The Council decided not to pass any resolution at present, but they are in favour of the project.

Letter-Boxes in Tramcars.—The *Bradford Observer* says: "In large towns which have adopted the tramways system the placing of letter-boxes in the cars confers a great boon to the inhabitants of the out-districts; yet the innovation, as inevitable as it is useful, is not taken kindly to by the Post Office authorities. Why this should be the case is not quite clear. At Halifax the Tramways Committee suggested it to the local postal authorities, but after a long delay the belated reply was that the privilege 'could not be recommended.' The municipality has offered to bear the cost of providing boxes, etc., so that there will be no expenses incurred by the Post Office. Now that the tramways extend several miles from the centre of the town, the inhabitants, say, of the remoter parts of Ovenden might easily have extended to them postal facilities greater than those hitherto enjoyed. Of course, collections need not be made at the end of every journey, except at nights, when the provincial dispatches could be met. The suggested innovation is bound to come."

Liverpool.—A new line serving the residential country district of Seaforth, Waterloo, Crosby, and Blundellsands was opened for traffic on Saturday. The new line is between two and three miles in length; it has been provided by the Liverpool Overhead Railway Company, and forms a continuation of their railway, which, extending from the Dingle to Seaforth, skirts the docks throughout its entire course of seven miles. The Tramways Committee recommend that Mr. P. M'Cullough, works superintendent and general assistant, at £360 per annum, be appointed assistant manager of the tramways at a salary of £500 per annum. The Tramways Committee were authorised on Monday to purchase from Messrs. Dick, Kerr, and Co. an additional 100 cars of a similar type to those at present being supplied under their existing contract, and at the price specified therein. Authority has also been given to the Tramways Committee to construct for electric traction certain lines mentioned in a report submitted from the city engineer and city electrical engineer to the committee on Aug. 5 at an estimated cost, including overhead electrical equipment, of £23 167.

Llanelly.—It has already been announced that the Llanelly Urban District Council has made arrangements with the British Insulated Wire Company to light the town with electricity and to provide electric traction. The *South Wales Daily News* states that an obstacle in the way of the project being speedily carried out has been removed. Mr. Solomon Andrews, of Cardiff, had an agreement with the Llanelly Tramways Company which entitled him to the use of the tramlines until next year, but negotiations have been carried on for some time with the view of inducing him to surrender the lease. Mr. Solomon Andrews visited Llanelly on Friday last and attended a meeting of the Llanelly Tramways Company at their offices in Stepney-street. As a result of the interview Mr. Andrews has agreed, on certain conditions, to give up his right over the lines on Sept. 29, and arrangements were also made by which his brother, Mr. James Andrews, of Llanelly, who works the tramcars, shall relinquish control of the cars, stables, etc., to the British Insulated Wire Company after that date. The road is now clear for the company to proceed with the project, as it is not anticipated that there will be any objection to their application to the Light Railway Commissioners, which will be heard in October next, to construct lines to the various villages around Llanelly.

North Durham.—The Bill for the construction of the Houghton and Sunderland line of tramways, which recently received the Royal assent, has received the sanction of the various Councils in the district—viz., the County Council of Durham, the Houghton-le-Spring and Hetton-le-Hole Urban District Councils, the Sunderland, Houghton-le-Spring, and Easington Rural District Councils, and the various parish councils. It is proposed to commence with the works during the current year. The overhead trolley system has been selected. Goods will be carried. The main line will start at Grangetown, Sunderland, and pass through Ryhope, Ryhope Colliery, Tunstall, New Silksworth, East Herrington, New Herrington, Philadelphia, Newbottle, Houghton-le-Spring, Hetton-le Hole, Easington Lane, on to Easington, and there will be branch lines from New Silksworth to Sunderland near Low Barnes, from New Herrington and Philadelphia to Penshaw Station, and from Houghton-le Spring to Fence Houses, a total length of about 20 miles. The engineers for the schemes are Messrs. D. Balfour and Son, civil engineers, and Messrs. Handcock and Dykes, electrical engineers, both of Newcastle-on-Tyne and London. Major Tulloch, C.B., R.E., late chief engineer of the Local Government Board, is chairman of the United Kingdom Tramways, Light Railway, and Electrical Syndicate, the promoters of the scheme.

Blackpool.—The *Gazette and News* has the following comment upon the breakdown in connection with the electrical tramway system last week: "The machinery at present in use is only calculated to generate the electricity required by 18 cars, but since the Claremont Park extension was opened it has been called upon to provide the motive power for 25 cars, and has therefore been greatly overloaded. New machinery to relieve this dangerous pressure has been on order for many months, but it has been found impossible to obtain delivery from the makers. The result was that on Tuesday night one of the 100-horse turbines broke down under the strain, and the tramway traffic on the promenade was altogether disorganised. Mr. R. C. Quin acted promptly in the

Digitized by Google

emergency, and as quickly as possible made arrangements with Mr. Cameron, manager of the Blackpool and Fleetwood Tramroad Company, for the necessary supply. The Fleetwood Company has fortunately some reserve plant which they were able to place at the disposal of the Corporation. It was arranged that the whole of the electricity required on the promenade line from the Gynn as far as the central pier should be supplied from the Fleetwood Company's works, while the other 100 h.p. turbine at the Corporation works would provide for the supply from the central pier southwards. In the meantime, Mr. Quin is hurrying forward the repairs to the broken-down turbine, and hopes to have it working again within a day or two. The electric lighting plant is also running at its top load just now. There was a greater demand for electricity on Saturday night than had ever previously been experienced at the local works, and every care is necessary on the part of Mr. Quin and his staff to keep the supply equal to the demand. In connection with this department, also, additional machinery has been on order for some time, but all the leading engineering firms are so congested with work that it is impossible to obtain delivery without long delay. However, there will be considerable extensions all round during the winter, and by another season arrives it is understood that both tramway and electric lighting departments will be fully prepared for all emergencies."

LIGHTING AND GENERAL.

Watford.—Mr. D. Smith has been appointed assistant electrical engineer.

Shrewsbury.—There is to be an extension of electrically lighting the public streets.

Dewsbury.—The voltage has been changed from 220 to 440 volts throughout the whole district.

Lurgan.—The Council are making enquiries as to the probable cost of lighting the town by electricity.

Crewe.—Another £10,000 will shortly be spent for the purpose of extending the public electric lighting.

Bradford.—Sanction has been obtained to a loan of £6,500 for the cost of electric lighting works at the workhouse.

Hawick.—An electric lighting company had secured a site in the town, and they expect to supply current before next July.

Birkenhead.—The expediency of reducing the charge for the use of electrical energy to 4d. per unit is under consideration.

Barnet.—The North Metropolitan Power Distribution Company started the electric lighting of the streets on Saturday last.

Stanley.—A special meeting will be held on Oct. 4 to consider the proposed application for a provisional order for electric lighting.

Halifax.—The Electricity Committee have decided to lay an electric main along Skircoat-road and Huddersfield-road at a cost of £1,900.

Wicklow.—The Urban District Council are taking steps to ascertain the feasibility and probable cost of supplying the town with electric light.

Wigan.—The work at the generating station and that of the tramways in general is progressing very rapidly, and the supply of current will be commenced shortly.

St. Pancras.—It is proposed that Messrs. S. Small and C. Williams be reappointed members of the Electricity and Public Lighting Committee of the Vestry.

Ripon.—The City Council intend to apply for an electric lighting provisional order, and Messrs. G. Harrison and Co., of Ure Bank, have been appointed consulting engineers.

Calverley.—The District Council have agreed to receive a representative of the North British Electricity Supply Company as to their proposal to supply the district with electric power.

Long Eaton.—The Urban District Council have decided to visit Northwich to inspect the Mond system of gas production, with a view to providing the power for their electric lighting scheme.

Warrington.—Mains are to be laid for lighting the infirmary with electric light. The price of electricity for motive power has been fixed at 2d. per unit for the first 3,000 units per quarter, and 1d. per unit after.

Alnwick.—The Urban District Council have decided to consent to the application of the Northern Counties Electricity Supply Association to ask for a provisional order for the lighting of the town by electricity.

Newark.—The Electric Light Committee are advertising for a site suitable for electric works. It is expected that £17,000 or £18,000 will be required for the scheme, and it will be necessary to provide for a loan.

Ilford.—Foundation stones were laid on Saturday of both the electric lighting station and the chimney shaft which are being erected by the Urban District Council for the purpose of generating electricity for lighting and tramways.

Grantham.—The Telephone Committee are of opinion that a municipal telephone system could be successfully worked, and have promised to lay a detailed estimate of the cost of the undertaking before the next meeting of the Town Council.

Kelso.—At a meeting of Burgh Commissioners on Monday communications were submitted from Messrs. Crompton, electrical engineers, and from the North British Electric Supply Company, who separately made proposals for lighting the town by electricity. The Board resolved not to take any steps at present in the matter.

Mexborough.—The electric engineer has been instructed to make provision for the lighting of the street lamps in the township, and to prepare the necessary plans, and to obtain tenders for the various works. Application is to be made to the Local Government Board for a loan.

Swansea.—The Electric Lighting Committee have decided to recommend Mr. James H. Cawthra, chief assistant engineer at Leeds electricity works, for the position of electrical engineer to take charge, under the superintendence of the consulting engineers, of the electric lighting works, at a salary of £300 a year. There were 75 applications for the post.

Eastbourne.—A resolution of the Highways and Drainage Committee recommending this committee to allow the erection of combined electric light and ventilating columns, in lieu of the existing columns in Wilmington-square and Lansdowne-terrace, for the purpose of ventilating the sewer on the Grand-parade is being considered by the electrical engineer.

Tredegar.—At the last meeting of the District Council the Clerk reported that several valuable concessions had been inserted in the South Wales Electrical Power Distribution Act, 1900, Clause 35 enabling the Council to exercise an absolute veto upon the company from obtaining any powers within the district for the supply of energy either for light or power.

St. Pancras.—At the St. Pancras Vestry's meeting on Wednesday, Dr. W. Smith, chairman of the Electricity Committee, in presenting the report, which we publish in another part of this issue, explained that the Vestry would hand over to its successors, the new borough council, a property worth £300,000, which had not, and would not, cost the ratepayers a penny. Had their undertaking been a joint-stock concern, it would have paid a dividend at the rate of 6 per cent.

London Gazette.—The last day for receiving proofs in the estate of B. Symmons (trading as B. Symmons and Co.), 2, North-street, Quadrant, Brighton, is Sept. 15. Mr. R. J. Ward, chartered accountant, 17, North-street, Brighton, is trustee.—An application for debtor's discharge *re* W. J. S. Green, 45, Birchfield-road, Aston, Warwick, will be made on Oct. 11, at 10.30, at the Court House, Corporation-street, Birmingham. — Messrs. Harrison and Brown, electrical engineers and contractors, Newcastle-on-Tyne, have dissolved partnership.

Appointments Vacant.—The Corporation of Eccles require the services of a consulting electrical engineer to advise them as to the extension of the existing electric light undertaking, including alterations required for the supply of power for tramway traction. The Town Council of Penzance having obtained an electric lighting order, propose to light the borough with electricity, and are desirous of receiving the names of electrical engineers who are prepared to advise them as to the best means of procedure. Particulars of these vacancies will be found in another column.

Tunbridge Wells.—At a meeting of the Town Council on Wednesday tenders were accepted for the installation of a municipal telephone service. The Corporation anticipate being able to provide a system which will cost subscribers £2. 10*s.* less than they are paying the National Telephone Company. The scheme also provides for a service to the surrounding villages. The town and district has been canvassed, and upwards of 300 subscribers obtained, and it is estimated that the initial cost of the installation will be £9,000 and the annual cost of maintenance about £1,000.

Stock Exchange. — The Stock Exchange Committee has appointed Sept. 13 as a special settling day for the Metropolitan Electric Supply Company's further issue of £125,000 3½ per cent. mortgage debenture stock, and has also ordered the same securities to be quoted in the official list. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to Eastern Extension, Australasia, and China Telegraph Company's further issue of 50,000 shares of £10 each. The committee have further been asked to allow the Western Telegraph Company's 4 per cent. debenture stock to be quoted in the official list.

Price List.—We have received from Messrs. Ashmore, Benson, and Co., Limited, of Stockton-on-Tees, a list of their Invicta accumulators for electric ignition purposes. The cells are made in two and four volt series, there being three sizes in each series. The cells have capacities ranging from 12 to 40 ampere-hours, and the price in the four-volt series varies from £1. 5*s.* to £2. 10*s.*, and in the two volt series from 14*s.* 6*d.* to £1. 7*s.* 6*d.* The list is accompanied by testimonials from a number of users of the batteries, notably Mr. F. Chanon, who did so well in the Gordon-Bennett autocar race. The batteries have the advantage of being comparatively very light, and are small enough at the same time to enable an extra set to be carried even on motor tricycles.

Leith.—At Tuesday's monthly meeting of the Town Council the electrical engineer, Mr. J. Gray Scott, submitted an estimate showing that the cost of a new feeder to Newhaven-road would be £5,375. Interest and sinking fund would amount annually to £429, and the revenue would probably be £440 per annum. He also reported that on account of the increasing demand upon supply mains a new feeder to Bernard-street was absolutely necessary, at a cost of £1,217. He strongly recommended that the work be carried out without further delay. A report by the treasurer of police was also submitted, showing that the capital expenditure on the electric lighting undertaking to date was £43,011. 1*s.* 8*d.*, and that if extension of works were contemplated, it would be necessary to get further permission from the Secretary for Scotland to borrow. These matters were remitted to the Executive Sub-Committee for report.

Digitized by Google

Rotherham.—At the monthly meeting of the Town Council on Wednesday it was reported to the Gasworks Committee that the work of erection of the electric light generating station has been carried out expeditiously and in a satisfactory manner during the past month.

Chelmsford.—The Town Council have decided to increase the fines payable by the Chelmsford Electric Lighting Company for neglecting, or omitting, to provide the lighting to any of the public lamps. The fine for arc lamps is to be increased from 4*d.* to 6d. per lamp per hour, and for incandescent lamps from ½d. to 1d. per lamp per hour.

Heddeeden.—The Urban District Council will at their next meeting consider a letter from the Middlesex and Herts Electric Light and Power Company stating that they intend to make application by memorial to the Board of Trade for a provisional order to authorise the company to supply electricity for public and private purposes within the area of the Council.

"**English Illustrated Magazine**"—A gruesome but thoroughly characteristic Chinese yarn commences the September number, and various good short stories follow. The prize of merit for the number must be awarded to the very excellent reproductions of photographic views of river scenery. The two archæological and historical essays which follow are worth preserving.

Bath.—In consequence of applications received from Sion and Lansdown roads, the cable is to be extended at a cost of £370. The Council have also agreed to extend the low-tension cables to the top of Miles's-buildings, which would cost £45, and to the St. John's Roman Catholic Church, at a cost of £180. On account of the increased cost of fuel, the Council have decided to increase the cost ½d. per unit, both for public and private lighting.

Paris Exhibition Awards.—The British Schuckert Electric Company, Limited, was represented at the Paris Exhibition in the following four sections: Section 23, electrical machinery and motors; Section 25, electric lighting plant; Section 29, general plant; Section 118, electrical apparatus for marine and naval purposes, and has been awarded in all four cases the grand prix. The engineers and representatives of the firm have also received nine gold medals and eight silver and bronze medals.

Newbury.—The Board of Trade have issued a notice to the effect that the Newbury electric lighting order expired on Aug. 22. The order was obtained by the Corporation eight years ago, but was never taken advantage of in the sense of installing the electric light in the borough, no doubt owing to the fact that the gasworks belong to the town. Now that the order has expired, it will, of course, be open for any electric light company who may feel disposed to initiate the necessary steps for setting up electric light works in the town.

Bangor.—The new electric lighting works for Bangor are rapidly approaching completion, and it is expected will be opened some time this month. The demand for supply is still increasing beyond all anticipation. Over 1,000 lights more than it was calculated would be required in three years have already been connected. Two engines had originally been arranged for, one merely as a stand-by in case of accident to the other, but owing to the great demand for lights both engines will have to be kept working, and a third ordered the moment the works are started.

Gloucester.—Many suggestions have been received with regard to extending the system of arc lamps, which, it is stated, the committee will act upon at the right time. The resident engineer (Mr. Bache) has compiled the following figures giving the number of lights supplied: public street-lighting, 730; total number of lamps connected, 9,230; lamps now being wired, and for which application had been received, 1,960; lamps for which preliminary applications have been received, 2,134—total, 14,058. It is proposed that in future the cables should be laid under the channelling, instead of picking up the granolithic paving.

Bolton.—A canvass is being made as to the probable number of consumers for electricity in the event of the Tonge Moor-road cable being laid. The engineer's report as to the cost of laying the cable for furnishing a supply of electricity to Halliwell Mills has been referred to the chairman and vice-chairman. Further requests for the supply of electricity have been received, and the engineer has been requested to furnish estimates as to the cost of laying the requisite mains, and also ascertain the probable number of consumers therefrom. The question of hiring out electric motors has been referred to the General Purposes Committee for further consideration.

Seaham Harbour.—At the last monthly meeting of the Urban District Council a report of the Lighting Committee was adopted, stating that notice having been given by the gas company to determine the existing contract, the committee recommended that a deputation, consisting of Councillors Gibson, Berkeley, and Chilton, should negotiate with the company the terms of a new contract, if practicable, on the basis of a change for the whole of the Council's lighting. The clerk was recommended to get information of the cost of electric lighting at places approximate to the size of Seaham Harbour, Thirsk included, and also to ascertain the position of the Durham Electric Lighting Company.

Cheltenham.—The Electrical Engineer reported at the last meeting of the Council that all work, both of extension and ordinary running, had progressed satisfactorily during the past month. Since his last report more than a dozen customers had been added, with the equivalent of about 800 8-c.p. lamps, making the total number of 8-c.p. lamps connected equivalent to about 24,970. As he considered it was useless to wait longer in order to include all the works necessary for the traction scheme, he laid before the committee a detailed estimate of works to the value of £6,000, for sanction to borrow which sum he recommended that application should be made to the Local Government Board.

Catalogue.—We have received from the agents, Messrs. J. B. Guthrie and Son, on behalf of the Smith's Injector Company, Limited (late Smith and Co.), Station-street, Nottingham, an extremely well got-up catalogue descriptive of their various manufactures. In the preface the firm state that since the issue of their 1894 catalogue they have entirely remodelled their patterns, and introduced new and special machinery of the most up-to-date kind. The range of the list is a very wide one, and the illustrations are exceptionally good. They refer to various kinds of injectors, water-lifters, steam jet elevators, valves, gauges, standpipes, and general steam-boiler fittings. We specially note wheel-valves in gunmetal.

Catalogue.—We have received from Messrs. Brown, Boveri, and Co., of Baden, Switzerland, a copy of their latest illustrated pamphlet. The pamphlet, which is illustrated in an exceptionally good manner, contains a report on the more important installations carried out by Messrs. Brown, Boveri, and Co. during the last few years. The list of installations includes some in most of the European countries, and also two or three in the Transvaal. The work done by this firm was very favourably commented upon on the recent visit of our Institution of Electrical Engineers to Switzerland, and more particularly the work done by them in connection with the Burgdorf-Thun and Stanestad-Engelberg rack railways.

Belfast.—The last report of Mr. M'Cowen, the engineer, states that at the present time there were over 63,000 lamps in use in connection with the system, and that with the new extensions applied for the total number would be over 73,000. There was also a request for a considerable amount of power to work electric engines. An application has been received for a supply of electric light to 242, Shankill-road, and though this is a good distance from the electric mains in the neighbourhood, and it is estimated that it would cost close on £200 to make the connections, the Electrical Committee is willing, in view of the importance of the thoroughfare, to grant the application, provided they receive at least two other orders for current from the same neighbourhood.

Liverpool.—The increased demand for current for the tramways has led the Electric Power and Lighting Committee of the Corporation to make an important recommendation as to the staff of the city electrical engineer. It recommended the following promotions be made as from Sept. 1: Mr. A. Clough, works manager, with a present salary of £460, increasing to £500, to be assistant electrical engineer at a salary of £550, to be increased in 12 months to £600; Mr. R. S. Downe, assistant engineer, to be first assistant engineer at a salary of £320, increasing £40 per annum to £400 (present salary, £250, increasing to £300); Mr. C. H Smith, engineer's secretary, office superintendent, at a salary of £150 (present salary, £120); Mr. J. Stirrup, inspector of electric meters, superintendent meter department, at a salary of £130 (present salary, £110).

Enfield.—At the last meeting of the Urban District Council a letter was read from Mr. Shelton, as solicitor to the Tottenham District Council, who wrote: "Since meeting the House of Commons, I have made further enquiries with reference to the proposed application to Parliament for powers under the Electric Light Acts, and I am satisfied that it is most desirable that each authority should pass resolutions and take such other necessary steps as will put them in a position to apply to the Board of Trade for a provisional order. This is the only safe course to adopt, but should it be found, on proceeding with the proposed Bill conferring powers upon a joint committee of the several urban district councils, that the provisional orders are unnecessary, the steps for obtaining such orders can then be dropped." It was decided to consider the subject at a special meeting.

Tivoli.—In view of the ninth anniversary of the opening of the Tivoli Variety Theatre on Sept. 4, several alterations have been made in the building whereby additional exits and improved ventilation are obtained. The main feature is the execution of Mr. Seddon's scheme for the improvement of the ventilation of the lower part of the house. By the construction of an alcove in the grand circle saloon, a window opening direct into the open air has been gained. This is furnished with one of the General Electric Company's electric fans, which drives the vitiated air outside, while on the opposite side another similar fan, connected with an air shaft of a diameter of about 18in., and which is carried up as high as the roof, ensures a rapid supply of fresh air. These alterations have been carried out under the direction of Mr. Walter Emden. The contractors for the structural work were Messrs. Howard and Co.

Saltburn.—The handsome building adjoining the brine baths being erected by the Cleveland and South Durham Assets Company for the production of electricity, is now nearing completion. Cables have been laid underground, and the plant and machinery will shortly be ready to supply current for lighting and motive power. Several houses have already been wired by the owners at their own expense, and others are in progress. The National Electric Wiring Company have undertaken to instal, free of initial cost, complete installations for electric light at an additional charge of ½d. per unit on the current consumed. This charge will amount *in toto* to 6½d. per unit, and will represent on the average about 3 per cent. on the purchase price of the installation. Arrangements are being made by the wiring company to open a branch at Saltburn. We learn that an equivalent of over 3,000 8-c.p. lamps has already been installed.

Goole.—At a recent special meeting of the Urban District Council the question of electric lighting and the notification

Digitized by Google

which the Council had received that a syndicate intended to apply for a provisional order for Goole was discussed. A resolution was carried to the effect that steps be taken at once to obtain a provisional order, and that the clerk reply to the syndicate that they were already applying for a similar order and would strongly oppose the granting of an order to outsiders. Several councillors pointed out that the Council had recently spent and were spending large sums to get their roads in order, and it would never do to allow an outside company to come and cut up their roads. Moreover, the Council had special facilities of their own in the way of cheap gas, for providing electric power and light, and they were quite prepared to put a plant down and supply it to all who wanted it, and were not going to allow any competition with their lighting.

Devonport.—The report on the street-lighting, which was adopted by the Borough Council on Thursday in last week, includes the following paragraph: "In the undermentioned streets in Devonport electric light mains are about to be laid down for domestic supply, and we recommend that in those streets electric lighting be adopted, and suggest that both arc and incandescent electric lamps be installed, the arc lamps of high candle-power to burn from sunset to 12 o'clock midnight, and from midnight to sunrise a pair of 16-c.p. incandescent lamps to be switched on in substitution for the arc lamp. The annual cost of the electric lamps, including supply current, cleaning, trimming, carbons, renewals, and maintenance, would be about £19 per annum for each pillar. The streets we recommend should be lighted by electricity are: Fore-street 10 arc lamps, St. Aubyn-street 4, Tavistock-street 5, Marlborough-street 5, Newpassage-hill 4, William-street 4, Paradise-road 9—total 41. In each street incandescent lamps in the order previously given, as follows: 20, 8, 10, 10, 8, 8, 18—total, 82."

Haslingden.—On Thursday last week the electric light installation on the road leading from Irwell Vale to Ewood Bridge was formally started in the presence of the Mayor of Haslingden (Alderman Holt), Councillor Baxter (chairman of the Lighting Committee), Alderman Law, Alderman Barlow, Councillors Hoyle, Haworth, Lord, Whittaker, and Worsley, Alderman Schofield (of Rawtenstall, chairman of the Outfall Sewage Board), the town clerk (Mr. Walter Musgrave), the borough surveyor (Mr. Green), the lighting inspector (Mr. Harris), Mr. Tatham (manager of the sewage works), and Mr. Garland (representative of the contractors). The road is lighted with 13 32-c.p. Edison and Swan lamps, attached to wrought-iron brackets supported on wooden pillars. The power is obtained from a 100-volt dynamo in the engine-house of the sewage works, the cables being carried in two branches—one towards Irwell Vale and the other towards Ewood Bridge. The work has been carried out by Messrs. Garland and Co., of Accrington, to specifications prepared by the borough engineer, who has also superintended the operations.

The Sydenham Explosion.—The following report appeared in the *Daily Telegraph*: "At Sydenham, Mr. Howard Williams and Mr. Hallett concluded their enquiry on behalf of the Board of Trade into the boiler explosion at the works of the Crystal Palace Electric Supply Company, Limited, on July 25. Whilst a number of men were engaged in a building at the works the boiler burst, killing one man instantaneously, and causing such injuries to another that he died in hospital. The commissioners, in giving judgment, found that the explosion was due in the first place to the faulty construction of the boiler, in certain parts of which cast iron had been used. Messrs. Hornsby and Sons had explained that at the time—nine years ago—the boiler was constructed by them they had in their employ an engineer whom they had afterwards dismissed for passing faulty work; but, mainly, the fault of the explosion lay with the Crystal Palace Electric Supply Company. The company was ordered to pay £100 and costs, and the Engine Boiler Insurance Company £50 and costs. Messrs. Hornsby and Sons were not adjudged liable in costs, as the boiler had been made by them so long ago."

St. Paul's Lightning Conductors.—The system of lightning conductors on St. Paul's Cathedral has undergone a total rearrangement under the direction of Mr. Killingworth Hedges, M.I.E.E., and is now complete. The *City Press* says: "The electrician states that the old idea that the erection of a lightning rod on the highest point of a structure protected an area all round it is quite illusory. The safeguarded area was supposed to be the space within a circle whose radius was equal to the height of the lightning rod. This theory is now discredited, and the cathedral has been protected by a system of conductors, perpendicular and horizontal, comprising over a mile of cables, to which at various prominent points are placed about 50 'aigrettes'—groups of solid copper spikes radiating upwards, and effectually connected at the base with the cables. The old system of joint-making by 'junction pieces,' or splicing and soldering, has also been abandoned, it having been found that if surfaces were merely screwed together they were apt to oxidise and set up resistance, and if they were soldered the soldering sooner or later would be very likely to become loosened and detached by the natural expansion and contraction of the metals."

Carnarvon.—At a meeting of the Gwyrfai Rural District Council at Carnarvon on Saturday last a prolonged discussion took place on proposals made by Mr. E. W. J. Peterson, of London, to construct a light railway in the district and to supply the district with electric lighting. A joint committee representing the Council and the Carnarvon Town Council had suggested recommendations by which Mr. Peterson was to be authorised, at his own expense, to apply for the sole power of supplying electricity for lighting and other purposes within the area of the Gwyrfai Council, subject to the details being from time to time submitted to the District Council for its approval; and the same applied to the proposal for constructing a light railway from Carnarvon along the foreshore to Dinas Dinlle; while in the event of the promoters failing to obtain an order or, after obtaining an order, to carry out the work, they were to transfer to the two councils concerned the benefit of the electric lighting provisional order on the payment of a share of the costs incurred in obtaining the order. It was announced that the Parish Council of Llanrug had approved of the proposals, while that of Llanberis had adjourned coming to a decision. A long discussion took place, during which it was stated that if all these schemes were carried out an expenditure of about £100,000 would be required. Finally, the recommendations of the joint committee were adopted.

St. Albans.—The North Metropolitan Electric Power Supply Company by their Act of Parliament are authorised to establish a generating station for the supply of electricity at Ponder's End, where they have acquired a large site of land near the Edison and Swan Company's factories. They intend to transmit electricity at a high pressure over a large area. At each town and village through which the trunk mains pass, electric energy will be delivered for distribution at low tension for all purposes of light, power, and traction. The company assert that under this comprehensive system of supply, the public will obtain electricity on terms far more economical than by isolated systems put down for the supply of each town. The company are in communication with the Enfield Urban District Council, and are proposing to make arrangements with them, under which the necessary provisional order would be obtained, the supply organised at the expense and risk of the company, with power to the Council at the end of a short term to take over the undertaking (so far as Enfield is concerned) on terms of an ordinary valuation as a going concern. The area which the company proposes to cover reaches from Harpenden on the west to Waltham Cross on the east, and from Bedfordshire on the north to the confines of Hendon and Hornsey on the south. The scheme is not likely to clash with the St. Albans scheme, as under present conditions the North Metropolitan Company may go round St. Albans, but not within, so far as the electric lighting is concerned.

Aberdeen.—The electric lighting accounts, noted in our last issue, as well as the estimates for the current year, were adopted by the Town Council on Monday. We herewith give in full the remarks of the Chairman of the committee, from a report for which we are indebted to the *Aberdeen Journal*: "The demand for energy has more than doubled itself during the year just closed, a fact of no slight significance in view of all that has been said against it. In the absence of two complete years' accounts to compare with each other, observations on a few general points may be welcome. You will observe that we have borrowed £81,953, being an increase of £15,142 on the year. Of this amount we have redeemed, by means of the sinking fund, £5,185, leaving our net borrowing at £76,768. You will observe that a year ago the expenditure on lands, buildings, and plant, etc., stood at £69,713. 7s. 7d. From that there has been written off £2 438. 15s. 4d., while we have added during the year £26 091. 16s. — leaving the net total under this head at £93,366. 8s. 3d. Turning to revenue account, you find it given at £14,211. 3s. 10d., as against £4,804. 12s. 1d. for the seven months in last year's accounts. The gross expenditure is given at £6.062. 10s., as against £2,080. 18s. 11d. for the seven months last year. The balance carried to net revenue account this year is £8,149. 3s., as against £2,723. 13s. 2d. last time. The balance on net revenue account, after writing off interest on mortgages and other loans, as well as depreciation, is shown at £2,487. 18s. 11d., from which has to be deducted the small debit balance arising on the seven months' accounts last year, amounting to £203. 11s. 4d., leaving a surplus of £2,284. 7s. 7d. Account No. 8 furnishes a most interesting statistical comparison of energy generated and sold from the commencement of the undertaking. This year no fewer than 1,005,505 units were generated, as against 471,965 for the whole of 1898 and 279,953 for seven months of last year. This year the units taken by our public lamps have risen to 64,637 units. Tramway traction appears, of course, for the first time, with a demand of 131,173 units. Private consumers have called for 650,202 units, as against 232,172 for seven months last year. Turning now to the estimate for the current year, you will observe what the committee propose. We have, if the Irishism be permitted, 'lowered the price by not raising it.' Absurd although the phrase may appear, yet it exactly describes the operation. During the year that is passed we have paid heavily for coal, and we have been compelled to contract this year again at high prices, quite sufficient in themselves to justify us in raising our rates for energy, as Edinburgh did the other day, to the tune of ¼d. per Board of Trade unit all round. Instead of doing that, however, the committee felt it better to let what, in normal conditions, would have gone to reduce the rate be used up rather in meeting the enhanced cost of materials. It will, therefore, be seen that there is a real, although not nominal, reduction for the current year. We are on the strain now to meet the demands upon us for the coming winter, and, as the Council know, we are busily engaged considering plans for the best laying-out and equipment of our new station at Dee Village, which must be ready to meet the winter's load of next year to some extent. We hope to lay these proposals before you on an early date, so that not a day may be lost in having operations commenced." The prices for electric current for the next year were fixed by the Town Council at the same meeting as follows: For lighting—for the first hour daily of the maximum demand, 6d.; thereafter, 3d. per Board of Trade unit. For motive power—for the first hour daily of the maximum demand,

Digitized by Google

3d.; thereafter, 1d. per Board of Trade unit. These charges are the same as were imposed last year. The Kingseat (Newmachar) Asylum will be lighted by electricity, the machinery which will pump the water being utilised for the purpose of generating the current.

Sheffield.—The *Sheffield Daily Telegraph* has an account of an interview with Alderman Styring, the chairman of the Electric Light Committee, who made some interesting remarks on the present position of affairs, and also on Mr. Fedden's report. We quote as follows: "Mr. Fedden says: 'In Sheffield, very large provision must be made for the future, because not only are the suburbs extending rapidly (and these suburbs should be electrically lighted), but the central portion of the city, with its workshops and small power users, may be expected to make an unprecedented demand on the electric supply department as soon as you are able to supply electric energy suitable for power, heating, etc., at a reasonable charge, say 1½d. to 1d. per unit.' If he had to design a new system, he says, he should propose to distribute on the continuous-current system in the central area, although he would generate and transmit the electrical energy from one large power station by polyphase alternating currents to different points in the city, and there transform it into continuous currents by means of rotary converters. As, however, an expensive alternating system is already laid down, such a radical change is impracticable, and he confines himself to recommending modifications in the existing system, which will have the effect of bringing it up to date. One of his chief suggestions is directed to making the system more suitable for motive power, and he strongly recommends the reduction of the periodicities from 100 to 50. This lower periodicity is in operation in a number of towns, and, he says, 'another advantage of changing our present plant from 100 to 50 periods would be that the plant would then be suitable for running in parallel with the large power station which Sheffield must shortly possess. I may add that the quality of the lighting would not be prejudicially affected by the change.' 'If you sanction the suggested change,' the report proceeds, 'the sets of plant would have to be changed one by one as opportunity occurred, and, of course, during the change, each particular set would be unavailable for service on the load. To enable the alteration being carried out it will be necessary to order two sets of plant (alternating 50 period), say each of 1,000 kw., to be delivered, if possible, before March, 1901, and when these are installed to gradually transform the present sets set by set. The cost of altering the present system to 50 periods will be about £9,400 (this includes alternators, motors, meters, and arc lamps). To carry out the above recommendations I estimate the following further expenditure for 1901: additions and alterations in boiler-house, £3,500; 2,000 kw. of new plant complete, £22,000; additional feeders, £5,000; contingencies, say 5 per cent., £1,995—total, £41,895. If these suggestions are carried out, the present station will be completely filled up with machinery put on a footing to give the best possible results as a system. The building of a larger station should also be taken in hand without delay, so that it may be steadily proceeded with concurrently with the above recommendations. One of the questions which our representative put to the chairman of the Electric Light Committee was, 'Are the extensions contemplated in order to enable the department to supply more power or more light? Is there a great demand for power at present?' 'No,' replied Alderman Styring, 'the present demand for power is very little, but we expect it will increase very largely. The first claim is for light. We think the machinery we have got in the station will take us comfortably over this next busy season—at any rate, we hope to pull through, unless anything unforeseen occurs. But we should like to have more behind us than we have. Ever since the undertaking came into the possession of the Corporation, it has been perfectly clear that large developments would be necessary. The attention of the committee has been devoted first to keeping up the supply, and next to making provision for future requirements. The position of the matter is a good deal complicated by the fact that the subject of electric supply has apparently not yet assumed a final shape. We are also a good deal hampered by having taken over a system of supply already established, and to a considerable extent developed. If the field had been clear, the problem for solution would have been very much simpler and more easily tackled. Since Mr. Fedden assumed his duties, he has been actively engaged in mastering the details of the system as established in Sheffield, and considering the aspects of the case with a view to future developments, and his report, presented recently to the committee, is the outcome of those deliberations.' 'The new station will not be kept for power purposes solely,' was the answer to another question. 'It will have to be designed so that it will work in harmony with the present station, and supply both light and power. We should use the present station as a central one, and have the machinery coupled up with that in the new station, so that assistance could be rendered by the latter. It is too early yet to speak of any proposed site for the new station.' A further enquiry brought from the Chairman an answer emphasising the necessity of extensions. 'There is real need for more machinery for producing electric light,' he said. 'The demand is rapidly increasing, and keeps up with anything that the undertaking has experienced since its inception. The capacity of supply at present existing is only, at the best, equal—notwithstanding all that the committee have done—to the present demands, and the demands which will certainly be made during the next few months.' As has already been stated, Mr. Fedden's report has been referred by the committee to Mr. R. Hammond, the consulting electrical engineer to the Corporation, and the committee have decided to send a deputation to the Paris Exhibition, to examine the most up-to-date machinery on view there."

PROVISIONAL PATENTS, 1900.

AUGUST 27.

15225. Improvements in electric arc lamps. Hugo Bremer, 42, Neuenweg, Barmen, Germany. (Complete specification.)

15227. Improvements in or relating to machinery for the production of electrical energy. Herbert Samuel Elworthy, 322, High Holborn, London.

15246. Improvements in the manufacture of electrically-conducting bodies. Eberhard Sander, 18, Buckingham-street, Strand, London.

AUGUST 28.

15265. An improved joint-box for electric cables. George Alexander Clark, 34, Ann-street, Glasgow.

15285. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

15298. Improvements in wireless telegraphy. Charles Edwin Wilson, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15310. Cable-preserving channel for underground cables. Conrad Freysag, 11, Kronprinzenstrasse, Bonn-on-Rhine, Germany.) (Complete specification.)

15313. Improvements in automotor trolleys for electric current. Pierre Barthèlemy Louis Lombard-Gerin, 6, Lord-street, Liverpool. (Complete specification.)

15332. Improvements in apparatus for stopping, starting, and reversing electric motors. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Skodawerke Actien-Gesellschaft, Austria.)

15334. Improvements relating to switches and apparatus for use in starting, controlling, and reversing electric motors. Arthur Henry Adams, 11, Southampton-buildings, Chancery-lane, London.

AUGUST 29.

15363. Improvements relating to the electro-deposition of metals upon articles of china, earthenware, and the like. George Cooke, Bank-buildings, George-street, Sheffield.

15378. Improvements in means for generating alternating electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

15379. Improvements in regulating dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

15380. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz and William Le R. Emmet, United States.) (Complete specification.)

15381. Improvements in thermal electric cut-outs. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William Le Roy Emmet, United States.) (Complete specification.)

15382. Improvements in systems of electrical distribution. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (Charles M. Green and John G. Callan, United States.) (Complete specification.)

15397. An improved railway signalling apparatus. Charles Edward Hobbs and Richard Deen, 55, Chancery-lane, London. (Complete specification.)

15398. Improved railway signalling apparatus. Charles Edward Hobbs and Richard Deen, 55, Chancery-lane, London. (Complete specification.)

15404. Improvements in incandescent electric lighting devices. William Phillips Thompson, 6, Lord-street, Liverpool. (The Voltohm Elektrizitäts Gesellschaft, A.G., Germany.)

15419. Improvements relating to the supply of current to electric vehicles by inductive means. Reginald Haddan, 18, Buckingham-street, Strand, London. (Ernst Sussmann Kellborn, Germany.)

AUGUST 30.

15457. Improvements relating to the production of electrical conducting bodies specially applicable for use in electric incandescent lamps. Eberhard Sander, 45, Southampton-buildings, Chancery-lane, London.

15470. Process of forming metallic electrode plates. Alfred Julius Boult, 111, Hatton-garden, London. (Ernst Andreas, Germany.)

15473. Process for the forming of electrodes. Alfred Julius Boult, 111, Hatton-garden, London. (Ernst Andreas, Germany.)

15475. Improvements in and in connection with the distribution of electrical supply. Frank Edward Beeton, 40, Chancery-lane, London.

Digitized by Google

AUGUST 31.

15479. Improvements in electric arc lights. Frank Edward Beeton, 3, Glen-villas, Folkestone-road, Dover.

15486. Improvements in or relating to overhead systems for the transmission of electrical energy. William Routledge, 73, St. Stephen's-road, Upton Park, London.

15483. Improvements in wireless telegraphy. Sidney George Brown, 9, Putney-hill, Putney, London.

SEPTEMBER 1.

15591. Improvements in automatic interruptors for electric circuits. Alfred Julius Boult, 111, Hatton-garden, London. (F. Katzenstein, Switzerland.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Sept. 22.

1899.

17445. Electric cables. Heyl-Dia.

17736. Electric telegraph apparatus. Brown.

18468. Electricity meters. Chamberlain and Hookham, Limited, and Holden.

18547. Continuous-current electric motors or generators of enclosed type. Wilson.

19103. Telephone conductors or cables. Joint-Stock Company, styled Kabelwerk Rheydt Aktiengesellschaft, and Zappe and Hohnholz.

19384. Electric clock systems. Lorrain. (Macdonald.)

19440. Electromagnetic wave apparatus. Armstrong and Orling.

20180. Indicating or recording and controlling the speed of electric railway cars or vehicles and other machinery. Nisbett.

20277. Electrical selector switch. Eckstein and Coates.

20321. Construction and arrangement of electrical resistance coils. Pye.

20655. Apparatus for use in forming joint ends on electrical conduits, drain pipes, and the like. Albion Clay Company, Limited, and Lawton.

20678. Electric switch. Houghton.

21076. Electric cells or batteries. Willcox. (Columbus Elektricitätsgesellschaft, Gesellschaft mit beschränkter Haftung.)

21377. Electric arc lighting. Vosmaer.

21381. Electric incandescence lamps. Lake. (Soc. de Commentry-Fourchambault et Decazeville.)

1900.

1618. Method of and devices for regulating or controlling electrical switches. Kingsland.

2710. Electricity meters. Mordey and Fricker.

5203. Lead presses for making plates for electric accumulators and the like. Thompson. (Accumulatoren und Elektricitäts Werke Act. Ges. vorm. W. A. Boese und Co.)

9397. Armatures for dynamo-electric machines. Heidel.

10319. Electric storage batteries. Fell. (Wiegand.)

11917. Method of and means for signalling, chiefly designed for submarine purposes. Lake. (Gray Telephone Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Sept. 1	807	668	+ 139	10,216	8,960
Birmingham Tramways Co.	,, 1	4,494	4,351	+ 143	151,240	143,858 *c*
Blackburn Corp'rat'n	,, 1	480	465	+ 15	13,864	15,649
Blackpool Corporatn.	Aug. 30	1 503	1,058	+ 445	19,185	14,828
Blackpool-Fleetwood	Sept. 1	1,519	1,471	+ 48	13,125	13,462
Bradford City Trams	,, 2	568	439	+ 129	11,041	9,063
Bristol Tramways Co.	Aug. 31	3,455	3,498	- 43	—	—
Central London Ry.	Sept. 1	4,499	—	—	22,828 *e*	—
City & South London	,, 2	1,528	891	+ 637	13,536	8,553 *c*
Cork E. T. and L. Co.	Aug. 30	493	518	- 85	14,195	13,021
Dover Tramways ...	Sept. 1	289	293	- 4	7,123	6,781
Dublin U.T., elec. cars	Aug. 31	4,227	1,743	+2,984	—	—
Dublin S.D. Electric	,, 31	1,629	1,121	+ 508	—	—
Glasgow Corporation	Sept. 1	9,269	9,002	+ 67	—	—
Halifax Corporation	,, 2	844	721	+ 123	17,548	13,782
Hull Corporat'n E.S.	,, 1	1,308	—	—	27,551 *a*	— *a*
Liverpool Corporat'n	Aug. 25 *b*	8,688	8,176	+ 512	259,304	230,197
Liverpool Overhead	Sept. 2	1,735	1,996	- 259	15,695 *c*	15,655
Sheffield Corporation	,, 2	2,561	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *d* Since July 5. *e* From July 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	—	—	11-11½
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	½-¾
—— 6 per cent. Cum. Pref., 1-50,000	1	—	½-¾
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2½-2¾ xd
—— 4½ per cent. Debenture Stock	100	..	106-111 xd
—— 4½ per cent. 2nd Debenture Stock	100	—	101-106
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-13½
—— 5 per cent. Pref.	5	—	5½-5¾
Crompton and Co.	3	—	3¾-4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	1¾-2¼
—— 5 per cent. Debentures	5	—	3¾-4¾
—— 4 per cent. Deb. Stock, Red.	100	—	83-91
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	—	68-72
Electric Construction	2	—	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-106
W. T. Henley's Telegraph Works, Ordinary	5	—	11¼-12¼
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	108-112 xd
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	13	—	85-89
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10¾-11¼
—— 5 per cent. Cum. Pref.	5	—	5¾-5¾
Willans and Robinson, Ordinary, 1-80,000	5	—	10¾-11¼
—— 6 per cent. Cum. Pref., 80,001-60,000	5	—	6¾-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	¾-⅞
Bournemouth and Poole, Ordinary	10	—	11½-12½
—— 4½ per cent. Cum. Pref.	10	—	9½-10¼
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8¼-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6-6½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	8¼-7½
—— 4½ per cent. Debentures	100	—	103-111
City of London, Ordinary	10	..	7½-8¼
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	130	—	123-128
County of London and Brush Provincial, Ordinary	10	—	8¼-9¼
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Bd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	—	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10¼
London Electric, Ordinary	3	—	1-1½
—— 6 per cent. Pref.	5	—	3¾-4¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	99-101
Metropolitan, Ordinary	10	—	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-98
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1-1⅛
—— £5 Shares	5	—	7¼-7¾
—— £4½ Shares, New	4½	—	6-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	105-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	—	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	14-15
—— 7 per cent. Pref.	5	—	8-9
Westminster, Ordinary	5	—	12-13
—— 80,001-109,437	2½	—	3¼-3½
Electric Railways.—			
Central London, Ordinary	10	—	9¾-10½
—— Pref. Half-Shares	5	—	4½-5½
—— ,, ,, deferred	5	—	4½-5½
City and South London, Consolidated Ordinary	100	—	57-60
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120-125
—— 5 per cent. Pref. Stock '91	100	—	138-143
—— ,, ,, '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	92 95
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16 xd
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary	10	—	14½-15½
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	123-126
—— ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¼-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	103-106
—— Prov. Cert., all paid	—	..	96-99
Isle of Man Electric Power, 6 per cent. Pref.	1	..	1/16-⅛
Kidderminster and District Lighting and Traction, Pref.	10	—	9½-10½
New General Traction, Ordinary	5	—	2½-3¼
—— 6 per cent. Cum. Pref.	5	—	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-19
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12¾
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10¼
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	98-101
Oriental Telephone and Electric Company	1	—	¾-1⅛

Digitized by Google

NOTES.

Books Received.—We have received a copy of "Electrical Engineering," with particular reference to conditions in Bengal, by Mr. J. W. Meares, electrical engineer to the Government of Bengal. The book consists of six lectures delivered to native students at Sipur Civil Engineering College, and is published by the Bengal Secretariat Press.

Another Electrical Exhibition.—It is stated in the French Press that a proposition by the Société Electrotechnique of Vienna to hold an electrical exhibition in that town in 1903 has been received with great favour. Committees are already being formed, and numerous enquiries have been made as to the details of the exhibition. Everything apparently is to be done to make it a success, and the work of organisation has already commenced.

A Substitute for Coal.—It is, we learn, proposed to use the great beds of peat which exist in Northern Germany for the purpose of producing electricity on a large scale. There are about 1,000 square miles of peat area, and an enormous quantity of good fuel could be obtained therefrom. The fuel from this source should prove to be very cheap when compared with coal, and both producers and consumers would, we think, obtain some benefit from its use.

A New Fire Alarm System.—We notice that the Berlin Fire Brigade have been experimenting with a new system of fire alarms introduced by Messrs. Mix and Genest. The most important feature of the system, apart from its simplicity and reliability, is that with the aid of simple wire connections any number of private alarms may be connected to each public alarm pillar at a very low cost, whereby the fire brigade may be communicated with from a large number of points.

Spark Length.—With reference to the note under this heading in our last week's issue, Mr. H. W. Geare has forwarded to us the following results of some experiments conducted by him, and which are of considerable interest. He employed a two-plate Wimshurst machine with glass plates, the apparatus being arranged as described in our note. Without the glass tube he obtained a spark $1\frac{3}{8}$in. long, but on placing the glass tube just in front of the positive pole, facing towards the negative, the spark was 5in. long. The glass tube that answered best he found was about 8in. long and $\frac{7}{16}$in. diameter.

French Cables.—The French Cable Committee, at the end of their report to their Government on the feasibility of constructing lines of cables, suggests the following lines: a line to Tangiers, a length of 290 miles, at an estimated cost of £32,000; a line from Brest to St. Louis, 2,500 miles, at a cost of £680,000; a line from Hué to a point north of Hong Kong, about 1,000 miles, at a cost of £220,000; a line from Tamatave (Madagascar) to Réunion, 455 miles, at a cost of £72,000; and lines in the Benin Gulf and French Congo. These lines the commission urge should be started immediately. Other lines are mentioned for which the need is not so pressing.

Automobile Driving.—Mr. J. P. Collins, of Scranton, has invented a "twin motor" for driving and steering automobiles, in which the driving wheels turn independently of each other. The motor is of very light construction, having a single field casing with two parallel armatures which operate independently, and whose shafts may be connected to the independent driving wheels of the automobile, so that these wheels may be driven at the same speed to propel the vehicle in a straight line or at varying speeds for turning corners. There are, no doubt, several good points in connection with this motor, which is illustrated in the *Electrical World*, but we are inclined to think the advantages gained are hardly worth the extra cost of construction.

Russia.—According to reports to hand, the introduction of electric traction and lighting into South Russia is making rapid headway. A Belgian has obtained a concession to construct and work an electric tramway in the town of Poltawa. The necessary capital will be found by a limited company to be promoted in Brussels. It is intended to commence the construction of the line next spring. Further, the Belgian Street Railway Company in Odessa have obtained a concession to construct and work an electric railway in Winnitza, and to light the town by means of electricity for a period of 30 years. Not long since a cable works was opened in Kiew. At present it is producing only insulated wires for telegraph and telephone work, but later on it is intended to instal plant for the manufacture of electric light cables.

Electric Traction in Greece.—The United States Consul at Athens reports that the Athens to Piré Railway Company under its charter is bound to adopt within three years' time electrical driving on its line. The line runs from the Quai du Piré into the centre of the town of Athens. Its length will be five miles, of which three-quarters of a mile will be in a tunnel running under a portion of the town. A Belgian company owning a steam line between Athens and Piré is also desirous of adopting electricity, but has not at present arranged for the conversion. A large number of passengers are carried on each of the lines. The president of the first company will visit the Paris Exhibition to investigate the electrical machines shown, and to consider which is the best system of traction for the line he represents.

Indian Telegraphs.—The Telegraph Department of India has established a new record in telegraph construction. It has been recognised for a considerable time that the Indian Telegraph Department has done remarkably good work, and the latest report tends to confirm this. Thus the Indian correspondent of the *Financial News* states that a smart piece of work has been executed in the laying of the new line linking Bombay and Madras. Orders for the erection of the new telegraph wire from Bombay to Madras, a distance of about 800 miles, which was required in connection with the abnormal traffic with the Far East, were issued on July 7 last. Work was commenced on July 15, and concluded on Aug. 14. This is a result of which the Telegraph Department may be justly proud, and the good work of the officers and men engaged is recognised by the authorities.

Damaging Telegraph Wires.—Just retribution has fallen on a lad named David Pritchard, who has been amusing himself lately by throwing stones at telegraph wires and insulators in the Harewood End district. This is not the first time that the boy has got into trouble for the same offence, as he was let off last December on the understanding that his parents should punish him. The damage done consisted of the breaking of seven insulators, and if such damage were to continue it would be a constant source of annoyance to the telephone employés. After deliberating in private, the magistrate said the Bench believed defendant to be guilty, and this was a thing that must be stopped. He was liable to a fine of £10 or three months' imprisonment, but they would be lenient, and hoped defendant's father would look after him in future. He would be fined £1 including costs. This verdict will probably help the father to look after his son, but we think

Digitized by Google

a liberal application of the birch would have a more lasting effect on the boy himself.

Lift Accidents.—The lifts at the London Bridge Station of the City and South London Railway were again recently the scene of an accident. The lifts at this place seem to have lately been under repair, and this last accident, like the more serious one of a month or two ago, was apparently the result of carelessness on the part of the workmen engaged. The previous accident it was shown could easily have been avoided, and this one, in which a workman was caught between the lift and lower platform, could also have been avoided if care had been taken. It is a pity that accidents of this sort occur, as they do not tend to increase the trust which people should place in electric railways. One or two accidents of this kind are sufficient to deter many people from using the electric railways, and make it harder for this method of travelling to become popular with the public.

Range-Finding.—During the Spanish-American war, at the bombardment of Santiago, the range-finding apparatus used by the Americans broke down, and became practically useless. The guns on which these range-finders were used were naval guns, and the *Electrical World* comments to the effect that the high-power mortars, for which the United States alone seems to have a preference, were not supplied with range-finders at all. The big guns were also without them, and consequently half their usefulness must have been taken away. In this matter our contemporary thinks that electricity should be brought to the aid of the gunner, and the range-finders now used might be greatly improved. From what we have ourselves seen of range-finders on this side of the water, we should say that much less delicate and, at the same time, quite as accurate instruments might be constructed as those now used. The time taken in getting the instrument properly placed, and the trouble experienced in keeping it in position afterwards, are great drawbacks to its use. The *Electrical World* also suggests that motors might be used to elevate and depress large coast-defence guns, and to turn them on the firing platform, as is done on ships in the Navy.

British Institution of Draughtsmen.—On the 7th inst. the members of the Manchester branch of the above institution visited Blackpool for the purpose of viewing the Corporation electric light station and the generating station of the Blackpool and Fleetwood Tramway Company. The former was especially interesting, owing to the various types of generators employed, which included Ferranti flywheel type, Fowler horizontal engines, driving by ropes Fowler alternators and Parsons turbo-generators. The latter type are also used for generating the continuous current for driving the cars. The turbines and the Ferranti rectifiers received marked attention from the visitors. It was noticed that extensive alterations are in progress, including what promises to be an unusually large chimney-stack. The members were much indebted to Mr. Robert C. Quin, the borough electrical engineer, for his kindness. The generating station of the Blackpool and Fleetwood Tramway Company was also interesting, owing to its symmetry and compactness. The visitors were received by Mr. MacMahon, who kindly explained the points of interest. The plant consists of five combined sets of 150 kw. each by Mather and Platt, and has run since its installation without any mishap.

Automatic Issue of Tram Tickets.—Several of our German contemporaries describe an electrically-actuated device designed by Herr Fritz Krull for the automatic issue of tickets on tramcars. The Germans have long since come to the conclusion that it lies in the interest of the tramway companies to issue tickets to the passengers travelling over their lines through the medium of reliable automatic machines, rather than through conductors. This applies not only for short lines with an infrequent service of cars, where conductors can well be entirely dispensed with, but also for lines upon which a conductor is necessary, owing to the frequent service of cars. In the latter case the employment of apparatus for the automatic issue of tickets to passengers enables the conductor to devote his whole attention to the control of the traffic, thereby enhancing the safety of the service. But hitherto attempts to introduce automatic ticket sellers on the electrically-worked lines have been unsuccessful, owing to the inability of such apparatus to withstand the violent shakings and concussions to which it is subjected. The latest device, however, is claimed to overcome this objection, and to satisfy every other requirement, even down to rejecting base coin.

The Electrolytic Production of Gases.—In an article contributed to the *Zeitschrift füer Elektrotechnische*, Herr M. U. Schoop considers the commercial production of oxygen and hydrogen by electrolysis, with special reference to the use of oxyhydrogen gas for soldering purposes. What appears to be a very efficient water electrolyser, of German design and manufacture, is described in the course of the article. In his concluding remarks the author compares the well-known disadvantages attending the production of hydrogen by chemical means with the advantages claimed for the electrolytical generation of the same. These latter, apart from the relative cheapness of the process, consist in that hydrogen produced by electrolysis, owing to its ideal purity, enables a flame of far more intense heat to be obtained, whereby quicker work and better soldering are rendered possible, while at the same time the gas gives off absolutely no fumes calculated to injure the health. It is further pointed out that with the exception of replenishing the electrolysers with water once in every 14 days, the apparatus requires no attention whatever. Having regard to these distinct advantages, Herr Schoop thinks there should be little difficulty in deciding to which process to give the preference.

Photographic Exhibitions. — We have received notices of the holding of two photographic exhibitions. The first, that of the photograhic salon, is to be held at the Dudley Gallery at the Egyptian Hall from Sept. 21 till Nov. 3. This is the eighth year of this exhibition, and the aim of the committee is stated to be to exhibit only that class of work in pictorial photography in which there is distinct evidence of personal artistic feeling and execution. The other exhibition, that of the Royal Photographic Society, is to be held from Oct. 1 to Nov. 3 at the New Gallery, at 121, Regent-street. This will be the forty-fifth annual exhibition, and it will be inaugurated on Sept. 29 by a private view followed by a conversazione. The exhibition will be opened on weekdays upon the days named from 10 a.m. to 6 p.m., and on Monday, Thursday, and Saturday evenings from 6 to 10 p.m. On these evenings lantern slide exhibitions are to be given. The admission at any time will be 1s. The exhibition will be divided into five sections—viz.: pictorial photographs; general professional work; photographic apparatus and material; photomechanical processes of reproduction; and scientific photography and photography in its technical applications. This exhibition, unlike the one previously noticed, will be a competitive one, and medals will be awarded for the best work.

Transformers.—Various proposals have been made, says the *Elektrotechnische Rundschau*, to employ stationary

Digitized by Google

armature coils and commutators for the conversion of alternating currents into continuous currents, by generating a rotary field in the armature and revolving the brushes. With regard to construction and efficiency, such an arrangement would offer many advantages, especially in that its magnetic lines in the stationary armature could have a closed path, and it would, moreover, be required to set small masses only in motion. That this method of transforming has hitherto found no practical application worthy of note must be attributed mainly to the fact that the collection of the transformer current, which, according to the proposals hitherto made, would have to be accomplished by means of revolving brushes bearing upon slip rings, presented great difficulties. The "Helios" Company, of Köln-Ehrenfeld, have, however, surmounted these difficulties by constructing a transformer with a stationary armature, in which the continuous current yielded is collected from points of the armature winding or of the transformer winding, which excites the armature, in either case, therefore, from stationary points. In this manner the function of the brushes becomes of minor importance, while the construction and arrangement of the brushes is simplified and the use of slip rings avoided.

Electricity v. Gas.—The *Electrical World* of New York publishes a summary of the convention of the Ohio Electric Light Association which was recently held at Toledo in that State. Amongst the papers, which seem to have been generally of a very instructive nature, was one by Mr. W. F. White, of the Cincinnati Edison Company, discussing the relative merits of gas and electricity for street-lighting. The gas lighting, with which electricity was compared, was with Welsbach burners. In his paper Mr. White stated that electricity was received with universal favour for public lighting. About 60 per cent. of the cities in the United States with populations of over 25,000 were shown to have adopted electricity, and the other 40 per cent. were rapidly reaching the same point. It was, he stated, shown that electric lighting was cheaper, in that the lighting companies provided all the equipment, in addition to the much better lighting of the streets. In order to show the advantage in extra illumination, photographs were shown of street-lighting with Welsbach lamps and those lighted with electricity. In the paper Mr. White states that one arc lamp of 800 useful candle-power gives as much light as 20 Welsbach lights of 40 useful candle-power. The photographs of the streets lighted electrically, it is interesting to note, were exposed for 12 minutes, while with the Welsbach lights considerably over 20 minutes was needed to get any picture at all.

The Central London Railway v The 'Buses.—The *Financial News* published recently a comparison of the takings of the London General Omnibus Company and the London Road Car Company on certain days of last and the present months with those of the corresponding days last year. The comparison was made in order to show the effect which the Twopenny Tube has had on the receipts of the above-mentioned companies. There can be doubt but that this effect is considerably felt, and will probably be felt still more in the wet and cold days which are not so far hence. Nothing could be more natural than that the electric railway should take away a large number of 'bus passengers. In the first place, the fare is much cheaper and the journey is accomplished in a much shorter time. One also remembers the discomforts of sitting either inside or outside of a 'bus in wet weather, and again the tube seems more attractive. In the five days for which figures are quoted the average drop in receipts per day by the Road Car Company is about £740, while with the General Omnibus Company it amounts to about £1,360. It is interesting, however, to note that the securities do not show much indication of the competition, as when the Central London Railway was opened London General stock was 170-180, and is now about five lower at 165-175. London Road-Car shares were then selling at 8½-9½, and are now about 8-9.

Wireless Telegraphy.—Mr. Marconi it appears is not to have a monopoly of wireless telegraphy, as other inventors appear to be making great efforts to outshine him. His latest rival is Prof. Rosenberg, who has invented a system with which he communicates from office to home, etc. It is stated that the system is yet in its infancy, but its inventor promises great things for it. When one wishes to be in communication with home or office, one has to carry a receiver with him. At present this would be rather a burdensome task, as the receiver is a rather cumbrous object. Prof. Rosenberg is, however, going to reduce it to pocket size, and then one can go anywhere within a certain radius, and still know what is going on at home. The inventor, who recently gave a demonstration of his instrument at the Crystal Palace, claims to have greatly improved on the Marconi system. He can transmit messages 40 miles or more through the air, and can also intercept other wireless messages. He claims to have done this on Hampstead Heath, but the persons communicating were evidently prepared for him, as he seems rather disappointed to find that they were either sending nonsense messages or were using a code with which he was unfamiliar. The exhibition at the Crystal Palace does not seem to have been such as to make the shareholders in the Marconi Company despair entirely, but we await the promised further development of Herr Rosenberg's system with interest.

A New Telephone System.—The new system of telephones recently brought out by the North Electric Company, of Cleveland, is worthy of mention. It is of the central battery type, having signalling equipment located at the central office, and being arranged so that the subscriber calls up the operator automatically by lifting the receiver from the hook. On the removal of the receiver an automatic gravity-restoring line signal is shown at the switchboard, indicating that a call is wanted. The operator, by inserting the answering plug, also automatically restores the line signal and establishes connection. On inserting the calling plug to call the subscriber required both the operator's and caller's sets are switched out while the generator current is on the line. In connection with each side of the cord circuit is a supervising signal, indicating when the talking is finished. The operator never has to cut in on the line to ascertain whether the conversation is ended, and at no time has she to use the line except to ask the number required. The North Electric Company claims with respect to this "supervisory" system that there is no centralised battery system having so small a battery consumption as there is in the regular operation of this system. In fact, it is to be perfectly practical in most exchanges to use ordinary closed-circuit types of batteries. This is an important feature to be considered when making out estimates of the maintenance expense of an exchange. A very neat and efficient power plant is provided, and also an alarm relay giving an automatic signal at any time an exceptional drain on the batteries occurs. It is also claimed that an operator with this system can take charge of a considerable larger number of lines than with the old magneto-call type.

Electric Railways in the States.—The extent of the development of electric street and other railways in the United States has been recently shown by a report of the United States commissioner of patents. The report,

Digitized by Google

which appears in *Cassier's Magazine*, states that the first electric street railway in the United States was put in operation little more than 10 years ago. In 1880, of the 2,050 road miles of street railway in the country, nearly all employed animal power. Electric power had not yet come into use, but a few miles of lines were operated by steam and by cable. The total number of persons then employed on American street railways was very nearly 12,000. Ten years later, in 1890, the United States census gave the number of street railway employés as 37,434, and at the close of that year the total mileage of street railways all over the country was given as 8,123 track miles, on 5,661 of which horses were used, while the remaining 2,493 miles were worked mainly by electric and cable power. The capital invested in these roads was about £42,255,558, and 71,000 persons were employed by them. In 1894 the total mileage was 12,527, of which 7,470 was electric. The capital invested was £129,666,151, of which £84,698,644 were invested in electric railways. One hundred and ten thousand persons were employed on street railways in that year. In 1896 the mileage had increased to 14,470, of which 12,133 miles were electric. The capital invested was £156,962,756, and the number of persons employed was over 140,000. The total mileage of electric railways in the United States up to October of 1897 was 13,765 miles, out of a total mileage of 15,718, and of these but 947 miles were horse-car lines. The total capital invested was £169,226,338, and the number of employés over 166,000.

Resistance of Thin Films.—Mr. A. C. Longden in the August number of the *Physical Review* continues his notes on the "Electrical Resistance of Thin Films deposited by Kathode Discharge." The instruments for measuring the resistance which were used in these experiments were exceptionally accurate, and had a wide range. Beyond this range the resistance was measured by the direct deflection method. In applying this method a new form of water battery was used, consisting of two copper plates, one of which was amalgamated with mercury containing a little zinc. This plate was equivalent to a zinc plate, but it did not dissolve in the cell or become brittle like zinc plate does. The resistance of this cell may be varied with its size, or by the introduction into the water of a very small quantity of sulphuric acid. The cell, if properly made and sealed, requires no attention for many months, and its E.M.F. is practically constant. It, however, polarises very quickly, and is only of use on high-resistance circuits. In measuring the temperature coefficients of film resistances, it was soon noted that the very thin films had negative temperature coefficients, and all the thick ones had positive temperature coefficients, and that for a certain range of thickness the temperature coefficients were almost at zero. Density also probably helped to produce this zero result. The length and width of all films tested were uniform, being 5cm. by 15mm. The author then describes the process of adjusting and standardising the film resistances, the choice of a metal for the production of standard film resistances, etc. The metal he chooses for the standard is platinum. His conclusions, stated briefly, are as follows: The process of depositing metals by kathode discharge is probably simple distillation, in which the vaporisation of the kathode is largely due to its electrification; the temperature coefficients of the very thin films are negative, and for films within a certain range of thickness the temperature coefficients are approximately zero; the necessity for artificial ageing is proportional to the magnitude of the temperature coefficient. He states that in general his method is capable of producing standard electrical resistances of a very high degree of precision, and of any desired value, from a few ohms up to several megohms; that these resistances may be made of pure metals, and that they are therefore free from the possibility of decomposition changes; that the metals may be those least likely to enter into chemical combination with other elements; and that, in addition to these qualities as pure metals, they possess the only desirable qualities of alloys—namely, high specific resistance and low temperature coefficients.

Rubber.—We notice in various American papers a report by Mr. O. J. D. Hughes, United States Consul at Coburg, on the German rubber trade. In this report he states that the import of crude rubber into Germany in 1899 amounted to over 13,000 tons an increase of over 50 per cent. in value over those of the year 1897. The exports of raw material amounted to nearly 5,400 tons, estimated at about £143,000. The United States Consul in Sierra Leone, in reporting on the rubber industry in that colony, says that the supply to Freetown market mostly comes from the hinterland of Sierra Leone and from the French protectorate further in the interior. This latter is, however, limited, owing to the export tax of about 1½d. per pound which is placed by the French on all rubber sold by natives outside the protectorate. This rubber though nearly always adulterated with clay, yet commands a high price. As in South America the natives in Sierra Leone bleed the roots of the trees occasionally in order to increase their stock. This kills the trees, and at the same time the rubber obtained is of a very inferior quality. In buying the rubber from the natives great care has to be taken by the agent with respect to adulteration. There are two classes of this, incidental and intentional. The former is the result of carelessness on the part of the gatherers, who do not use proper receptacles for the juice. Intentional adulterations are due to efforts to increase volume and weight by use of dirt, sand, bark, and sometimes stones. Another species of fraud is the mixture of other non-elastic gummy substances with pure juice; still another is to soak rubber by placing it in pits close to the water for a long time. Rubber so treated is seriously injured in quality, and at the same time increased in bulk and weight. The colonial authorities, as well as the chambers of commerce, are endeavouring, by proper instructions to those concerned, to discourage these abuses, and to emphasise in every way possible the importance of improving the quality of the rubber brought to Freetown Market. There is being inaugurated by the governor and officials a plan to foster the planting of rubber trees and vines in the colony. To this end they have caused to be issued pamphlets of instructions in regard to seedings, transplanting, etc., through the departments of agriculture and horticulture. It is hoped that there will be a decided improvement in the quality and quantity of the exports in the near future. The value of the rubber exported from Sierra Leone in 1898 was about £51,000, of which the amount shipped to Germany was £6,700, the remainder going to England.

Popularising Electricity.—In a recent number of the *Universal Provider* is an article dealing with the question of increasing the popularity of electricity for lighting purposes amongst the ordinary public. Up to quite recently the use of electricity for lighting was confined to shops, offices, etc., there being comparatively few places in which it was used in residential districts. Many of the causes of this state of affairs have now been removed, and the ordinary gas-using householder could with great advantage to himself in most of the larger towns change over from gas to electricity. The unreliability which in past years greatly militated against the success of

Digitized by Google

electricity as an illuminant has practically been done away with, and it is only on rare occasions that inconvenience is caused owing to the failure of the light. The cost of electricity has also in recent years decreased some 40 or 50 per cent., and it can be now obtained in most cases more cheaply than gas. In the fittings also great improvements have been made, and instead of the old expensive, badly-made, and short-lived fittings, we now have articles which are almost perfect. The initial cost of wiring and fitting houses is even now somewhat heavy, but in a number of cases the fitting and wiring is done by the company or municipality, and the cost repaid in the same way that the free gas fittings are. This, however, sometimes comes rather heavy on certain consumers, and a plan has in certain instances been adopted whereby the landlord or householder obtains an estimate from a local contractor. If he desires hire purchase he submits his scheme to the lighting corporation, who, on the condition that the consumer undertakes to wipe off the amount in a certain number of quarterly sums, pays the contractor, less 5 per cent. for cash. The installation is afterwards maintained by the consumer. This system seems to be fair to the lighting companies, local contractors, and customers alike, and has the merit of simplicity. In cases where tenants occupy premises under agreements for short terms the landlord is made a party to the contract, so that the wiring becomes his property on the cessation of the tenancy. As regards meters, there seems to be a tendency on the part of those who supply the current not to follow the example of the gas companies in charging rent for their use. This seems but fair, as it is hard to see why the consumer should have to pay for having the current measured for the convenience of the supply corporation in making up their bills. Much might be done also by vestries and corporations if they laid new mains in their newer districts and wired numbers of new houses on the off-chance of securing their owners as customers. The investments in the face of the above facts would probably prove very successful.

An Interesting Scheme.—Some particulars of an interesting scheme now in course of execution for the supply of Lausanne with electricity for lighting and power purposes were given in a recent issue of the *Schweizerischen Bauzeitung*. The most noteworthy feature in connection with the undertaking is that the energy will be transmitted in the form of high-pressure continuous current over a distance of 56 km., and afterwards distributed in the form of three-phase current to consumers in Lausanne. The generating station will be situated near St. Maurice, in the upper valley of the Rhone, which river will furnish the motive power for driving the generating plant. At the point selected the available fall of water varies between 34·5m. and 36m., which yields a minimum of 6,000 h.p, while during 10 full months of the year 14,000 h.p. may be obtained. The initial instalment of plant will comprise five turbines with horizontal shafts, each capable of developing 1,000 effective horse-power when running at 300 revolutions per minute. To each of these turbines will be direct-coupled two continuous-current dynamos, designed to yield a constant current of 150 amperes. These 10 generators will be connected in series according to the immediate requirements of the load, a maximum line pressure of 22,000 volts being available with all the generators so connected. The terminal potential will be maintained constant by automatic regulation of the speeds of the generators. The constant current generated will be conveyed by means of two bare conductors of each 150mm² sectional area to Lausanne, 56 km. distant from the generating source. The loss of energy in these conductors is not to exceed 300 kw.—that is to say, one-tenth of the full load. In the immediate proximity of Lausanne a transformer station is to be erected. This will contain at first five continuous-current motors coupled in series, and driven by the current generated by the plant in St. Maurice. These motors will each have a capacity of 400 h.p. running at a constant speed of 300 revolutions per minute. They are destined to drive three-phase generators of equivalent output, with a line pressure of 3,000 volts—that is to say, 1,730 volts in each phase. Two of these groups of transformers are to be supplemented by vertical steam engines of 400 h.p. each at 300 revolutions per minute to serve as a reserve. By means of the latter provision it will also be possible to inaugurate the supply of electrical energy to consumers before the installation in St. Maurice is completed. The three-phase current will be distributed by means of underground cables to some 30 transformer substations situated in various parts of the town, in which the pressure will be reduced to 125 volts for final distribution to consumers.

Terrestrial Magnetism.—We notice in Mr. Carl Hering's digest in the *Electrical World* an abstract of a paper read by Mr. Sutherland on "Earth's Magnetism" before the Australasian Association for the Advancement of Science. The author states that a possible cause of the earth's magnetism is the rotation of an electrostatic field within the earth. He treats analytically the case of a sphere revolving around a central axis and charged with electricity of a given surface density; he shows that the formula of the magnetic field in this case has exactly the same form as that of the potential for a uniformly magnetised sphere, or for a sphere with an infinitely short magnet of finite moment at its centre. To account for the magnetic field of the earth, the electrostatic surface density has to be 51,000 electrostatic units; such a charge would produce an enormously strong electrostatic field at the surface of the earth, for which there is no evidence. But if we imagine the equal and opposite electric charge gathered at the centre, it would completely neutralise the electrostatic field due to the surface charge, while by being at the centre it would fail to affect the magnetic field of the surface charge. This gives an ideal model of the earth's magnetic field as produced by the rotation of a powerful internal electrostatic field; the magnetic field outside the earth would be the only external evidence of the existence of the electrostatic field within. Calling the field got by averaging round circles of latitude the primary, and the residual field which causes the want of coincidence between magnetic and rotational axes the secondary, our possible cause for the primary is such as will prevent the primary field from sharing in the earth's rotation. Thus the substance of the earth revolves through a magnetic field which is as fixed as if derived from fixed external magnets. The earth, with magnetic material in it and with a conducting crust, is somewhat like a dynamo armature revolving in the field of the exciting magnets. The magnetic material intensifies the primary field of the last section by magnetic induction, and if the permeability is unsymmetrical the induced field may not lie in the same direction as the inducing. The actual obliquity of the magnetic to the rotational axis is therefore traced to unsymmetrical magnetic permeability of the earth, which also causes the induction of the earth currents, the secular variation of whose tracks is the cause of the magnetic secular variation. The theory advanced by the author to account for daily variation is that under the action of the sun's rays the oxygen and ozone of the atmosphere become the active substance of a large secondary battery whose alternate charge and discharge are the cause of the daily variations.

Digitized by Google

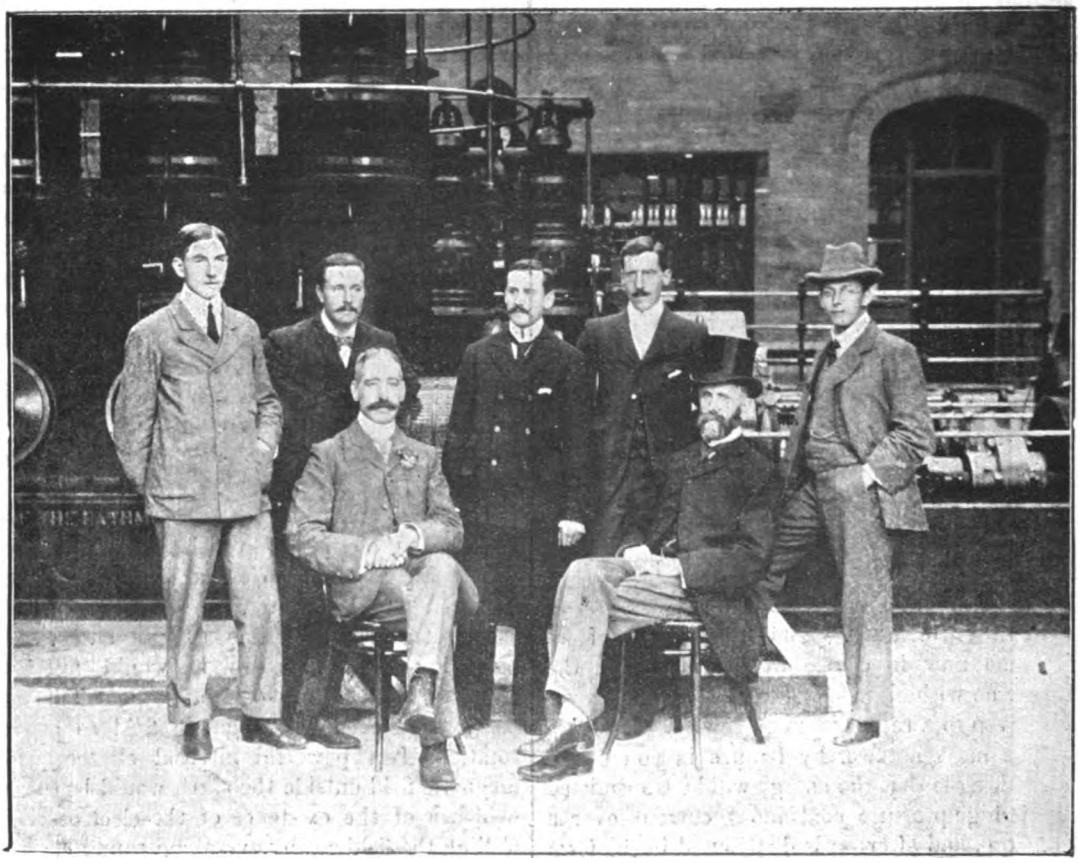
RATHMINES MUNICIPAL ELECTRICITY WORKS

The question of providing a supply of electricity for Rathmines first received practical attention in 1895, when, principally owing to the exertions of the late Mr. Samuel H. Bolton, J.P., a special committee was appointed to consider the advisability of establishing a municipal supply. It was the general feeling that the work should be undertaken by the local authority—then the Rathmines and Rathgar Improvement Commissioners—and as a first step towards the realisation of the project the Commissioners authorised the committee to make application to the Board of Trade for a provisional order under the Electric Lighting Acts. The result was the granting of the Rathmines and Rathgar township electric lighting order in 1896, the Royal assent to the confirmatory Act being accorded on July 20 of that year. In the meantime the Commissioners had consulted Mr. Robert Hammond, of Westminster, as to the best means of fulfilling their statutory obligations under their order. At the same time the committee devoted themselves to an energetic investigation of the practical issues of the project, and although rather a long interval took place between the granting of the order and the decision to proceed to lay down the works, the time was not ill-spent, since it enabled the committee to take advantage of the experience that was afforded by the successful operation of many electricity works that had been established by municipal authorities. In July, 1898, Mr. Hammond was authorised to prepare the necessary plans and specifications for the generating works and mains, and tenders for the various sections of the work were publicly invited in the following year. These were carefully examined by the committee, and on their recommendation the Council eventually gave out the contracts as follows:

R. Taylor and Sons, Marsden, Yorks, boiler-house plant.
Mather and Platt, Manchester, engine-house plant.
J. Spencer, Limited, Wednesbury, pipework.
Wheeler Condensing and Engineering Company, U.S.A., condensing plant.
Klein Engineering Company, Manchester, water-cooling plant.
Higginbottom and Mannock, Manchester, travelling crane.
James White, Glasgow, switchboard and testing instruments.
Tudor Accumulator Company, London, accumulators.
British Insulated Wire Company, Prescot, supply mains (insulated cables and trench work).
S. Z. de Ferranti, Limited, Hollinwood, house meters.
Verity's, Limited, Birmingham, arc lamps for public lighting.
General Electric Company, London, incandescent lamps for ditto.
J. Donovan, Dublin, buildings.

System of Supply.—The direct-current three-wire system is employed, energy being supplied to consumers at a standard pressure of 220 volts for lighting and for small motors, and 440 volts for motors requiring more than 5 kw.

Site of Station.—The generating works are situated in a convenient central position on the Council's land at the rear of the town hall, where adequate space for extension is available. The buildings form a substantial structure of brick and stone, and comprise engine and boiler houses, battery and test rooms, engineers' offices, stores, and workshops. The engine-house is 37ft. wide, the length from the wall at the back of the switchboard to the temporary end being 48ft. Parallel with it is the boiler-house, and on the opposite side are the workshops and the chief assistant's offices. The battery-room, test-room, and general offices form the front part of the group.



RATHMINES ELECTRICITY WORKS.

MR. L. L. ROBINSON.
MR. S. T. LAND, Chief Assistant.
MR. H. M. TAYLOR.
MR. G. F. PILDITCH, Resident Engineer.
MR. SPENCER HAWES.
MR. R. DEENE BOLTON, Chairman of the Electric Lighting Committee.
MR. F. P. FAWCETT, Clerk of the Council.

Boiler-House Equipment.—The steam generating plant comprises three Lancashire boilers, made by Messrs. Robert Taylor and Sons, of Marsden, each 30ft. long and 8ft. in diameter. They are constructed of six rings of mild steel, and have an evaporating capacity of 7,000lb. of water per hour at a pressure of 160lb. per square inch with the feed water at 60deg. F. Regular firing is secured by mechanical stokers of Messrs. Vicars's manufacture. The flue dampers are handled from the boiler front by means of counter weights sliding in guides calibrated to show the extent of the opening. A full complement of safety fittings, valves, and gauges were supplied by Messrs. Hopkinson. The lagging of the boilers with fossil meal to a depth of 3in. was undertaken by Messrs. Haacke and Co. A double-ram steam-driven pump by Green's, a Holden and Brookes

Digitized by Google

injector, and an electric combination consisting of a Lundell motor with a three-throw single-acting pump by Blake and Knowles, are provided to deal with the feed water. The steam and feed pipes are of lap-welded steel, the latter galvanised, and the lagging is of sectional magnesia covering. The contract for the pipework, including the erection of the cast-iron feed tank and the feed-water heater, has been carried out by John Spencer, Limited, of Wednesbury. For the purpose of heating the feed water on its way to the boilers, one of Green's economisers, containing 96 tubes, has been erected in a by-pass from the main flue between the boilers and the chimney stack, and is capable of easy enlargement when required. The scrapers of the economiser and the mechanical stokers are operated through belting by an iron-clad 6-b.h.p. motor from Messrs. Crompton and Co.'s works at Chelmsford. Fig. 1 gives a good view of the boiler-house and arrangement of feed pump, pipes, etc.

Engine Room Plant.—In the engine-room (Fig. 2) there are two sets of generating plant, one of 300 kw capacity and the smaller of 150 kw., the two being capable of supplying electrical energy for about 22,500 lamps fixed on consumers' premises. With the aid of the accumulators the demands of 30,000 lamps could be dealt with. Each set consists of a pair of four-pole direct-current Mather and Platt dynamos, driven by a Willans central-valve engine. The larger engine has three cranks and nine cylinders, and runs at 320 revolutions per minute. The smaller engine has two cranks and four cylinders, and deals with its maximum load at a speed of 360 revolutions per minute, the working steam pressure being 150lb. to the square inch. Steam separators are fitted to each engine, and lubrication is effected automatically. The guaranteed steam consumption at full load when running condensing is 24½lb. per kilowatt-hour for the 300-kw. plant and 29lb. for the 150-kw. set. A Mather and Platt motor-generator is provided for the charging of the regulating cells of the battery of accumulators. A jet condenser with a steam-driven direct-acting pump has been fitted in the cellar by the Wheeler Condensing and Engineering Company. It maintains a vacuum of 26in., and raises the water to the top of a Klein cooling tower, where it is reduced in temperature by about 30deg. F. This tower cooler uses natural draught, and is able to deal with 40,000 gallons of water per hour. The engine-room is traversed by a 10-ton crane supplied by Messrs. Higginbottom and Mannock, of Manchester.

Switch Gear.—The switchboard (see Fig. 2), surmounted by an electrically-wound clock, is situated on a platform at the end of the engine-room, and stands upon a plinth of glazed bricks 18in. high. Its length is about 17ft. The board is divided vertically into three panels, the arrangement being as follows:

Positive Panel.	*Centre Panel.*	*Negative Panel.*
Feeder ammeters.	Voltmeters.	Feeder ammeters.
Feeder switches.	Battery regulators.	Feeder switches.
'Bus bars.	Booster switch and ammeter.	'Bus bars.
Dynamo ammeters.	—	Dynamo ammeters.
Dynamo switches and regulators.	Neutral bar.	Dynamo switches and regulators.

The necessary labels are provided in three distinct colours, indicating the purpose and polarity of each piece of apparatus. Provision has been made on the outside panels for four dynamos and for nine three-wire feeders, also for the main circuit of the battery. The centre panel carries the electrostatic voltmeters for the "pilots" and battery, together with the ammeters for the "neutral" and the earth mains, together with a protective device to short-circuit the earth current recorder. In each dynamo circuit is a minimum cut-out, an ammeter, a two-way switch and fuse, and a shunt regulating switch. One polarised voltmeter serves each pair of dynamos. Each feeder has two ammeters, with duplex switches and fuses fixed on the upper half of the outer panels. A chamber below the switchboard contains the neutral bar and the registering watt-hour meters on Aron's three-wire system. The battery is arranged to be charged by the booster in conjunction with the generators. A multiple contact switch for regulating the supply when taken from the accumulators is situated in the accumulator-room, and is operated through rods and chain gear from hand-wheels fitted at the bottom of the centre panel of the switchboard. The booster gear consists of an ammeter and double-pole two-way switch and fuse, with a starting switch for the motor side. A Crawley automatic switch protects the dynamo of the booster, and a double shunt regulator permits the insertion of a variable resistance into the field-magnet circuits. Messrs. J. White, of Glasgow, the sole makers of Lord Kelvin's instruments, erected and connected up the board and made all the apparatus thereon excepting only the watt-hour meters.

The Accumulators.—The battery consists of 274 Tudor cells, each cell consisting of six positive and seven negative plates in a lead box. They are arranged in two tiers upon

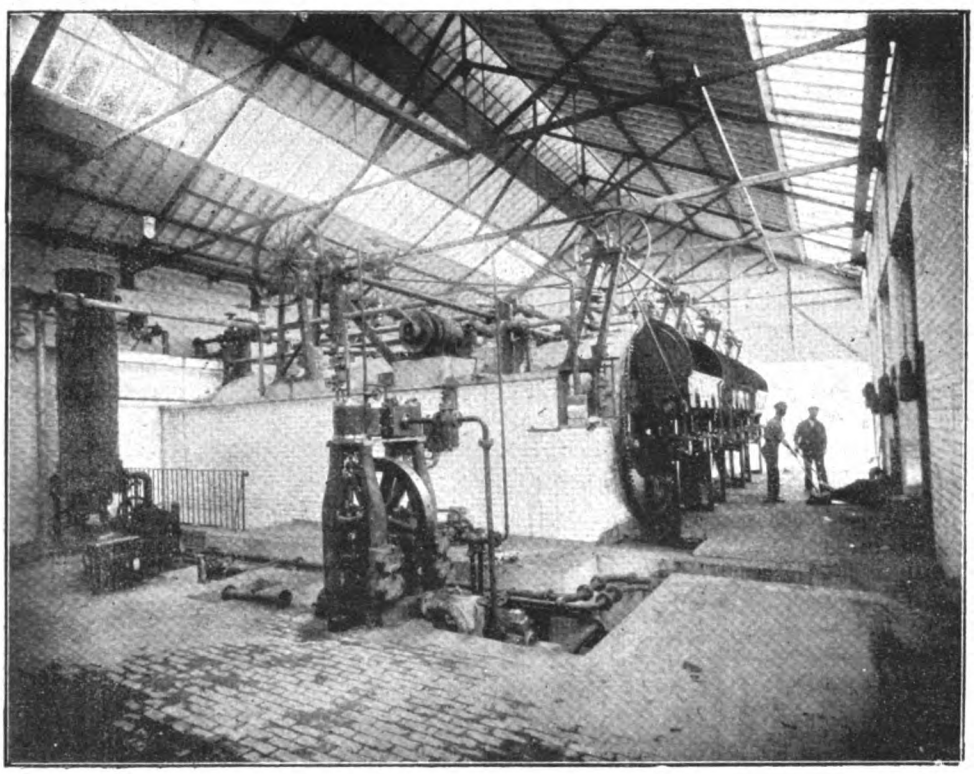


FIG. 1.—View of Boiler-House, Rathmines Electricity Works.

Digitized by Google

stout oak frames, which are protected from acid spray by a coating of special paint. Forty-nine cells on each side of the neutral wire serve as regulators, and are connected in steps to the steps on the regulating switch by bare copper rods. The battery is capable of discharging 80 amperes for 10 hours with a terminal E.M.F. of 500 volts. The normal and maximum rates are 120 and 150 amperes "on charge," and 80 to 216 on "discharge" respectively.

Distribution.—The whole of the work connected with the manufacture and laying of the cables has been carried out by the British Insulated Wire Company. The solid system has been adopted, all the feeder and distributor cables being triple-concentric paper-insulated and lead-sheathed. They are laid in cast-iron troughing filled in solid with pitch tempered with resin oil. For the distributing network ·10 and ·05 square inch cables have been laid, the outer conductor forming the "neutral" of the three-wire system. There are at present seven feeders, comprising ·4 and ·3 square inch cables. For the public arc lamps $^{7}/_{16}$ single cables are used, while concentric cables are employed for the incandescent street lamps and for house connections. Altogether 45 miles of cables have been laid. This does not include the pilot wires, which are laid in the same London and Dublin. They are connected through a switch and fuse in the base to the distributing network.

Scale of Charges.—Under their electric lighting order the Council are authorised to charge as much as 8d. per unit for electricity, but with the object of placing the supply at the disposal of all classes of consumers the Council have adopted the following moderate rates: 6d. per Board of Trade unit for private lighting and 3d. for power and heat. A discount of 5 per cent. is allowed off the above-named figure which brings down the prices approximately to 5¾d. per unit for lighting and 2¾d. for power. It is generally accepted that one unit of electricity is equivalent, light for light, to a little more than one-eighth of 1,000ft. of gas, so that electricity at the net price of 5¾d. per unit charged by the Rathmines Council for lighting can be obtained at practically the same cost as gas when the price of the latter is 3s. 8d. per 1,000 cubic feet. For motive power the price of 2¾d. per unit is equivalent to gas at about 1s. 10d. per 1,000 cubic feet. For the benefit of those consumers who do not care to expend the necessary capital in installing the wires and fittings in their premises, the Rathmines Electric Lighting Committee have adopted the free wiring scheme of the National Electric Company, of London. Upon the

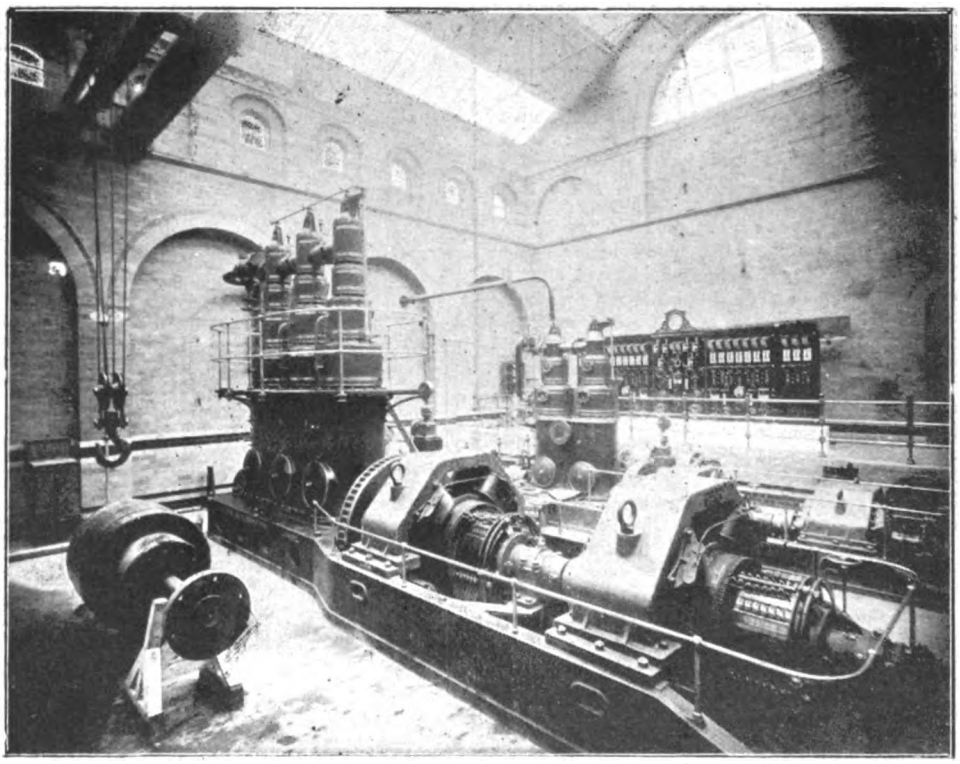


FIG. 2.—View of Engine-Room, Rathmines Electricity Works.

troughs as the feeders. The insertion of cast-iron junction boxes at numerous points facilitates the isolation of any section of the distributing network, either for repair or connections.

Public Lighting.—Arc lamps to the number of 108 have been fixed in the principal thoroughfares, spaced about 65 yards apart, and carried at a height of 18ft. from the roadway by cast-iron pillars with an ornamental curved bracket of wrought-iron construction. The lamps were made by Messrs. Verity, and the posts by James Allen, sen., and Sons. The arc lamps are run in 12 series of nine lamps each, connected across the outers of the distributors. The extinguishing of one or more lamps will not affect the remainder, as an automatic switch is provided to substitute a wire resistance for the lamp. The terminal lamps on each series are fitted with single-pole switches and fuses. All the lamps are provided with substitutional switches. Lowering gear enable trimming operations to be carried out from the roadway. Lighter and shorter posts, 230 in number, each bearing a two-arm bracket carrying a pair of incandescent lamps, deal with the lighting of the quieter streets. These were cast by Macfarlane and Co., and were fitted up and erected by the General Electric Company, of

application of an intending consumer, the wiring company provides and fixes on the premises the necessary wires and fittings, and completes the installation ready for connection to the District Council's supply mains. No charge is made for this work, but the consumer has to pay to the Council by way of rental for the wires and fittings the sum of 1d. per unit for every unit of electricity energy used, this sum, of course, being additional to the amount of the charges made by the Council for the electrical energy supplied.

Area of Supply.—The area of supply constitutes the whole of the district of Rathmines and Rathgar, the following being the names of the streets in which the Council's mains have been laid, and throughout which a supply of electricity is available: Belgrave-road, Belgrave-square North, Belgrave-square East, Brighton-road, Bushey Park-road, Castlewood-avenue, Charleston-road, Church-avenue, Cowper-road, Dartmouth-road, Frankford-avenue, Grosvenor-road, Harolds Cross-road, Kenilworth-road, Kenilworth-square North, Leeson Park-road, Leeson-street (Upper), Leinster-road, Upper Mount Pleasant-avenue, Lower Mount Pleasant-avenue, Mount Pleasant-square South, Orchard-road, Orwell-road, Palmerston-road, Ranelagh-road, Rathgar-road, Rathmines-road, Upper Rathmines-road,

Digitized by Google

Temple-road, Temple-gardens, Terenure-road, Winnefield-road, Zion-road. An extension of the mains to other parts of the district has already been decided upon, and the contract will shortly be given out for the probable requirements over the next three years. The Council will therefore be able to lay down mains in any other street where the demand is likely to yield a reasonable return on the capital expenditure on that section of the mains.

At present there are about 1,160 lamps of 8 c.p. connected, while applications for a further 3,050 lamps are in hand. In addition to these, the public lighting represents about 2,540 8-c.p. lamps, the total demand thus being equivalent to 6,750 lamps. A temporary supply has been given for the past month free of charge.

The capital cost of the generating works, mains, and public lamps amounts to about £71,000.

The whole of the works have been carried out under the supervision of Mr. Robert Hammond, the consulting engineer. Mr. G. F. Pilditch, who has acted as clerk of the works for Mr. Hammond, is now the resident electrical engineer, Mr. S. T. Land being his chief assistant.

Formal Inauguration.—The opening of the above-described works took place on the 31st ult. in the presence of a large and fashionable gathering. The function was performed by the Lord-Lieutenant of Ireland, who was received, together with Countess Cadogan and the Viceregal party, at the town hall by Mr. E. Hodgson, chairman of the Rathmines Urban Council; Mr. R. Danne Bolton, chairman of the Electric Lighting Committee; the members of the committee; and Mr. F. P. Fawcett, clerk of the Council Subsequent to the formal inauguration of the supply and the involved speechmaking, the Viceregal party was conducted round the electricity works by the chairman of the Council and the members of the Electric Lighting Committee, including Messrs. R. D. Bolton (chairman), R. Booth, J.P., F. A. Butler, C.E., C. W. Hely, J.P., T. Hewson, E. Hodgson, L. C. Murphy, J. P. Pile, and Thomas Edmundson. The consulting engineer, Mr. Robert Hammond, explained the working of the generating plant and other electrical apparatus.

SOME NEW MOTOR-STARTING SWITCHES.

We were invited recently by the Electrical Transmission Company, Limited, of Albert Works, Hammersmith, to a private inspection of two new motor-starting switches which the firm are about to place on the market. A brief description of these switches may interest our readers. What may be termed the "B" type switch possesses several special features, the essentially novel of which is perhaps that the handle is not directly attached to the switch arm, but is only held to it by electromagnetic means when the conditions are suitable. The switch arm and handle lever are of iron, and have pole-pieces attached to them extending across the face of a coil mounted to surround the iron spindle of the switch, and together they constitute an electro-magnetic clutch. The switch also has a temporary contact (shown just above the clutch coil in the illustration, Fig. 1), a "non-sparking" arrangement (shown at the bottom left in the illustration), and a maximum cut-out and hand switching-off handle (shown at the bottom right in the illustration).

Fig. 1 shows the switch in the "off" position. The action of switching on is as follows: The handle is brought towards the switch arm, so as to bring the pole-pieces together, and in doing so makes the circuit at the temporary

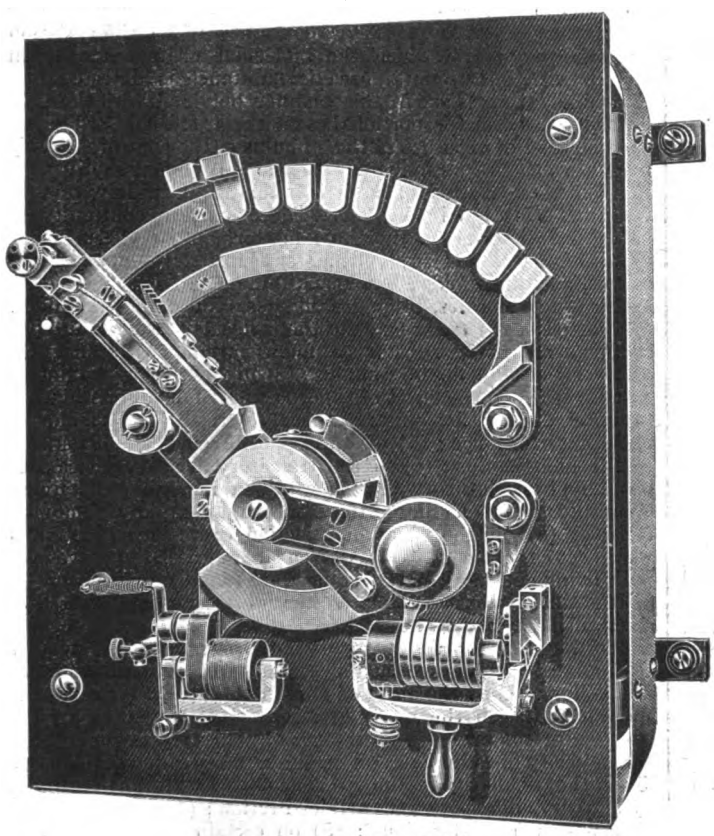


FIG. 1.—"B" Type Switch.

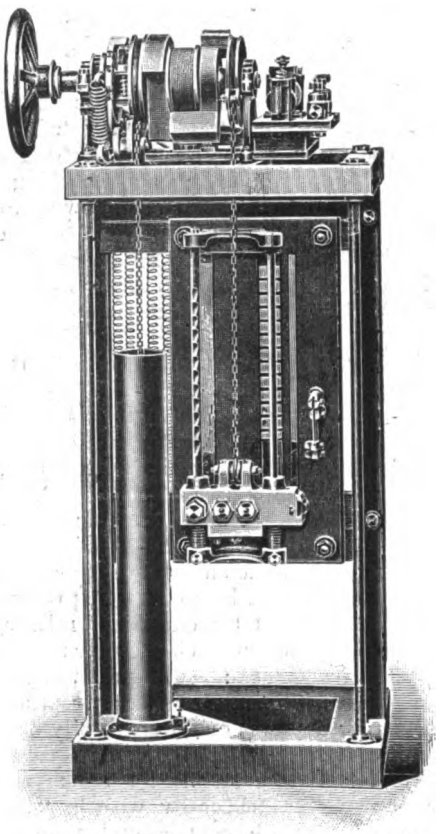


FIG. 2.—"A" Type Switch (on special frame).

contact to energise the clutch coil and also excite the motor magnets, as the clutch coil is in series with the motor field-magnet coils. It is then necessary to pause for a short period, depending on the size of the motor, until the current in the field magnets has risen to about its proper amount, as otherwise the clutch will not be sufficiently powerful for the switch handle to draw the switch arm against the spring which has brought it to the "off" position. The switch arm may then be drawn slowly from contact to contact until the full "on" position is reached, when the switch handle is held by a spring detent. The gradual rise of the current in the field magnets of a motor, especially those of large size, can be easily noted by placing an ammeter in the circuit, and where it is not taken into account serious excessive flushing of current with damage to the switch contacts and sparking at the motor brushes results, through the only partial excitation of the magnets. Should the operator switch on too fast the maximum cut-out acts, short-circuiting the coil, so releasing the switch arm from the handle, when it springs back to the "off" position, inserting the resistance as it does so. The object of the "non-sparking" arrangement is to temporarily close the circuit whilst the switch arm is travelling to the first contact of the switch, when it is cut out of circuit.

Digitized by Google

Open-type switches are provided in all cases with wire guards so that the action of the apparatus cannot be interfered with, and the maximum cut-out handles are arranged so that they cannot be held down. The other special features claimed for the "B" type switch may be summed up as follows: it cannot be switched on until the motor field magnets are well excited, or without a suitable difference of potential; it automatically switches off if the operator attempts to switch on too quickly; it automatically switches off if the current exceeds a given amount; it automatically switches off if the current supply fails; it always inserts the resistance before breaking the circuit; it breaks the circuit on carbon-sparking contacts; and all contact parts are interchangeable and easily renewable.

In general principle the "A" type switch is the same as the switch just described, but the arrangement of the parts is different, as the contacts are arranged vertically in alignment, and the clutch and other apparatus is fixed at the top of the pedestal. The great advantage of this switch over the "B" type is that it takes the starting-up entirely out of the operator's control, and switches on at the speed for which it is adjusted. The operator is unable to interfere with the process of switching on, although at any time he can instantly switch off. It also avoids a fault which has prevented the satisfactory continuous working of other slow-moving switches, in that the switch arm stops when fully on each contact and proceeds with a "quick-make" to the next, when progressively cutting out the resistance. This prevents the fusing and sparking which takes place with a slow-moving switch arm, owing to the great current density when passing from one contact to the next, as practically the whole current passes through the contact in advance, and with a slow moving switch the actual contact area for a considerable time may amount to little over a line or a point.

The action of the switch (Fig. 2) is as follows: When starting up the operator winds up a heavy weight in a dash-pot, by means of a spring bolt. When fully wound up the hand-wheel shears out of engagement with the weight by compressing the spring bolt, and is locked to prevent further forward movement. The weight then descends in the dash-pot, drawing the switch arm over the contacts, and the "step-by-step" motion is secured by a spring detent, which acts at each contact. The action of moving the hand-wheel backwards to switch off causes the short-circuiting of the clutch and release of the switch-arm. Of the special features claimed for this switch the following may be mentioned: it is practically impossible for the most unskilled operator to damage either the motor or the switch; it switches on automatically at a slow speed, which is out of the operator's control; it switches on automatically after the motor field magnets are well excited; it switches on automatically with a "step-by-step" action, stopping on each contact and then proceeding with a "quick make" to the next; it switches off automatically if motor is overloaded or the current exceeds a given amount; it switches off automatically if the current supply fails; it always inserts the resistance before breaking the circuit; it breaks the circuit on carbon sparking contacts; it cannot be operated if there is no current supply, or without a suitable difference of potential; the rotation of the hand-wheel "clockwise" switches on, whilst a small movement in the reverse direction switches off; there is nothing outside the case but the operating handwheel (the whole of the mechanism is enclosed in a strong weather-tight case, the side doors of which are bolted from the inside of the top cover; the padlock on the top cover, therefore, locks up the entire case); and all contact parts are easily renewable.

With both of the above-described switches the name of Mr. Walter F. Jones, manager for the Electrical Transmission Company, Limited, must be associated as inventor. We understand that a large sum of money and a great deal of labour have been expended in perfecting the gear, but if extended experience with the switches proves the objects aimed at to have been satisfactorily attained, this expense and labour will have been amply rewarded. It only remains to add that repeated operations of the switches under normal conditions in our presence were entirely satisfactory.

ON THE SIMILARITY OF EFFECT OF ELECTRICAL STIMULUS ON INORGANIC AND LIVING SUBSTANCES.*

BY JAGADIS CHUNDER BOSE, M.A., D SC, PROFESSOR OF PHYSICAL SCIENCE, PRESIDENCY COLLEGE, CALCUTTA.

If we take a piece of living tissue, say a piece of muscle, and subject it to an electric stimulus, there will be produced a contraction; the stimulus causes a molecular rearrangement by which the form of muscle is changed. On the cessation of stimulus the muscle, recovering from the molecular strain, gradually attains its original shape. The effect of stimulus on nerves is, however, not apparent; there is no change of form. The molecular disturbance due to stimulus can, nevertheless, be detected in an indirect manner from certain electromotive variations that are produced. If, now, a mass of metallic filings be taken and subjected to electric shocks there is no visible change. The substance appears to be irresponsive or dead to stimulus. Are inorganic substances, then, really irresponsive? Could this apparent want of response not be due, after all, to our inability to detect the profound molecular changes that may have nevertheless taken place in the substance under the action of stimulus? In nerves it is seen that the molecular changes can only be detected indirectly by an electric method. The author describes an electric method based on the variation of conductivity, by which the molecular change due to an electric stimulus in an inorganic substance is detected and measured. Curves are in this manner obtained with the conductivity variation (proportional to molecular effect) as ordinates, and the time of exposure to the stimulus or the time of recovery from the effect of stimulus as abscissæ. It is next shown that the effect on matter of electric stimulus of widely varying frequencies is a continuous one. There is also a continuity of effect on all forms of inorganic matter, similar effects being produced not only (1) in all elementary substances—metals, non-metals, and metalloids; but also (2) in metallic compounds—such as the chlorides, bromides, iodides, oxides, and sulphides.

Comparisons are next made of the molecular response in both inorganic and living substances under varying conditions: (1) on the effect of moderate stimulus; (2) on the effect of maximum stimulus; (3) on the effect of superposition of medium stimuli—(*a*) effect due to slow intermittence, (*b*) tetanic effect due to rapid intermittence; (4) on the opposite effect due to strong and feeble stimulus; (5) on the transitory negative effect; (6) on the physical theory of "fatigue" in inorganic and living substances; (7) on the various means of rapidly removing fatigue; (8) on the effect of injection of various substances which act as "poisons." In all the above cases the curves for both living and inorganic substances are found to be similar.

The author next explains a theory of vision, and describes an artificial retina; the various effects of radiation on this artificial retina explain many obscure phenomena of vision. Parallel experiments are then described with the artificial and real retina: (1) on the effect of short exposure to the action of radiation; (2) on the effect of intermittent radiation, on the question of the presence or absence of "flicker" depending on the intensity of radiation, and on the rapidity of intermittence; (3) on the peculiarity of the visual sensation curve, as explained by the curve of effect on the artificial retina; (4) on the different elements of retinal fatigue; (5) on certain curious reversal effects; (6) on after-oscillation and visual recurrence; (7) on the novel phenomenon of binocular alternation of vision, and on the analysis of superposed images by alternate after-vision; (8) on the persistence of retinal oscillation, and its continuity with the phenomenon of memory.

In all the phenomena described above there is seen an identity of effect of external stimulus on both living and non-living forms of matter. It is difficult to draw a line and say "here the physical process ends and the physiological process begins," or "these are the lines of demarcation that separate the physical, the physiological, and the beginning of psychical processes." No such arbitrary lines can be drawn, there being no breach of continuity.

The Hospital Scandal.—The reports received by Lord Roberts as to the treatment of the British prisoners in South Africa, and more particularly the sick and wounded, reflect very unfavourably on the Red Cross staff with the Boers. There are, however, a few names which stand out very clearly as men who did their duty well, in deep contrast with others, who were unwilling to risk trouble with the Boer Government by doing so. The report of Colonel Hunt to Lord Roberts with reference to the Pretoria hospitals gives the names of two or three of these men, amongst whom we are pleased to find an electrical engineer, Mr. Wolley Dod. This gentleman was one of a committee of three, formed in the town, who ably assisted Dr. Von Gernet. To this doctor the greatest praise is given, as also to the committee who helped him.

* Abstract of paper read before the British Association at Bradford.

Digitized by Google

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

(Continued from page 310.)

THE ELECTRIC CONSTRUCTION COMPANY.

The manufactures of this firm in connection with switchboards for high-pressure continuous current are well known, but they have, however, erected boards for alternating-current stations also. They resemble the preceding boards in respect to connections and passage at the back. Fig. 31 is a photograph of a board supplied to the Morley Corporation for their alternating-current station. It consists of alternator and circuit panels arranged for a single-pole system, the outer being earthed. The alternator panel is fitted with switches, fuses, and instruments for three alternators, each machine being provided with an ammeter, two single-pole switches, and fuse. The two switches, which are of the plug type, are provided to enable the machine to be connected to one of two 'bus bars. The fuse is drawn through a glass tube fixed in a porcelain case, and fitted with suitable contacts. The machine switches are provided with guides, so that the switch may be fixed in readiness for driving in after synchronising. The circuit panel is exactly similar to the alternator panel, with the exception that the switches are not provided with guides.

The dynamo and circuit panels are placed on either side of a synchronising panel, fitted with Cardew voltmeter, synchronising lamps, three low-tension voltmeters (one for each bar and one for incoming machine), eight synchronising plugs, and an interconnecting switch for coupling the bars together. Five small transformers are provided for synchronising and for the voltmeters. Fig. 32 is a drawing of this high-tension board, which will make clear what is not seen in the photograph. A regulating table is placed in front of the main board, from which the exciter currents are controlled. Fig. 33 shows this table with its regulating and field-breaking switches and ammeters. In the photograph of the high-tension board the table may be seen, and the cables leading from the stops on

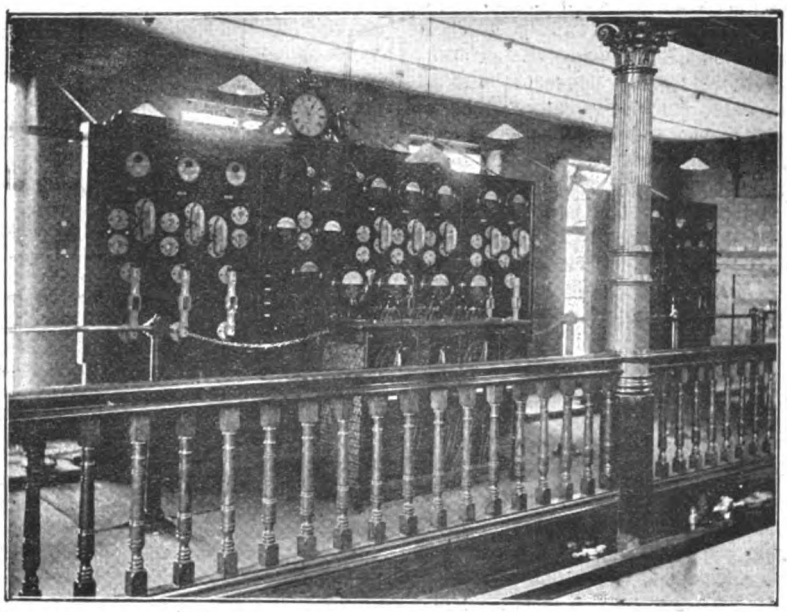


FIG. 31.—Morley Switchboard.

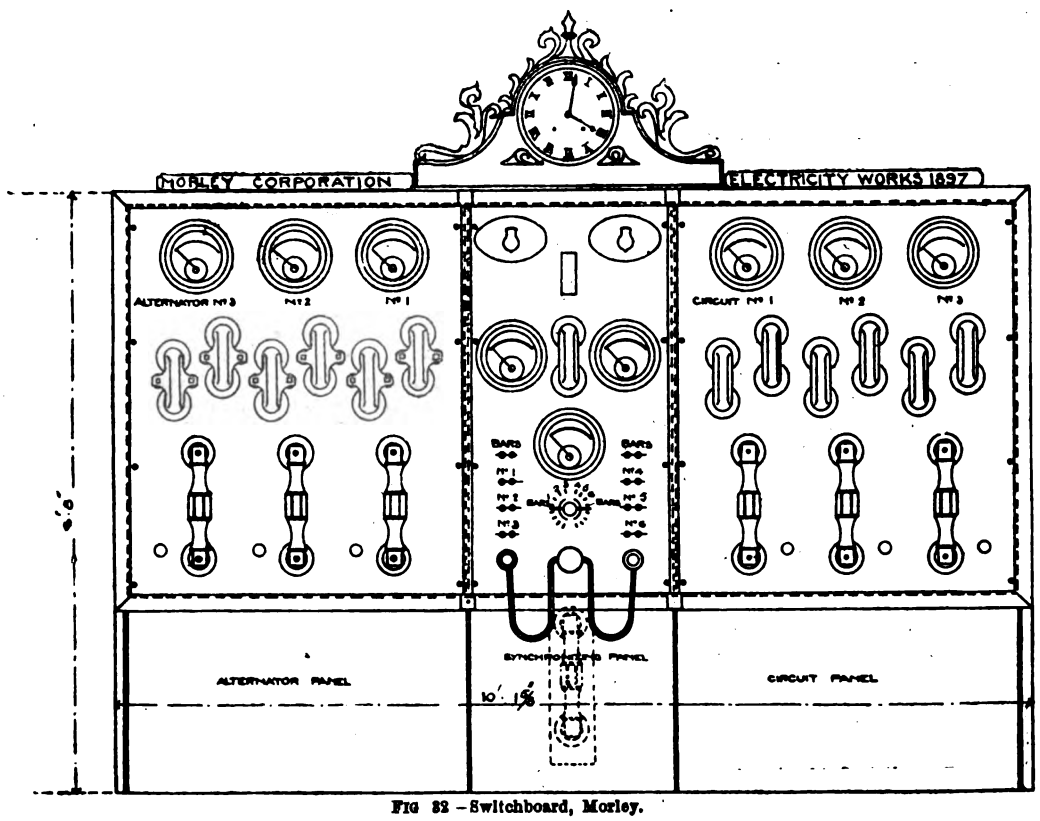


FIG 32.—Switchboard, Morley.

Digitized by Google

the regulating switches to the resistance frames are also very evident.

Fig. 34 is a photograph of a board of older construction, it having been made some eight years ago for Johannesburg. At first sight it resembles a continuous-current board, and might be mistaken for such. In the distance is the alternator board, fitted with field breaking and regulating switches at the bottom and high-tension fittings above. Cardew engine-room voltmeters are fixed above this board In the middle distance is the synchronising board, fitted with double-pole switches for paralleling and synchronising plugs and lamps. In the foreground are the circuit panels, four in number, fitted up with main switch, ammeter, plugging arrangement for coupling the circuit to any

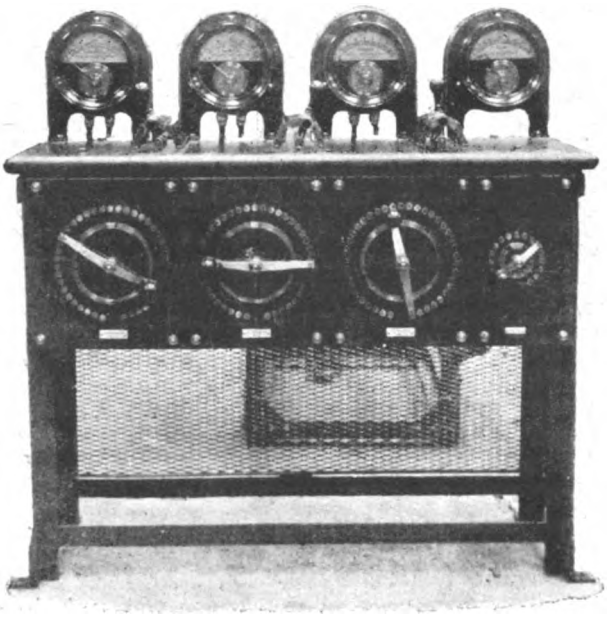


FIG. 33.—Regulating Table, Morley.

machine, and a throw-over switch, by means of which any machine may be taken off the circuit and another one inserted. It will be noticed that ample room for extension is provided in both dynamo and circuit panels. It must be noted that the above boards were made to engineers' specifications, and since first erection have been considerably extended.

COWAN STILL.

The switchboard to be now described differs from those previously illustrated in that it has no passage at the back, and it cannot be handled at the back except in a "dead"

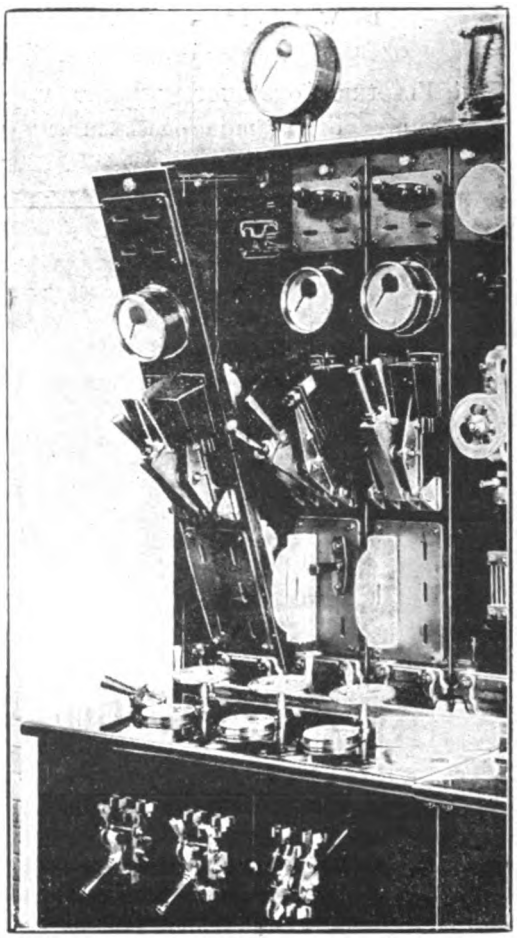


FIG. 35.—Cowan Panels.

state. This desirable result is obtained by making the board up of narrow slate panels which can be hinged forward on their lower edges, so that the back of the slate becomes accessible. The photograph (Fig. 35) shows a portion of a board so constructed, where it will be seen that each panel is fitted with two 'bus-bar plugs, ammeter, switch, and duplicate fuse contacts. Below the high-tension board is the regulating table with rheostat, hand-wheel, ammeter, and field-breaking switch, arranged verti-

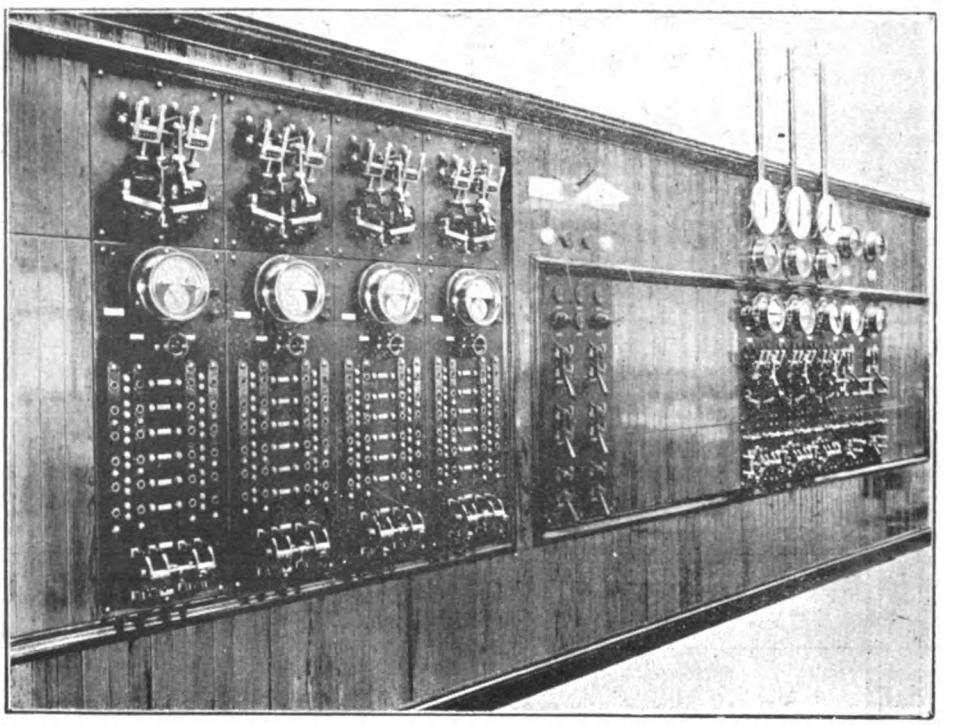


FIG 34.—Johannesburg Switchboard.

Digitized by Google

cally under the dynamo panel they are intended to control. By this means high and low tension portions of the board are kept in perfect symmetry. By withdrawing the 'bus-bar plug and high-tension fuse the panel may be hinged forward as shown in the photograph, and any alterations required can be carried out with safety, as the removal of these fittings from the circuit entirely isolates the panel.

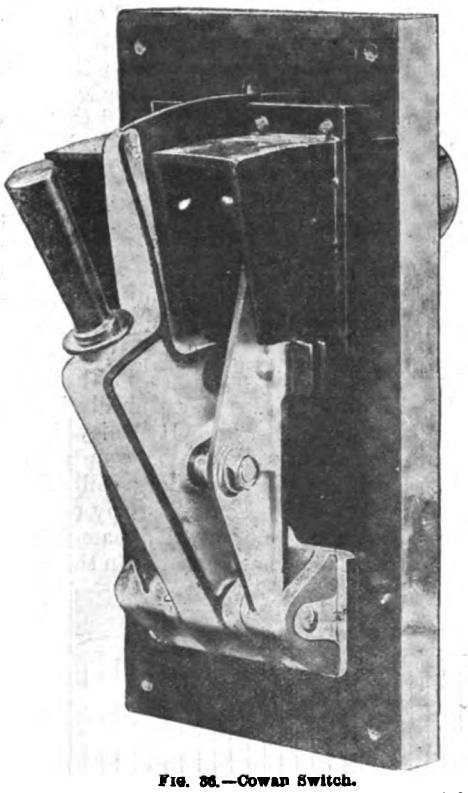


FIG. 36.—Cowan Switch.

FIG. 37.—Cowan High-Tension Fuse.

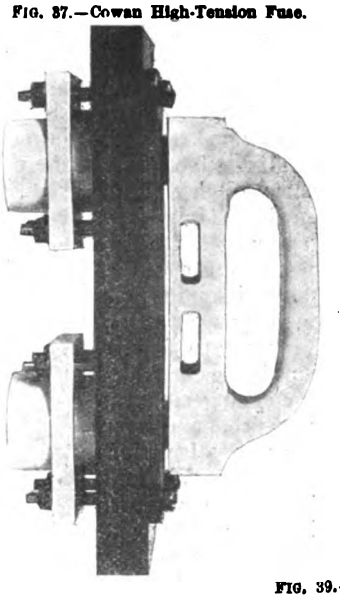


FIG. 38.—Ordinary Switch, Opening Field Circuit.

FIG. 39.—Patent Switch, Opening same Circuit as above.

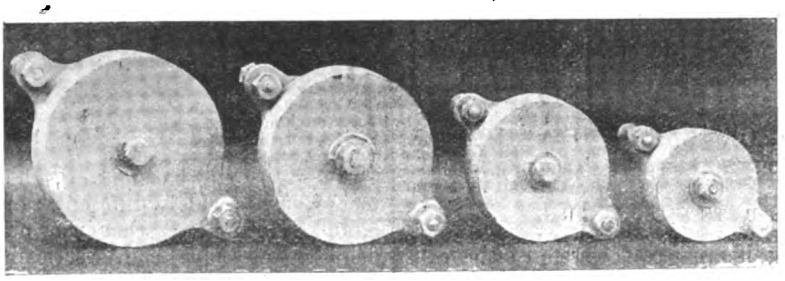


FIG. 40.—Cowan Fireproof Iron-clad Resistance Units.

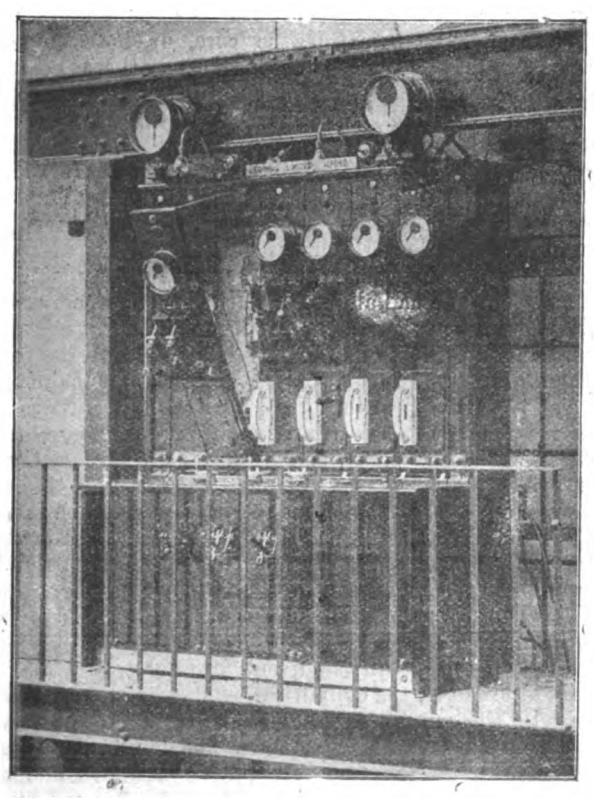


FIG. 41.—Small High-Tension Board at Watford.

Fig. 36 is a photograph of the high-tension switch, which is of the double-break type. An insulating shutter is fixed between the two blades and attached to the handle.

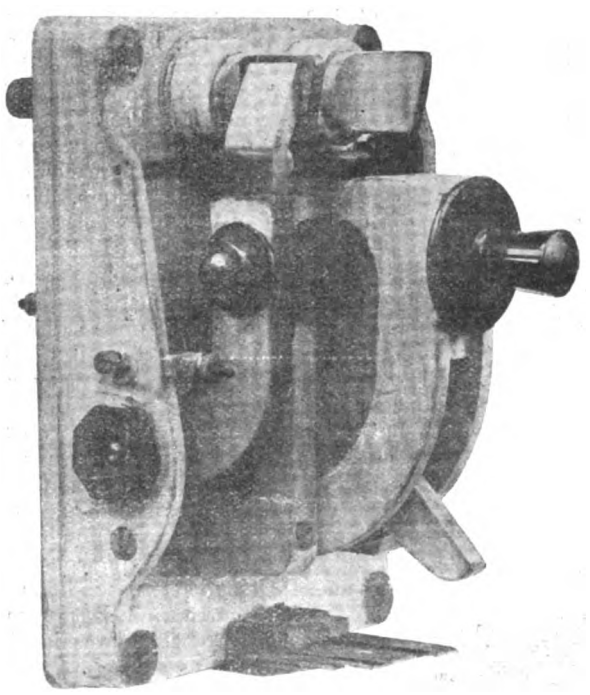


FIG. 42.—Andrew's Discriminating Cut-out. Low Tension for Sub-Stations.

A switch of this pattern will safely open circuits of 500 amperes capacity, and all high-tension parts are most care-

Digitized by Google

fully shielded. The high-pressure fuse is illustrated by Fig. 37. It is of the switch-fuse type, and only differs from other examples in the arrangement of the fuse wire. This passes from one terminal in the handle to the other through a chamber formed of asbestos pieces laid side by side, retained in position by mica strips. Duplicate fuse contacts are provided in the panel to allow a faulty fuse to be replaced without interrupting the circuit. In the figure a small plug will be seen inserted to the right of one of the fuses. This is the synchronising plug, and it may be inserted to couple the synchroniser to the incoming machine. The alternators may be connected to one of two 'bus bars by means of a plug inserted at the top of the board above the ammeter. The field switch, mounted on the front slates of the regulating desk, is arranged to short-circuit the field on itself through a non-inductive resistance. Fig. 38 is a photo of an ordinary switch opening the field when the arc produced can be plainly seen, while Fig. 39 is a photo of Cowan's patent switch opening the same circuit. The two small white points at the contact jaws represent the arc, which is, of course, inappreciable. The resistance units are constructed on a new principle, there being no connecting wires leading away to frames, etc. Each unit is encased in iron, the stops being embedded in a fire-resisting composition. The whole arrangement can be raised to a very high temperature without danger. Fig. 40 is a photograph illustrating four units of various sizes. Fig. 41 is a small Cowan board erected at Watford. This firm are the makers of Andrews's patent non-return cut-outs for use with alternators running in parallel, and Fig. 42 illustrates a discriminating form for use on low-tension circuits in sub-stations. When dealing with heavy currents Messrs. Cowan's make use of a switch of the water-break type placed above, and operated from, the switchboard platform by means of levers.

THE CONSTRUCTION OF LARGE DYNAMOS AS EXEMPLIFIED AT THE PARIS EXHIBITION.*

BY SILVANUS P. THOMPSON, F.R.S.

The author, in opening his paper, referred to the continual changes which are taking place in the design of electrical apparatus, and of the way in which practices which seemed to be quite standardised are gradually discarded in different countries. He was, therefore, very keen when visiting the Paris Exhibition to see what progress had been made by the various nations in dynamo design. The Exhibition afforded exceptional advantages in this respect, on account of the large alternators and direct-current dynamos which were exhibited by electrical engineers from every country manufacturing such machines. As an instance of the way in which types appear and afterwards die out in different countries, Prof. Thompson referred to the two-pole type of direct-current dynamo so largely used in England. This class of machine was not exhibited, except for very small motors, by any Continental firm. Another English type which was not represented by foreign exhibitors at the Paris Exhibition was the alternator with the armature built up of thin coils of bare copper, such as is manufactured by Mr. Ferranti. To begin with the alternators exhibited at the Paris Exhibition, the author characterised them as getting more "flywheel" in style—that was, they were increasing in diameter and decreasing in length. The alternators might be divided into four types. The first of these had external magnets which were fixed, and a revolving armature inside the same. The second type contained those machines which had a stationary armature surrounding an internal system of magnet poles built up on a flywheel. The third type had no revolving conductors in either armature or field. It included what is known as the inductor alternator. The fourth and last type of alternator had a stationary armature which was inside a revolving magnet, and in order that this might be arranged the field-magnet system had to overhang at one side of the flywheel. With respect to the number of machines of each type which were exhibited, there were rather few of the first type and a great many of the second type. Of the third or inductor type there were hardly any exhibited, which was somewhat surprising in view of the great attention which had been paid to inductor alternators in the past. There were three machines of the fourth type on view, in which he was much interested. He believed that this class of machines was first used by Mr. C. E. L. Brown, who employed the type when making the Cairo alternators. The advantage of the machine was a mechanical one. With the poles fixed on the inside of the extended rim of the flywheel, the centrifugal force of the revolving mass of each pole tended to keep it in place against the rim. It also counteracted the magnetic pull which was inwards. In the more usual type of alternator field with the poles projecting outwards from the flywheel, both the centrifugal force and the magnetic pull were in the same direction, and had to be provided for mechanically in the means of attaching the poles to the rim. He believed that Mr. Ferranti was the first to introduce bare copper strip wound in an edgewise spiral for the exciting coil of the field magnets. This method was now very largely used by practically all the large manufacturers of dynamos, and large sections of copper tape were now wound up in this way.

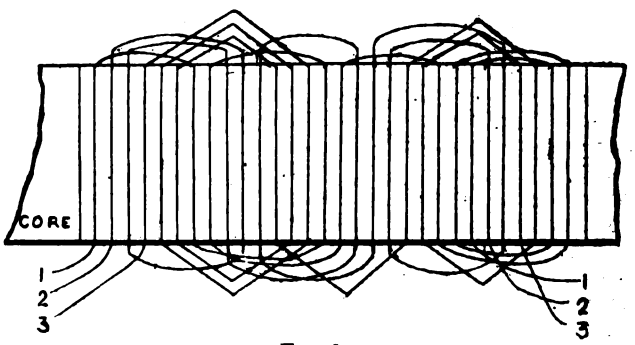


FIG. 1.

As was somewhat natural, the voltages of the various machines was widely different, ranging from 2,000 volts to 5,000. He noticed that the practice of laminating the field-magnet cores had practically disappeared as far as continental makers were concerned. They used instead a cast-steel core with a laminated pole tip. Amongst the large armatures there was not one of the surface-wound type, but in every case the conductors were either wound in holes in the core, or between teeth formed in the same. For insulating these holes or teeth, mica or micanite was almost universally employed. It was interesting to compare in this respect the machine of the present day manufactured by continental makers with those exhibited at the Frankfort Exhibition in 1891. The machines at that date almost all employed what might be described as the paper type of insulation, and screwed connections between the armature conductors and the commutators. English manufacturers even at that date had all adopted the sweated connection. This year showed that the screwed connection at the commutator had practically disappeared, as had also the paper type of insulation, except where it was used for making up space. He had looked into the question of the number of slots per pole, or, to put it more accurately, the number of slots per pole per phase, employed by the various Continental makers. In the case of one large machine, this was as low as one slot per pole, but the greater number had at least two slots per pole per phase. In the largest alternator which was exhibited by the Allegemeine Elektricitäts Gesellschaft, of Berlin, five slots per pole per phase were used. There was one machine which, curiously, had 2½ slots per pole.

In the winding of direct-current armatures, and also in certain alternators, the cylindrical winding was very largely used. In this winding there were at least two conductors in each slot, one above the other. The lower conductors were bent round the armature in one direction and the upper conductors in another, but they were always kept at the same distance from the axis, so as to form ultimately a cylinder. On a machine exhibited by Ganz and Co., he had discovered a most unsymmetrical system of winding. It

* Abstract of paper read before the British Association at Bradford.

Digitized by Google

was a three-phase machine, and the three circuits were arranged as shown Fig. 1. It will be seen that circuit No. 1, for instance, passes from the first slot to the sixth; it then skips seven slots, and, turning round, embraces six slots instead of five; with the next turn it embraces five, and the last turn six again. If the third circuit is looked at it will be seen that the first complete turn embraces no less than nine slots. The reason for this great irregularity is that it enables certain sections of the armature core, equal to four poles, to be wound in the shops, while only single connections have to be made to each circuit when erecting the various sections in the station. It will be seen from the diagram that the section diagrammatically represented is complete in itself.

The Helios company showed machines which would give either single-phase or three-phase currents at will, but Prof. Thompson had not time to describe in detail the winding employed. With the increase in diameter of the alternators, due to increased output, the mechanical stability of the large rings was of importance. It was interesting to note the different ways in which different makers obtained the necessary strength. In one case he noticed that the cast-iron frame was made about one yard wide, whereas the length of the core was only 10in. In an alternator exhibited by the Schuckert Company the required stiffness was obtained by a number of stay-rods in tension, which were secured to a ring concentric to the shaft and of comparatively small diameter.

The question which in France seemed to be largely engaging the attention of dynamo designers, was the compounding of alternators. There were two methods of doing this exhibited, the first of these was the Hutin-Leblanc system, which has already been described in our columns.* Prof. Thomson proceeded to describe another system, which depended on the principle that an induction motor with its rotor driven slightly above synchronous speed becomes a generator. These compound exciters for generators were designed to compensate not only for changes in load, but also for changes in the power factor of that load.

The Russian branch of Messrs. Siemens and Halske exibited a direct-current dynamo, in which the tendency to spark was kept down by the following means: the inner surfaces of the poles did not form a cylindrical surface concentric with that of the armature. Instead of this the width of air-gap was increased, being smallest at the edge of the pole which the armature conductors approached, and largest at the edge from which the conductors receded. In the case in point the increase was from 7mm. to 9mm. Another new type of direct-current dynamo was exhibited by Messrs. Ganz and Co., in which unusually large teeth were formed in the armature. They were in fact only six teeth to a pole. The poles had extended pole-pieces of peculiar shape, and were built up of laminated steel. The whole of the plates, however, did not have the polar extensions on them, so that the horns had a small cross-section of iron.

It was, of course, impossible to obtain accurate test figures for all the machines without carrying out a series of experiments, which would take a long time. He had tested some of the machines by the Steinmetz formula, in which d equals the diameter of the revolving part and l equals the length of core. Steinmetz found then that the expression $\frac{d\,l}{K\,W}$ gave a numeric varying from six in bad designs down to, say, three in good designs. With an increase in size, however, the numeric was decreased, so that for a 1,000 h.p. he had found the figure as low as $1\frac{1}{2}$.

Discussion.

Mr. Alex. Siemens, in opening the discussion, explained that the reason why their dynamo at the Paris Exhibition was not at work more frequently was that the circulating pump could not always provide the necessary water for condensing. The pump had been placed too high by a draughtsman who wished to give the pump due prominence. Other engines used the same circulating water, which hence got somewhat aerated. The result was that the pump in question would not always lift the water from the main.

Mr. J. Sheolbred remarked that the relative advantages between the two-pole and multipolar type of dynamo was largely a question of £ s. d. He would express his opinion, however, that up to the present he had not been able to find a multipolar dynamo to give as good results as the two-pole type did for sizes up to 200 kw.

Prof. S. P. Thompson suitably replied.

* *Electrical Engineer*, vol. xxvi., p. 56.

RECENT TRAMWAY CONSTRUCTION, WITH SPECIAL REFERENCE TO THE DEMERBE SYSTEM.*

BY WILLIAM DAWSON.

It is about 35 years since the introduction of tramways into the large towns of Europe, and an account of the changes and developments which have been made in this means of transport would be very interesting from an historical point of view, but of little technical or industrial interest. The principles of construction, the different systems formerly in use, and the mode of traction have all been revolutionised in the comparatively short time which has passed since the introduction of tramways into this country, so that there is little to learn from the past. It would take up too much time to enumerate and investigate all the systems of tramway construction which were successively tried when tramways were generally worked by horse traction, and which have now given place to other methods more suitable for mechanical or electric traction. The first tramrails were laid on either longitudinal or transverse wooden sleepers, but it was found that the wood soon rotted. The sleepers were therefore discarded, and experiments made with tramways constructed entirely of metal. The Vignoles rail was adapted for this purpose, and, finally, rails of the Brocca (or girder) and the Demerbe (or trough) type were manufactured.

The Brocca rail was afterwards adopted in Germany and England under the name of the Phœnix or Girder rail. This form of rail was a modification of the Vignoles rail, as the foot or bottom flange was merely widened and laid direct on the soil or on a bed of concrete. It is now generally adopted throughout England, but in my opinion has not proved a success. When animal traction only was used, very little attention was given to the fishing of the joints of the rails, but on the introduction of steam and electric traction it was soon found that the joints were unable to stand the increased strain. The fishplates were increased in length and thickness until in some cases they were 3ft. long and 1in. thick; eight 1in. fishbolts were used, sole-plates were placed under the ends of the rails, narrow steel strips were placed on the top of the bottom flanges of the rails at the joints, and the whole securely bolted together with six $\frac{3}{4}$in. bolts. The joints still worked loose, and it is now recognised that all it is possible to do in this direction is insufficient to make a perfect joint. In Germany, the ends of the rails were cut obliquely, afterwards they were halved on to each other, or the ends were notched, and a fishplate placed in the recess. All possible methods have been tried to prevent the joints working loose, and numerous patents have been obtained for different ways of strengthening the fishing—all costly, and not completely satisfactory in spite of the extra outlay. The girder rail joint is undoubtedly defective, and the trouble which arises is to be attributed partly to the fact that the top and bottom of the fishplates corrode, as also does the under side of the head of the rail. The fishplates then occupy a less space, and are less in depth than they were when new. The head and bottom flange of the rail is not firmly gripped by the fishplates, and as their proper work is to maintain the level of the ends of the rails under the action of unequally distributed forces, the joint soon becomes loose. It is not, therefore, surprising that the consideration of the best means of fishing the joints of tramways has brought to the surface numerous, complicated, and often very remarkable methods of dealing with this branch of tramway construction.

The Demerbe system of tramway differs entirely from all other types, and possesses in many ways some of the chief attributes of a perfect tramway. It consists of a hollow trough rail (A, Fig. 1), and the fishplate (B, Fig. 1) is placed inside under the ends of the rails, and exactly fits

* Paper read before the British Association at Bradford.

Digitized by Google

its contour, the point of application being immediately under the head of the rail. When this system was first introduced the fishplate was pressed into the rail by means of bolts, but it was soon found that this was not satisfactory, and cotters (E, Fig. 1) were used. As the holes in the fishplates and rails are cut at different depths, when the cotters are driven in the fishplate is forced close up to the underside of the rail. The ends of the cotters are then clinched against the side of the rail, and are thus fixed and prevented by any possibility from working loose. The rail (D, Fig. 3), a little smaller than the opening it has to fit, is inserted and driven up. This arrangement of the tie bar enables the rails to be fixed to gauge with almost mathematical exactitude.

In England, as a rule, a concrete foundation is laid the whole width of the carriageway to receive the paving, and when the Demerbe rail is filled with concrete in the manner above described it becomes attached to the concrete foundation, and is practically part and parcel of the carriageway. It is, therefore, capable not only of withstanding the strains

FIG. 1. SECTION OF THE RAIL WITH FISHPLATE

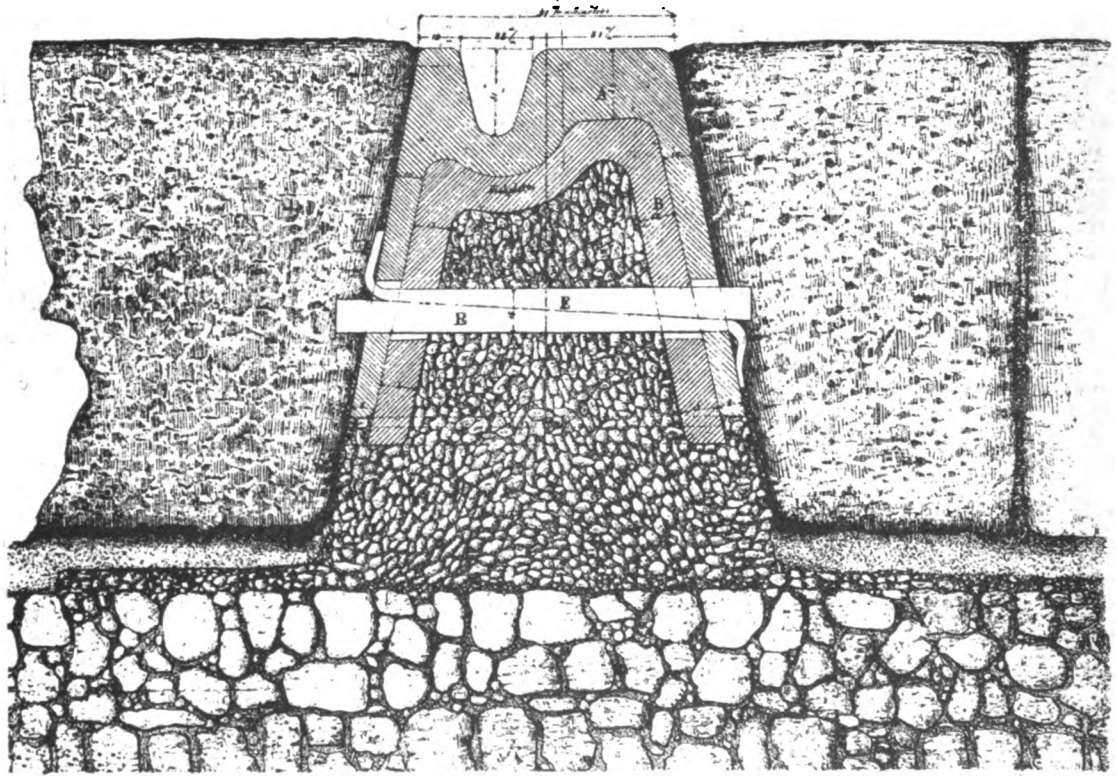


FIG 2 TRANSVERSE SECTION OF THE LINE PAVED

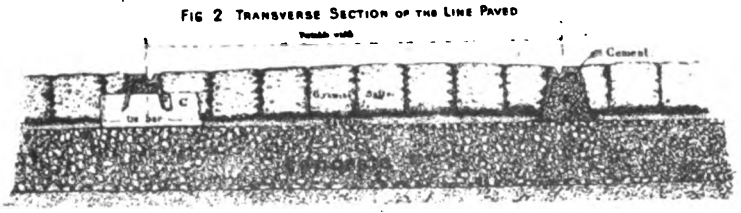
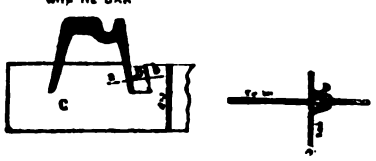


FIG 3. CONNECTION OF RAIL WITH TIE BAR



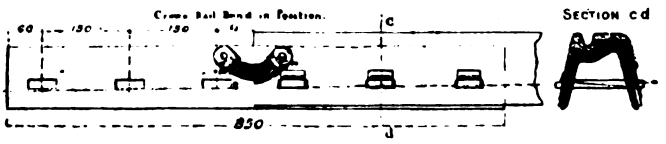


FIG. 5 SECTION c d

FIG. 4 ELEVATION OF FISHPLATE AND JOINT

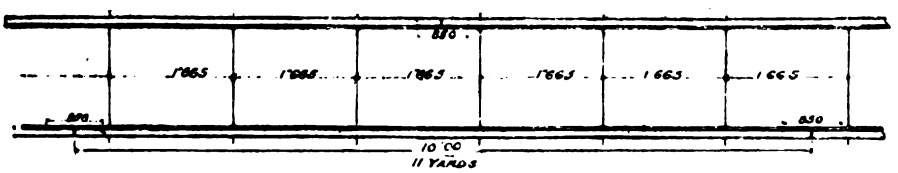


FIG. 6 PLAN OF THE LINE

when laid in position in the carriageway is completely filled, by means of specially designed tools, with concrete, composed of four parts of ½in. unscreened granite shingle to one part of Portland cement. The tie bars (G, Figs. 2 and 3) used in the Demerbe system are flat, and the use of screw ends, nuts, and bolts is avoided. The rail is inserted into two oblique grooves, one of which is cut so as to exactly fit the outer side of the rail, whilst the other is wider, so as to facilitate the introduction of the inner side of the rail. In the space which is left a wedge of soft steel caused by the cars, but also all the strains and vibrations caused by the ordinary vehicular traffic, without any loosening of the joints or displacement of the paving. The girder rail is laid direct on the concrete foundation, and the oblique strains brought to bear on the head of the rail by the tramcars and other traffic causes the extremities of the foot or bottom flange of the rail to have a tendency to crush the concrete, and so allows the rail to oscillate on its base. As soon as the rail is subjected to the least movement or vibration, a narrow fissure is produced along-

Digitized by Google

side, which increases in width as the foot becomes more moveable. Water penetrates between the paving and the rail, and in frosty weather the paving is uplifted. The joint of the rails is also partly responsible for these defects, as the water finds an early passage between the rails and fishplates.

It is necessary to take into account another factor which contributes to the grinding away or pulverisation of the concrete. The ends of the rails rest on a sole plate, which is intended to maintain the ends of the rails at one level. When the cars pass over the track the shock is harder at the joint than on the rest of the rail, where the movement caused by the car is more elastic, because the sole-plate and the concrete do not support the rail with the same rigidity, and the rails become dented at the joints even when they are in perfect allignment. It follows then that the same rigidity should exist at the middle of the rail as at the joint. In the Demerbe system this is so, as the concrete becomes perfectly attached to the rail, and the ridge of armoured concrete becomes part and parcel of the foundation itself. The same resistance is offered to the weight of vehicles for the whole length of the rail, no part being found to be weaker or more elastic than another.

In 1894 a short experimental length of the Demerbe rail was laid in Leeds-road, Bradford, end to end with a similar length of girder rail. Both portions have been subjected to a five minutes' service of steam locomotive cars since that time. About three weeks ago a Demerbe rail was removed, in the presence of the Tramway Committee, to ascertain its condition. The rail, joint, and gauge were found to be in every way perfect, and it was only after repeated blows with heavy hammers that the rail could be detached from the concrete foundation, and when raised it dragged up with it part of the foundation. No money whatever has been spent in repairing this portion of Demerbe tramway, but the adjoining portion of girder rail has been several times repaired during the six years it has been laid down. The setts used alongside the Demerbe rail are splayed to fit the sides of the rail, and laid directly against it, the rail thus serving as a support for the paving; and there is no tendency either for the setts to rise or fall as is the case with the girder rail. There are in Bradford 40½ miles of tramways, of which 36½ miles are laid on the girder system, with rails weighing 105lb. per yard, and fishplates weighing 80lb. per pair. There are four miles of Demerbe tramway, constructed of rails weighing 70½lb. per yard, and fishplates weighing 51½lb. each, and the Corporation have further in course of construction an additional 10½ miles of tramway, which they are putting down on the Demerbe system.

The detailed cost per yard of single track on the two systems, based on the price of materials delivered at Bradford, is as follows:

Demerbe System.	s.	d.
Rails	10	7·9
Fishplates	0	9·4
Tiebars	1	6 8
Wedges	0	1·4
Cotters	0	7·1
Track labour, including curve	2	6 0
Rails, etc., carting	0	1·1
Packing rails (labour)	0	11·0
Half-inch unscreened granite shingle	1	0·0
Cement	0	11·5
Team labour	0	3 2
	19	5·4

Girder System.	£	s.	d.
Rails	0	15	11·2
Fishplates	0	1	8 8
Marshall's patent joints	0	0	9 9
Bolts and nuts	0	0	5 4
Soleplates	0	1	0 3
Tiebars	0	0	2·8
Unscreened granite shingle	0	0	4·0
Cement	0	0	5·1
Labour (packing rails)	0	0	3·6
Road scrapings (for plastering rails)	0	0	0 6
Track labour	0	1	3·0
Team labour	0	0	1·6
Soleplates punching	0	0	1·9
Blacksmiths' work	0	0	1·3
Repairs to punches	0	0	1·9
	£1	3	1·4

Although it will be seen from the foregoing tables that the first cost of the Demerbe track is cheaper than the girder track, this point if not the most important. There is the cost of maintenance to consider, and judging from the condition of the Demerbe track in Leeds-road after six years' wear and tear, it does not appear that any repairs will ever be necessary during the life of the rail once it is properly laid. This life I should estimate to be about 20 years, whilst the girder rail has to be renewed in 16 years.

The opponents of the Demerbe system when they compare these rails with the girder type, state that the latter rail when laid on two supports will carry a heavier load than the Demerbe rail under the same conditions. This is quite true, but the Demerbe rail does not act, nor is it intended to act, as a girder. It is supported throughout its entire length by a ridge of concrete, and the rail merely acts as a metallic covering.

The advantages of the Demerbe system of tramway over other systems may be summarised as follows: (1) The system is simple, being composed of very few parts. It is also cheaper, and can be laid more quickly than the girder system. (2) The rail and concrete resist the heaviest loads without displacement, depression, or other alteration of the track. (3) The cost of maintenance of rails and paving is reduced to a minimum. (4) The tie-bars are constructed without rivets or nuts. No punching or drilling of the rails is therefore necessary, as the tie bars can be fixed to any part of the rail by means of the slots. (5) Curves of quick radii are made at the works, and are laid as quickly as straight track. (6) The concrete support effectually prevents water finding its way under the rail.

Having regard to the very large sums spent annually on tramways maintenance, it is of the highest importance that lines should be constructed on a system which promises the longest working life, with a minimum of cost for repairs. The writer after a considerable experience in tramway construction and maintenance, has no hesitation whatever in affirming that the Demerbe system possesses points which place it far before the girder and other systems, and he can confidently commend it to the consideration of those having in any way to do with the development and extension of facilities for public transport by means of tramways. And as Bradford is the only city in the United Kingdom which has tested the Demerbe system, it is perhaps not unfitting that this paper should form a contribution to the British Association when it holds its meeting in that city.

Discussion.

The first gentleman who spoke on Mr. Dawson's paper raised the question of how the system described by him affected the roadway. Was the upkeep of the road just round the tramway more difficult to keep in order than was the girder type of railway?

Mr. Alexander Siemens pointed out that with the Demerbe system a 71lb. rail was used, as against 105lb. rail on the girder system. He noticed that in spite of this the cost was not so widely different.

Mr. Dawson, in reply, said that the roadway could be kept in order much more easily with the rails laid on the Demerbe system. This was because the granite sets did not tend to work loose in the same way as they did when laid on the under flanges of a girder rail. The vibration of the girder rail then tended to loosen the granite sets very considerably.

FORTHCOMING EVENTS.

Sept. 18 21.

Iron and Steel Institute.—Paris meeting, Sept. 18, 19, 20, and 21

Sept. 17.—Secretaries' office opens at the Société d'Encouragement pour l'Industrie Nationale, 44, Rue de Rennes, at 3 p.m. 6 p.m., meeting of council at Mr. Henry Chapman's office, 10, Rue Laffitte.

Sept. 18.—9.30 a.m., reception of the president in the hall of the Société d'Encouragement; reading and discussion of papers. 2 p.m., visit to the Exhibition. 9 p.m., Soirée Musicale et Littéraire by the Comité des Forges de France.

Sept. 19.—9 30 a.m., general meeting in the hall of the Société d'Encouragement; reading and discussion of papers. 2 p.m., visit to the Exhibition. 7.30 p.m., the Institute entertains the Reception Committee at a banquet at the Hôtel Continental, Rue Castiglione.

Sept. 20.—10 a.m., visit to the exhibition at Vincennes (locomotives, railway plant, and machine tools). 8 p.m., Group A will start for the St. Chamond Works. 10 p.m., Group B will start for the Hayange Works.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.
Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:
139-140, SALISBURY COURT, FLEET STREET.
LONDON, E.C.

CONTENTS.

Notes	361	Lock and Block Signalling	379
Rathmines Municipal Electricity Works	366	Wireless Telephony	380
Some New Motor-Starting Switches	369	The Manchester and Liverpool Express Railway	381
On the Similarity of Effect of Electrical Stimulus on Inorganic and Living Substances	370	Manchester and Liverpool Railway: Brakes and Signals	382
The Evolution of Switch Gears for High-Pressure Alternating Currents	371	Questions and Answers	383
The Construction of Large Dynamos as Exemplified at the Paris Exhibition	374	The British Association: Address to the Mathematical and Physical Section	384
Recent Tramway Construction, with Special Reference to the Demerbe System	375	Aberdeen Electricity Accounts	388
Forthcoming Events	377	South Shields Electricity Works	388
Municipal Trading at the British Association	378	Contracts for Electrical Supplies	389
Correspondence	379	Traction Notes	391
On the Apparent Emission of Cathode Rays from an Electrode at Zero Potential	380	Lighting Notes	392
		Light Railways	394
		Provisional Patents	395
		Specifications Accepted	396
		Traffic Returns	396
		Companies' Stock and Share List	396

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

MUNICIPAL TRADING AT THE BRITISH ASSOCIATION.

The energy of mankind is largely directed by what concerns the individual Ego; hence the necessity at times for looking behind the scenes in order to obtain an insight into the true origin of action. The world has need of the two classes—the one with whom Ego reigns supreme forming the great bulk of extremists, the other a class having obtained more or less powers of reasoning forming the moderates. The gradations, however, between the extremists on the one side to the extremists on the other side are almost co-extensive with the number of individuals. Thus it comes naturally that most men look upon a particular question from the point of view how it affects the individual, and each conclusion is in this way unconsciously biassed. Points which do not seem to concern anybody in particular are not readily examined, and, indeed, in many cases are not examined at all. What real information as to the incidence of rating is given in Mr. Priestman's statement, similar to what has been often given before, that "the debt incurred by local authorities had increased from £60,000,000 in 1868 to £262,000,000 in 1898; and of this £87,500,000 was estimated to be on account of municipal trading." These figures and many others are given (corrected to date) in the annual reports of the Local Government Board. Frequently the amount per head of population is stated for the purpose of showing how small is the amount per head. It seems never to have struck these amateur statisticians that the amount per head of population is misleading, and what is far more to the point the amount per responsible head—that is, per person responsible for interest or repayment—is never stated. The total population includes men, women, and children. Even taking the population as consisting only of men and women, the divisor would be two, assuming that every man was responsible for his proportion of the debt. But this we know is not the case, and probably a truer number for responsible population would be to divide by six or eight, getting rid of irresponsible women, children, paupers, etc. A still further and a very large reduction must be made for the population residing in districts which have no debt. Then, again, the incidence of rating must be applied to every individual district, and not divided equally over the responsible population of the whole country. Taking round figures for an example, and assuming Cardiff to have a total population of 128,000, and a local indebtedness of about £2,000,000, the number of responsible ratepayers dividing by eight will be 16,000, giving a local indebtedness of £125 per head, a vastly different figure to the not quite £2 per head of population given in popular lectures. Arundel has a population of about 2,700, a debt of about £8,500, or a debt per head of responsible population of less than £25. Not long since, hoping to get trustworthy figures to put before the joint committee, we sent a circular to every authority in the country asking for official figures relating to population and indebtedness, but while obtaining many hundreds of replies, a large number of those authorities whose indebtedness is

Digitized by Google

greatest refused the information, not a few suggesting that if the committee wanted the figures they could compulsorily obtain them. The sting of accurate figures no doubt is in the fact that success in trading is not always assured, and those who indulge in trading should have some approximate knowledge of their real liabilities. We would suggest that all those who can obtain access to authoritative figures should find out the indebtedness per pound ratable value, so that every ratepayer would have some idea as to how far his credit is in pledge.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—I have no desire that my critics should "temper justice with mercy," but I certainly think your correspondent, Mr. F. Johnston, might have tempered his want of mercy with a little justice. He says: "Mr. Dunton . . . describes the case of a rectangular coil of wire having its plane parallel to a uniform magnetic field; and then, after asserting, what is most obviously true, that there will be no current generated in the coil under these conditions, evidently thinks that he has proved his case." He then goes on to show that the statement to which I object does not imply that there will be a current under such conditions, and that I have therefore "found a veritable mare's nest." Now this apparently crushing reply is founded upon a gross misrepresentation; for my argument was not that there will be no *current*, but that "there will be no *E.M.F.*" Strange to say, in another part of his letter he quotes these very words of mine, which makes it somewhat difficult to believe that his misrepresentation is the result of a mere oversight.

Mr. Johnston further says: "Remembering that the so-called 'lines of force' are simply graphical means of representing the direction or 'grain' of the medium or state known as the magnetic field, it is evident that the E.M.F. impressed on a conductor, whether it be in the shape of a rectangle or not, is dependent on the density of that field and the rate at which the conductor cuts it at right angles to its direction." This is the most shocking case of *non sequitur* that I have ever met with; even if the second proposition is true, it certainly does not follow as a logical consequence of the first. Further, the first is not true, for the lines represent the strength of the field, not simply its direction.

My contradiction of the statement which Mr. Johnston upholds is based on the authority of Faraday, who holds that the cause of an induced current, or of a tendency to such a current, is the linking or unlinking of magnetic lines into or out of the electric circuit. I quite admit the possibility of Faraday being wrong and Mr. Johnston being right, but the theory put forward by Faraday strikes me as being by far the more probable one. However, the question could be decided by an experiment.—Yours, etc.,

Stockwell, S.W., Sept. 8, 1900. W. F. DUNTON.

LOCK AND BLOCK SIGNALLING.

The report of the Board of Trade inspector, Lieutenant-Colonel Yorke, on the enquiry into the causes of the accident on the North British Railway near Charing Cross Station, Glasgow, in March last, by which seven persons lost their lives and over 30 others were injured, has just been issued. Colonel Yorke places the responsibility for the disaster upon the signalman on duty at the time at Charing Cross box, and assigns as the immediate cause the use of apparatus under conditions which were demonstrated by the accident as improper.

The line is worked under the "lock and block" system of signalling, and the conditions leading to the accident were as under: Train A immediately on passing Charing Cross box found some difficulty with the brake, and stopped in consequence before reaching the advance clearing treadle for the box named. The signalman at the rear box had train B waiting there, and intimated the fact to Charing Cross. The latter found he could not clear the rear section as his instrument was locked. He seems to have immediately assumed that the passage of train A had failed to operate the treadle; and, taking the releasing key provided for use under exceptional circumstances, unlocked the instrument for the rear section, cleared the line and accepted train B, with the consequences already detailed.

On the advantages of "lock and block" working over the ordinary form of signalling there is no occasion to dwell now. Yet, here, where such a system is in regular use, and where the apparatus appears to have worked exactly as it was devised to do, the conditions obtaining are such as permit a signalman to commit an error of the first magnitude, and of precisely the same class as if the apparatus provided no special check upon error.

That releasing keys introduce a weak point in an-otherwise admirable system of checks against error is not new, and they have before now been pointed to as violations of the fundamental principles underlying the "lock and block." Their use is, no doubt, hedged about with regulations, and requirements in the way of explanations, but it must not be forgotten that, given the opportunity of use at will without positive check, no regulations, however stringent they may be, or appear to be, will repair the mischief that may arise from use under misapprehension. As criminal intention is absurd as an assumption for certain actions, the train of circumstances must initially be ascribed as due to a misapprehension.

It is a fundamental principle of railway signalling that failure of apparatus should not cause danger of accident, but should result in delay to traffic only. In ordinary signalling failure of apparatus leads to working being carried on at "Caution," and "lock and block" systems should not be exempted from the same rule. Suppose the treadle had failed, as was assumed in the case under notice, the use of the releasing key would not have repaired it. The traffic would have been facilitated undoubtedly, but the preventive check, which is the sole reason for the use of the particular class of apparatus, would be absent, and if apparatus temporarily fails in the function which constitutes its superiority over other apparatus under normal conditions, surely such failure is justification for altered conditions of working to meet the less efficient checks available. Moreover, if there are means for obviating the natural results of such a defect, there is a tendency to regard the repairs as of no particular urgency, and the dangerous conditions are prolonged.

The fact is, of course, the provision of a releasing key is a confession of the inability of the apparatus to meet all the conditions of railway working. They are, of course, useful in other ways than for bridging over defects, as, for instance, when cancellation is necessary. But traffic should hold second place to safety, and if such dangers as are here considered exist, it would seem desirable that the use of such auxiliary apparatus should be discontinued. In all probability it would be found that under rigid supervision and closer enquiry the necessity for their use is more apparent than real. Where it is easy to rectify a mistake, it is often considered unnecessary to aim at great accuracy.

It may also be noted that the usual suggestion for making special releasing of the instrument safe—concurrent action on the part of the two signalmen concerned—would have failed in the Glasgow case, since the man at whose instance the operation would have been undertaken failed to realise the cause for the instrument remaining locked, and the other man, who would be a party to the operation, would have no means of checking the statements made to him.

Other questions than those referred to might be discussed with advantage—the extremely prompt resort to the releasing key on the assumption that the treadle had failed is significant—but not now. The accident, deplorable as it is, cannot fail to draw attention to the subject. Regarded as a test of the principle of lock and block signalling, the apparatus may with truth be said to have done better than

Digitized by Google

its manipulator and director, and should stimulate confidence in its ability to prevent such accidents if the fatally easy means of nullifying its checks in the direction of safety are not provided.

ON THE APPARENT EMISSION OF CATHODE RAYS FROM AN ELECTRODE AT ZERO POTENTIAL *

BY CHARLES E. S. PHILLIPS

It has been noticed by many people who work with X-ray or other vacuum bulbs that numerous bright green patches occasionally appear upon the inner surface of the glass walls of a bulb while a discharge is passing, especially during the process of exhaustion. These green flecks vary considerably from time to time both in shape as well as in position, and efforts have been made to connect their existence either with want of uniformity in the composition of the glass or with irregularities in the surface of the negative electrode. I have already, in another place, given some account of an experiment made with the object of clearing up this uncertainty, and now beg to supplement that work with the following observations as to the cause of the phenomenon. The experiment just referred to consisted in using a pivoted disc of aluminium as the negative electrode in a bulb containing rarefied air, so that when green patches appeared a rotational movement of the disc (actuated by means of an external magnet) would show whether the patches of green moved in a corresponding manner or not. It was seen that they did so move.

A distinct feature of the experiment, however, consisted in ascertaining whether these flecks which persisted after the discharge had ceased were still sensitive to movements of the cathode. This also was found to be the case. The proof, therefore, that the green patches were associated with an emission from the cathode appeared complete. But it was further noticed that subsequent to the passage of a discharge, and even when either or both of the electrodes were connected to earth, still the green flecks were easily visible upon the glass walls of the bulb, and continued to move as before when the cathode was rotated. This was apparently a case in which cathode rays were emitted from an electrode at zero potential.

I do not know that any explanation of this effect has so far been offered, and I therefore venture to bring forward the following suggestions, supported by further experiments. When a piece of metal is placed in a rarefied atmosphere and made the negative pole for an electrical discharge passing across the attenuated gas, innumerable small bright specks of light appear over the surface of the metal. It was found convenient in my particular case to use an iron electrode for observations of this effect, because it had the advantage of being readily magnetisable from without. The addition of a similar iron electrode to act as the anode determined the shape of the magnetic field. With such an apparatus it could be seen that the bright spots appeared principally upon the cathode while the discharge passed, and that the creation of a magnetic field between the electrodes made visible the individual luminous streams of gas emanating from those tiny points of light. The paths of these luminous streams becoming bent by the action of the magnetic field followed the direction of the lines of magnetic force, and exhibited a tendency to become spiral in accordance with well-known laws. In this way a fine layer of sodium upon the anode was caused to fluoresce through the action of the negatively electrified particles beating down upon it. One was able, in fact, by this means to cast shadows of objects placed in the paths of the bent streams, and at a pressure considerably higher than that necessary for the production of the well-known cathode shadow effects. In the above case, however, the method served to clearly establish the fact that the bright points of light upon the surface of the cathode indicated the places from which the jets of gas originated. The number of these jets became less as the exhaustion was continued, and individual streams were very clearly seen owing to the action of the magnetic field. When the discharge began to cause fluorescence in the glass of the bulb some green patches made their appearance, and, in some cases, when the cathode was magnetised a bright spot, which was previously judged to indicate the origin of a green patch upon the glass, would shift to a new position upon the electrode. In all such cases the corresponding patch also moved in a similar manner upon the glass. At sufficiently high exhaustions the bright spots upon the electrode disappeared entirely, although green flecks were still visible upon the glass. But a movement as before of the electrode, as well as its magnetisation, gave results consistent with previous observations. Under these conditions, when the discharge through the bulb was stopped, green flecks were still visible for about ten seconds. A positively charged body was brought up to the outside of the bulb and the patches brightened considerably. A negative charge similarly placed extinguished the flecks completely. This was also the case when the electrodes were connected to earth.

Finally, vacuum bulbs, such as X-Ray lamps, etc., exhibiting green flecks while in operation, were generally found to deteriorate if laid aside for a month or two, owing to an increase in the pressure of the contained gas. We see, therefore, that, in the first place, the bright points of light upon the surface of the cathode are due to the emission of fine jets of gas; also that such jets, if negatively charged, may be made to cast shadows of objects suitably placed in their paths. It is, at the same time, clear that the green flecks referred to above are due, during the passage of a discharge, to these same jets of gas impinging upon the inner side of the glass walls, and that, under the conditions existing immediately subsequent to the passage of the discharge, it is evident that streams of gas continue to be emitted from the pores of the electrodes. In spite of the fact that with the electrodes connected to earth these streams consist of unelectrified particles, they assume that property of ionisation during their passage across the space within the bulb which appears to be essential to the production of local fluorescence in the glass upon which they impinge. This latter effect, while explaining the process by which a cathode emission may appear to originate at an electrode with no electrical charge upon it, is one to which I wish to draw special attention, for there is reason to believe that the upper limit of speed for the individual particles constituting the jets cannot exceed the rate at which sound is propagated. It is, therefore, interesting to find that, under such circumstances, fluorescence was produced in the glass upon which the streams impinged.

As many of the observations referred to here were made during the course of an investigation into the diselectrifying action of magnetism now being carried out by myself at the Davy-Faraday laboratory of the Royal Institution, I desire to express my indebtedness to the managers of that institution for the facilities which they have kindly placed at my disposal.

* Paper read before the British Association at Bradford.

Discussion.

Prof. Fitzgerald commented on the results obtained by the author, and wondered if the radiation from the electrode connected to earth would still continue if it were taken out of the vacuum.

Prof. Lodge thought that the glass must have something to do with the effect observed, in spite of the fact that the luminous spots revolved when the electrode was rotated. It was an exceedingly difficult subject to investigate. With respect to the alteration of the vacuum in X-ray tubes with time, he wondered if the author had noticed any tubes being spoilt by the vacuum increasing.

Mr. C. E. S. Phillips, in reply, said he did not fancy there would be any action if the cathode were taken out of the tube. He had noticed that in certain cases the vacuum had gone up with time, although the tubes in question were not being used at all. There seemed to be an absorption into the glass of the gases, or else it would look as though the same were carried out through the glass by the discharges.

WIRELESS TELEPHONY.*

BY SIR WILLIAM HENRY PREECE, K.C.B.

The first experiments in this direction were made in the month of February, 1894, across Loch Ness, in the Highlands. On that occasion trials were made to determine the laws governing the transmission of Morse signals by my electromagnetic method of wireless telegraphy, which has formed the subject of frequent reports to this section since 1884. Two parallel wires well earthed were taken, one on each side of the lake, and arrangements were made by means of which the wires could be systematically shortened, with a view of ascertaining the minimum length necessary to record satisfactory signals. It occurred to Mr. Gavey, who was experimenting, to compare telephonic with telegraphic signals—i.e., to ascertain whether articulate speech could be maintained under the same conditions as Morse signalling. The trials showed that it was then possible to exchange speech across the loch at an average distance of 1½ miles between the parallel wires, when the length of the wires themselves was reduced to four miles on each side of the water. What led to this train of thought was the fact that, although the volume of a telegraphic current was immensely greater than that of a telephonic current, whenever through want of balance in a loop disturbance was evident, then telephonic cross talk was also manifest. In other words, a weak telephonic current was apparently as powerful a disturber as a strong telegraphic one.

The sensation created in 1897 by Mr. Marconi's application of Hertzian waves distracted attention from the more practical, simpler, and older method. Mr. Evershed and Principal Oliver Lodge had in the meantime much advanced the system by introducing admirable call systems. In 1899 I conducted some careful experiments on the Menai Straits, which determined the fact that the maximum effects are produced when the parallel

* Paper read before the British Association at Bradford.

Digitized by Google

wires are terminated by earth-plates in the sea itself. It became quite evident that the ordinary inductive effects are much enhanced by conductive effects through the water, and that in consequence shorter wires are practical. No special apparatus seems necessary. The ordinary telephonic transmitters and receivers were used. It became desirable to establish communication between the islands, or rocks known as the Skerries, and the mainland of Anglesey, and it was determined to do this by means of wireless telephony. The lighthouse at the Skerries was wanted to be in communication with the coastguard station at Cemlyn, which is connected with the Post Office system. The bottom of the Channel is too rough, and the currents too violent for a cable. A wire 750 yards in length was, therefore, erected along the Skerries, and on the mainland one of 3½ miles from a point opposite the Skerries to Cemlyn. Each line terminates by an earthplate in the sea. The average distance between the parallel portions of the two wires is 2·8 miles. Telephonic communication is readily maintained and the service is a good one. Lodge's call system will be used.

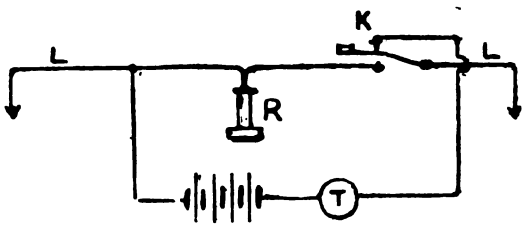
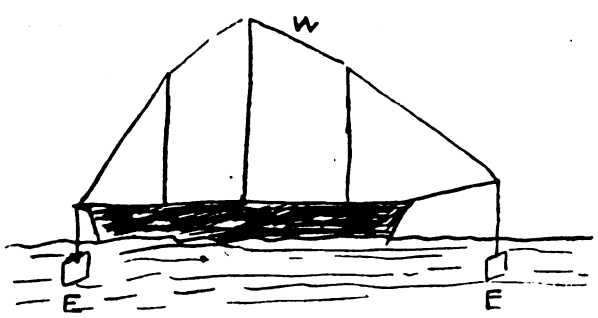


Diagram of Connections: LL = Line Wire earthed at either end. R = Telephone Receiver. T = Transmitter. K = A Key in receiver, which has to be depressed when message is being received.

Further experiments with wireless telephony have recently been made between Rathlin Island, on the north coast of Ireland, and the mainland. The east and west portion of the island of Rathlin is about eight miles from the mainland, but a tongue of land projects southward to within a distance of four miles. Communication was required between the lighthouse near the north-eastern corner of the island and the mainland, and the question for solution was whether an overhead line running the whole length of the island from east to west was necessary to obtain good communication, or whether a shorter line across the neck of the southern peninsula would serve. The preliminary experiments that have been made proved conclusively that communication, both telegraphic and telephonic, has been readily maintained by means of temporary wires established across the neck of the peninsula along the shorter line. Wireless telephony across the sea is now a practical and commercial system.



W = Wires of sending and receiving circuit.
E E = Plates in the sea.

No experiments have yet been made with ships, but it would appear simple to speak by telephone between ship and ship, or between ship and shore, to considerable distances across space by means of a circuit formed of copper wire terminating at each end of the ship in the sea, passing over the topmast and using simple telephones.

Discussion.

In proposing a vote of thanks to the author, the **Chairman** called on Dr. Oliver Lodge to open the discussion on the important paper read by Sir W. H. Preece.

Dr. Oliver Lodge said that he had always urged the importance of having earthplates in the sea, as he had found that earth connections increased very much the range of such systems of telegraphy or telephony. It was surprising how small a base line between the earthplates was sufficient in such cases. Thus he signalled between his college and private house over a distance of two miles with an exceedingly small distance between the earthplates. When using the telephone as the sending and receiving instrument, he thought that good results were produced because the electrical energy was only distributed over two dimensions. The high frequency of the waves tended to keep the electricity on the surface, so that it did not diffuse downwards. When signalling between warships as suggested by Sir W. Preece, he was afraid that the arrangement of conductors over the mast and bowsprit of the ship ending in an earth plate fore and aft, would not be very successful. This would be perhaps all right with a wooden ship, but in an iron vessel the earth-plates would be almost short circuited by the mass of iron between them. It was exceedingly difficult, of course, to discriminate between the induction effects and the conduction currents, but he believed that a large proportion of the energy transmitted went by conduction.

Mr. Sydney F. Walker did not think that signalling from warships as suggested by Sir William Preece would be serviceable. He had some years ago investigated the lines of current flow in connection with signalling without wires. The results he had obtained were described in an article in the *Electrical Engineer* for Dec. 9, 1892.

Mr. Julius West said that in signalling from one ship to another, the relative angles would, he was afraid, make a great difference between the distances to which signalling was possible. He had experimented largely on a lake in Germany in order to determine whether signals were transmitted by induction or conduction. A line similar to the one described by Sir W. Preece was erected along the shore of the lake, ending in two earth-plates. The receiving line was connected between two yachts on the lake, one of these being anchored. The other yacht then moved round in a circle, and he found that when the two vessels were in a line perpendicular to the sending wire on shore, no signals were received. He concluded from this that the signals were sent by induction. *

Another speaker commented on the fact that a telephone connected between the gas and water service always gave a loud click when a flash of lightning took place in the neighbourhood.

Sir W. H. Preece, in reply, said that the effect noted by the last speaker was well known, although it was somewhat surprising, in view of the close proximity of the gaspipes and water-pipes. Telephones with an earth return always acted as recorders of thunderstorms. He remembered, for instance, that when the London to Paris telephone system was being inaugurated, the ladies and gentlemen who were at the London instrument were surprised to hear what seemed like a series of loud reports intermingled with the music and speech from Paris. These noises were due to a thunderstorm in France. Mr. Gavey had last year tried at Dover a most interesting experiment on the possibilities of signalling by means of the discharges from the clouds. When a violent thunderstorm was taking place he transmitted signals from the sending station of the Marconi telegraph to the Boulogne station without using the usual sources of electricity. The signals were received and were quite readable, although they were interspersed with interruptions caused by the violent discharges from the storm.

THE MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.†

BY SIR W. H. PREECE, F.R.S.

A monorail line has been projected by Mr. Behr between Manchester and Liverpool to accommodate express passenger traffic alone between those two cities. It is to be worked by electric traction, and to attain very high speeds. The train is to consist of only one coach, weighing 45 tons and seating 64 passengers. Starting at every 10 minutes, and travelling at the mean rate of 110 miles an hour, it will do the distance of 34½ miles in 20 minutes. The fares will be slightly lower than those charged at present. There will be no intermediate stations, no points nor crossings. There will thus be no necessity for signals to protect the line during other operations. Signals would be needed only to secure a perfect block system of working the line. The monorail railway was projected by Lartigue in 1882. We have only one example of this system of railway in the United Kingdom—viz., between Listowel and Ballybunion, in County Kerry, Ireland. This line was designed and engineered by Mr. Behr. The Act was obtained in 1887 and the line was opened for traffic in February, 1888, and it has been running ever since. The line is 9¼ miles long. It has one intermediate station, Liselton. There are 42 level and farm crossings. It is worked by steam. The train consists of a locomotive and four coaches. It cost £33,000 to build, or £3,060 per mile. When I inspected the line in the early part of this year there had never been a Board of Trade enquiry into any accident. The maintenance of the structure had been effective. No rail had ever been turned. The mechanical structure had exhibited no defects, but several breakdowns had occurred in the locomotive and rolling-stock. There are three locomotives, 11 passenger coaches, and two brake vans. They had, however, continued to work the line uninterruptedly for 12 years, and there had been no renewals or new stock. Its main principle is the suspension of the coaches on a single elevated rail so that their centres of gravity are below the rail. Each coach sits the rail like a saddle. The rail is fixed on

* N.B.—It seems to us that Mr. West's experiment is not conclusive, as exactly the same would take place if the signals were transmitted by conduction only, and not by induction at all.—Ed., *E. E.*

† Paper read before the British Association at Bradford.

Digitized by Google

trestles which are tied and braced together, the tie-bars being light rails against which guide wheels roll.

The Manchester and Liverpool express is intended to be more massively and rigidly built. Derailment on such a structure is impossible, and curves of comparatively small radius can be passed with safety at high speeds. Vibrations and noise will be reduced, and travelling will be conducted with greater comfort than at present. It is proposed to fix the generating station midway at Warrington, and to transmit the electric energy at high-pressure (10,000) volts to each terminal station. There would be sub-stations along the line at distances apart of four miles, where the 10,000 volts would be brought down to 1,000, at which pressure it would be picked up by the motors on the coach. The speed which a train can acquire on a railway depends on the power that can be continuously applied at the tread of the driving wheel. Electricity enables the engineer to apply instantaneously to light loads a power which steam cannot supply; hence speeds are possible with electricity which are unattainable with steam. A coach weighing 45 tons can easily and quickly attain 110 miles an hour; 1,600 h.p. will accelerate the coach so as to attain this speed in 110 seconds, and 500 h.p. will maintain this speed on the level. Electricity has two advantages over steam. It enables us to obtain an acceleration of 1½ft. per second, which is virtually the limit that can be obtained without causing discomfort to the passengers; and, secondly, it applies a continuous and constant torque instead of the variable one, due to the reciprocating action of the ordinary steam locomotive. Hence it not only enables us to maintain high speeds on long through lines like the proposed Manchester and Liverpool Express, but it enables us to attain high speeds with greater rapidity on short lines having frequent stoppages, like the Metropolitan Railways of London, and thus increase the capacity of the line for traffic. The chief causes of accident on ordinary railways—viz., collision, derailment, points, and the human error of the signalman will be removed from lines. Hence travelling will be much safer.

MANCHESTER AND LIVERPOOL RAILWAY: BRAKES AND SIGNALS.*

BY F. J. BEHR.

The question of brakes and signals are so intimately connected that the one cannot be treated separately from the other. The most perfect condition under which a railway could be worked, would be that in which both brakes and signals could be dispensed with, therefore it follows that the fewer the occasions for using either the better. Now as to brakes, there is a limitation of their application, which depends not so much on the mechanical appliances themselves as on the endurance of the human bodies in the trains. It was stated by an eminent railway official that with the Westinghouse brake, a train travelling at 60 miles an hour could be stopped, as an emergency brake, within 360 yards without inflicting too great a shock on the passengers. In the same way a train travelling at 110 miles an hour could be stopped within 500 yards, and probably in a shorter distance, as in the latter case electrical means are at hand, such as the reversal of the motors, so as to turn them into dynamos. More rapid stoppage could only be made with great discomfort to the passengers. Now in the ordinary way of working our railways at present there are many occasions in which it might be important to stop the train as rapidly as possible. For instance, if a train in front should be seen, or some shunting operations were not completed, or many others too many to enumerate, but no brake, however powerful, would be of the slightest use to-day to avoid a sudden obstacle, such as a stone placed on the rail, or a broken rail, for it is impossible for the driver to be aware of such obstacles until he is practically upon them. For these cases of great emergency, therefore, the stoppage at 300, or 200, or even 100 yards is quite useless.

What I wish to show now is that on the proposed high-speed electrical railways, though it is quite possible to brake the train within less than 500 yards, it never can be necessary to bring it to a standstill at even a much longer distance. On the proposed railway there are no level crossings, no switches, no shunting operations, and, in fact, nothing that will require the train to be brought to a standstill, except in the event that a preceding train should break down. Besides this one case, the brakes can only be used for stopping as you approach the stations. A broken rail offers no danger in this case whatever, for the train would run over it without any danger or difficulty. This can easily be shown by carefully considering the relative position of the wheels in the carriages to the rails over which they travel. I now, therefore, have only to explain the manner in which it is arranged that the driver of each train shall be informed of the possible stoppage of the train in front of him. No second train will leave the station at Manchester or Liverpool until the first has reached Warrington, a distance of just 17 miles. We subdivide the line for the purpose of signalling into eight sections of 4·3 miles each. As trains leave Manchester station a danger signal is put up automatically at that station, a second similar danger signal is put up in the same way at 4·3 miles off, the first remaining at danger. The train travels on until it reaches 8·6 miles, when it puts up a third danger signal, and simultaneously the signal is lowered at Manchester or Liverpool station, so that the second train can leave when the time comes. Now, we will assume that the first train has met with an accident after passing point 8·6 miles, the second train would travel at a higher speed right on, but when it passes point 4·3 miles the danger signal at that point not having been removed by the first train, as this never reached point 13 miles, the driver of the second train would be informed that the first train had met with an accident beyond 8·6 miles, and therefore that he had to slow down, but that for such lowering of his speed he had a clear run of over four miles. Therefore, there could be no difficulty in any case to stop even without using the brake at all, by simply cutting off the current. Whenever a train passes over a point where the danger signal is put up this is also produced, either electrically or mechanically, by a very simple and inexpensive contrivance in the cabin of the electrician, so that he should be perfectly able to see it without difficulty even if there was a thick fog.

Under these conditions of travelling it seems, therefore, superfluous to have any emergency brakes, and though we shall be able to stop the trains within 500 yards, no case can be imagined in which it would be useful or necessary to resort to such a stoppage. A six minutes' service of trains can be established without any alteration in the proposed arrangement, and if a three minutes' service was required, the blocks would have to be reduced to two mile sections, giving a clear run of two miles in case of a breakdown.

* Paper read before the British Association at Bradford.

Discussion.

The President announced that the discussion on the papers read by Sir W. H. Preece and Mr. F. J. Behr would be taken together, as they referred to the same subject.

Mr. Jas. Shoolbred asked if they could not be given more details as to the reason why the House of Commons Committee had refused to pass the Bill. He understood that though both the Dock Board and the Salford Corporation had successfully objected, there was also the question raised by the committee of the brakes and of the general safety of the system. Could the authors give any information on the air friction of trains at such high speeds. He understood that in America recently some experiments had been made on the air friction caused by the gaps between the carriages. Speaking from memory, he thought that the air friction was reduced by 40 per cent. by boarding up these spaces. He was surprised to find that the bogie carriage proposed to be used would weigh 20 tons, which would be practically double the weight of an ordinary passenger bogie.

Mr. Behr, interposing, explained that the weight of a carriage was not the thing to be considered, but rather the weight per passenger carried. On the proposed Liverpool and Manchester express this weight would be 12cwt. per passenger, whereas on one of our principal railways the weight came out at 1¼ tons per passenger.

Mr. Sydney F. Walker referred to the enormous advantage on such a system of the use of polyphase transmission, which had so many advantages over continuous current. He proceeded to refer to some experiments by Prof. Weber on the capability of the human body to withstand shock. The professor had found that 50 volts was sufficient to paralyse him when passed through from hand to hand, the hands being moistened. With dry hands 90 volts alternating had the same effect. When the current was passed through from head to feet, standing on gravel, a shock of 2,000 volts could be taken, but on wet clay the professor was paralysed at 1,300 volts.

Mr. Behr, in reply, said that he thought the present paper would answer any objections brought by the committee on the braking question, but the braking question was, after all, not for the committee to decide, but for the Board of Trade, who had full control of this matter, and also of the safety of the public from shock. They had used 750 volts without doing any damage in Brussels, and he thought the step to 1,000 volts was quite justifiable. One of the great dangers from high speeds resulted from the coupling of carriages, which they avoided by having single cars only. The single cars also gave great economy and enabled them to run a frequent service. The question of the number of people carried by the railways now connecting the two cities of Manchester and Liverpool had not been cleared up before the committee. The railway companies said that the traffic did not pay, and that they only carried 1,500 per day. He had counted up to 4,000 per day, but even then the number travelling depended on the facilities given, and he expected that their estimate of 7,500 passengers was none too high. The company could, however, pay a dividend of 15 per cent. when carrying 4,000 per day. In answer to another question Mr. Behr stated that the centre of gravity of the cars was 15in. below the top of the rail.

Sir. W. H. Preece, also in reply, thought that the figures referred to by Mr. Walker must have been wrongly given in the

Digitized by Google

foreign paper in which they appeared. A shock of 200 volts would not paralyse anyone, and he thought that 500 volts was absolutely safe.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

307. To what extent would the capacity of a compound or shunt machine be affected when working in extremes of temperature, such as are experienced on some ocean liners? Give the ratio.—F. W. G.

308. In providing condensing plant for a central station, what should be the governing factor in deciding the size of the plant? What is the mistake so often made?—A. G. M.

ANSWERS.

Question No. 301.—In installations on board ships working with only one insulated wire, and using the ship as the return, which pole of the dynamo should be connected to the ship?

Answer to No. 301 *(awarded 7s. 6d.)*.—In a two-wire circuit carrying direct current it is found that the negative wire tends to assume earth potential. This is due to the rapid deterioration of insulation brought about by what is known as electric osmosis. By reason of this action any moisture present tends to move from the positive and collect round about any exposed connections to the negative wire. As all insulation is more or less porous, this creeping action is not confined solely to the leakage surfaces. This condition of things is naturally more pronounced in connection with ship lighting than in ordinary installation work. As the negative wire approaches earth potential this destructive action becomes less marked, and can be prevented to a large extent by deliberately earthing the negative wire. In many cases, therefore, the negative wire has been dispensed with and the hull of the ship used as a return. This, of course, reduces the cost of wiring, so that more may be spent upon the insulation and installing of the remaining wire. Greater security from fire risk, and other advantages outside the scope of this question, accrue from the use of this single-wire system. If, however, the positive pole were connected to the ship instead of the negative, the detrimental action on the insulation of the negative would not only be maintained but intensified, until eventually the system would break down altogether. This end would be hastened by electrolytic action, which would be set up wherever leaks should happen to occur. The ironwork of the ship would become pitted at these points, and the wire itself be unfavourably acted upon. If lead-covered wire were used, the sheathing being electro-positive to the wire would quickly be corroded. It is therefore very evident that the negative pole ought to be connected to the ship rather than the positive.—P. S. T.

Answer to No. 301 (*awarded* 7*s.* 6d.).—In single-wire ship installations it is advisable to connect the negative pole of the dynamo to the ship. The reason for this is that it is impossible to make the connections between the wiring and the hull so perfect as to do away with electrolytic action. This electrolytic action takes place between the copper of the conductors and the iron of the ship; the presence of salt in the moisture which collects on the sides and bulkheads of the vessel (due to "sweating") causes the electrolysis to proceed very rapidly where an imperfect connection exists. When the negative pole of the dynamo is connected to the ship, the current from the various small connections for the lamps flows from those connections to the ship, and tends to clean the copper at the contact, as it is constantly being eaten away to a greater or less extent. Of course, the reverse effect takes place at the negative pole of the dynamo, where the current, leaving the ship, enters the main negative cable to the dynamo. As it is, however, much easier to make and maintain a good connection in the case of one large cable than it would be to make and maintain a good connection at all the various small lamp connections scattered throughout the ship, the advantage of having the negative cable connected to the shell is obvious. The reduction in the resistance due to the above method of connection is, of course, only a small amount for each joint, but when this small reduction is multiplied by, say, 200 or 300, the total reduction is an important factor.—R. M. W.

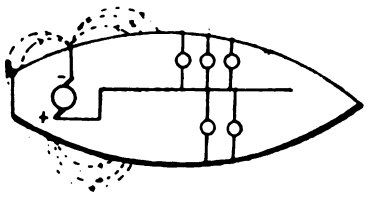
Answer to No. 301 (*awarded* 5*s.*).—The negative pole of the dynamo must be fastened to the ship in order to avoid damage to the ship by electrolytic action. A little experiment will make this perfectly clear—viz.: Take two small copper wires (No. 20 or No. 18 will do nicely), and attach one to the negative pole and one to the positive pole of a battery of not less than two cells in series, then dip the two free ends into a cup containing sulphuric acid solution (10 per cent. acid and 90 per cent. water will do nicely), and allow the current to pass for a little while. Now examine the ends of the wires dipped into the acid solution, and it will be obvious that the wire attached to the positive pole of the battery has been dissolved away more or less according to the strength of the current and the time allowed for the experiment. With a dynamo instead of a battery the current would probably be greater, and therefore the damage done to the wire would be greater and more rapid. A solution of salt and water would have the same effect on the wire—*i.e.*, the free end of the positive wire would be eaten away. In electrolysis the metal passes in the same direction as the current, and any acid in the electrolyte passes in the opposite direction, and so attacks the positive electrode. At sea the ship would seldom be dry for long, and therefore damaging electrolytic action would be certain to occur to the ship if the positive pole of the dynamo were attached to it, but with the ship attached to the negative pole all tendency to damage the ship is obviated, and the tendency to damage or corrosion by electrolytic action is transferred to the positive wire, which can easily be protected by insulation.—F. G. A.

Answer to No. 301 (*awarded* 5*s.*).—Assuming in the first case the + pole to be connected to the ship and the − pole to the insulated wire, then if leakage caused by dampness takes place between the bare metal parts of the insulated wire (such as switches, lampholders, etc.) the leakage will tend to increase. This effect is due to what is known as electric osmosis—*i.e.*, moisture will constantly creep from the ship (+) to the fault on the insulated wire (−) reducing its insulation resistance and thus increasing the leakage current. But, in the second case, if the − pole be connected to the ship and the + pole to the insulated wire, then a leakage current from the insulated wire which is now + will cause moisture on it to creep to the ship which is −, increasing the insulation resistance of the insulated wire. Thus, in order to keep good insulation between the insulated wire and the ship, the − pole should be connected to the ship.—A. H. M.

Answer to No. 301 (*awarded* 5*s.*).—If the metal work of the ship forms a complete and uninterrupted circuit, as is usually the case, from one pole of the dynamo to all lamps or other apparatus in use, there is no preference as to which pole should be connected to the ship. The case cannot be compared with the ordinary single-trolley tramway circuit, in which the earth return is usually made the negative. In the case of the ship, leakage from + to − will not pass into the sea at all, but will be entirely confined to the inside of the ship. There is, however, a likelihood of leakage occurring locally through the sea on the outside of the ship from points working at higher potentials to other points working at lower potentials. On this account it would be worth while changing the dynamo leads over every few weeks or months, so as to make the ship some-

Digitized by Google

times negative and sometimes positive. In this way damage to the ship's plating will be prevented. For, whilst the ship's side is the negative pole, the leakage current will flow in one direction, depositing metal off one point and on to another (as shown by the dotted lines in the figure), and



when the polarity is reversed the direction will be reversed, and the deposition will take place in the reverse direction, thus tending to repair the damage done with the first polarity.—Q.

Question No. 302.—How would you determine the proper size and lifting power of a travelling crane for an electric generating station?

Best Answer to No. 302 (*awarded* 10*s.*).—The size and lifting power of a crane for an electric generating station is governed by the weights it will be called upon to lift during the erection of the plant, and in case of any repairs cranes in central stations should be designed very liberally, for most growing stations find that when a unit of 100 kw. is used at the commencement it is most economical to adopt a 500-kw. unit as the load on the station increases. Now, if a bare margin is only allowed a new crane will have to be erected, and it would have paid to put up a larger crane at first. Where the load is assured, and the commencing unit is a standard, as in traction plants, the crane must be designed with a 50 per cent. allowance above the heaviest weight to be dealt with. The following table is taken from modern central station practice:

Size of units.	System.	Strength of crane.
80 h.p.	Direct	6 ton.
120 h.p.	Direct	8 ton.
500 h.p.	Direct	10 ton.
180 h.p.	Alternating	10 ton.
750 h.p.	Alternating	20 ton.
750 h.p.	Three-phase	25 ton.

This shows the strength of cranes which are advised by our prominent consulting engineers. The 180-h.p. set and the 750-h.p. set are engines with slow speed, all others high speed. In the two latter sizes the crane was operated by electricity, and where heavy castings have to be moved the electric cranes are an advantage, being easily controlled and quicker in their action than a crane operated from the engine-house floor by means of chains. The table beneath shows crane speeds under various loads:

Load	5	10	15	25 tons.
Hoist	151	10	8	6ft. per minute.
Traverse	90	50	45	45ft. ,,
Travel	100	100	100	100ft. ,,

The horse-power of a crane motor is arrived at by taking the actual power used in lifting a load, and allowing 25 per cent. for power lost in gearing; for cast wheels in the gearing a higher figure than 25 per cent. must be taken. A slow-speed motor on a crane, although higher cost, is better than higher-speed machines; in the former no wear and tear of gearing takes place, and they possess quicker reversing power. Speeds should be kept down in a three-motor crane to 300 per minute for hoist and 700 per minute for travelling. I advise a single-motor crane for this class of work controlled by a main switch. A resistance in series with the shunt will give variation in speed.—F. M. M.

Answer to No. 302 (*awarded* 5*s.*).—Cranes for central-station work are designed in many cases with three motors instead of one, so as to obtain the highest economy of power in working, and at the same time to avoid the complications of gearing which is necessary with the single motor type of crane. The proper size and strength is determined by the following items: (1) the maximum weight to be lifted, and at what speed; (2) speed of cross traverse for maximum load; (3) speed of longitudinal traverse; (4) maximum height to be lifted; (5) the span, or distance from centre to centre, of rails and total length of gravity.

Thus suppose the maximum weight to be lifted be five tons, and the speed of elevation to be 10ft. per minute, then the work done in one minute will equal $2,240 \times 5 \times 10 = 112,000$ foot-pounds $= 3{\cdot}39$ horse-power, which will have to be developed at the point of suspension. Thus the motor should have a brake horse-power of 3·4, plus any loss due to friction and gearing. Then having arrived at the brake horse-power necessary, and knowing the available E.M.F., we can calculate the current that the motor will take, which thus gives us the amount of copper, and the weight of the motor can be calculated, which will be a dead weight, for which allowance must be made in arriving at the strength of the crane frame.—J. C. B.

THE BRITISH ASSOCIATION.

Address to the Mathematical and Physical Section

BY JOSEPH LARMOR, M.A., D.SC., F.R.S., PRES.C.P.S., PRESIDENT OF THE SECTION.

(*Concluded from page 341.*)

If, then, we have so small a hold on the intimate nature of matter, it will appear all the more striking that physicists have been able precisely to divine the mode of operation of the intangible æther, and to some extent explore it in the fields of physical influence of the molecules. On consideration we recognise that this knowledge of fundamental physical interaction has been reached by a comparative process. The mechanism of the propagation of light could never have been studied in the free æther of space alone. It was possible, however, to determine the way in which the characteristics of optical propagation are modified, but not wholly transformed, when it takes place in a transparent material body instead of empty space. The change, in fact, arises on account of the æther being entangled with the network of material molecules; but inasmuch as the length of a single wave of radiation covers thousands of these molecules the wave-motion still remains uniform and does not lose its general type. A wider variation of the experimental conditions has been provided for our examination in the case of those substances in which the phenomenon of double refraction pointed to a change of the æthereal properties which varied in different directions; and minute study of this modification has proved sufficient to guide to a consistent appreciation of the nature of this change, and therefore of the mode of æthereal propagation that is thus altered. In the same way, it was the study and development of the manner in which the laws of electric phenomena in material bodies had been unravelled by Ampère and Faraday, that guided Faraday himself and Maxwell—who were impressed with the view that the æther was at the bottom of it all—in their progress towards an application of similar laws to æther devoid of matter, such as would complete a scheme of continuous action by consistently interconnecting the material bodies and banishing all untraced interaction across empty space. Maxwell, in fact, chose to finally expound the theory by ascribing to the æther of free space a dielectric constant and a magnetic constant of the same types as had been found to express the properties of material media, thus extending the seat of the phenomena to all space on the plan of describing the activity of the æther in terms of the ordinary electric ideas. The converse mode of development, starting with the free æther under the directly dynamical form which has been usual in physical optics, and introducing the influence of the material atoms through the electric charges which are involved in their constitution was hardly employed by him; in part, perhaps, because, owing to the necessity of correlating his theory with existing electric knowledge and the mode of its expression, he seems never to have reached the stage of moulding it into a completely deductive form. (In 1870 Maxwell, while admiring the breadth of the theory of Weber, which is virtually based on atomic charges combined with action at a distance, still regarded it as irreconcilable with his own theory, and left to the future the question as to why "theories apparently so fundamentally opposed should have so large a field of truth common to both."—"Scientific Papers," ii., p. 228.)

The dynamics of the æther—in fact, the recognition of the existence of an æther, has thus, as a matter of history, been reached through study of the dynamical phenomena of matter. When the dynamics of a material system is worked up to its purest and most general form, it becomes a formulation of the relations between the succession of the configurations and states of motion of the system, the assistance of an independent idea of force not being usually required. We can, however, only attain to such a compact statement when the system is self-contained, when its motion is not being dissipated by agencies of frictional type, and when its connections can be directly specified by purely geometrical relations between the

Digitized by Google

co-ordinates, thus excluding such mechanisms as rolling contacts. The course of the system is then in all cases determined by some form or other of a single fundamental property, that any alteration in any small portion of its actual course must produce an increase in the total "action" of the motion. It is to be observed that in employing this law of minimum as regards the action expressed as an integral over the whole time of the motion, we no more introduce the future course as a determining influence on the present state of motion than we do in drawing a straight line from any point in any direction, although the length of the line is the minimum distance between its ends. In drawing the line piece by piece we have to make tentative excursions into the immediate future in order to adjust each element into straightness with the previous element; so in tracing the next stage of the motion of a material system, we have similarly to secure that it is not given any such directions as would unduly increase the action. But whatever views may be held as to the ultimate significance of this principle of action, its importance, not only for mathematical analysis, but as a guide to physical exploration, remains fundamental. When the principles of the dynamics of material systems are refined down to their ultimate common basis, this principle of minimum is what remains. Hertz preferred to express its contents in the form of a principle of straightness of course or path. It will be recognised, on the lines already indicated, that this is another mode of statement of the same fundamental idea; and the general equivalence is worked out by Hertz on the basis of Hamilton's development of the principles of dynamics. The latter mode of statement may be adaptable so as to avoid the limitations which restrict the connections of the system, at the expense, however, of introducing new variables; if, indeed, it does not introduce gratuitous complexity for purposes of physics to attempt to do this. However these questions may stand, this principle of straightness or directness of path forms, wherever it applies the most general and comprehensive formulation of purely dynamical action: it involves in itself the complete course of events. In so far as we are given the algebraic formula for the time integral which constitutes the action, expressed in terms of any suitable co-ordinates, we know implicitly the whole dynamical constitution and history of the system to which it applies. Two systems in which the action is expressed by the same formula are mathematically identical, are physically precisely correlated, so that they have all dynamical properties in common. When the structure of a dynamical system is largely concealed from view, the safest and most direct way towards an exploration of its essential relations and connections, and, in fact, towards answering the prior question as to whether it is a purely dynamical system at all, is through this order of ideas. The ultimate test that a system is a dynamical one is not that we shall be able to trace mechanical stresses throughout it, but that its relations can be in some way or other consolidated into accordance with this principle of minimum action. This definition of a dynamical system in terms of the simple principle of directness of path may conceivably be subject to objection as too wide; it is certainly not too narrow; and it is the conception which has naturally been evolved from two centuries of study of the dynamics of material bodies. Its very great generality may lead to the objection that we might completely formulate the future course of a system in its terms without having obtained a working familiarity with its details of the kind to which we have become accustomed in the analysis of simple material systems; but our choice is at present between this kind of formulation, which is a real and essential one, and an empirical description of the course of phenomena combined with explanations relating to more or less isolated groups. The list of great names, including Kelvin, Maxwell, Helmholtz, that have been associated with the employment of the principle for the elucidation of the relations of deep-seated dynamical phenomena, is a strong guarantee that we shall do well by making the most of this clue.

Are we, then, justified in treating the material molecule, so far as revealed by the spectroscope, as a dynamical system coming under this specification? Its intrinsic energy is certainly permanent and not subject to dissipation; otherwise the molecule would gradually fade out of existence. The extreme precision and regularity of detail in the spectrum shows that the vibrations which produce it are exactly synchronous, whatever be their amplitude, and in so far resemble the vibrations of small amplitude in material systems. As all indications point to the molecule being a system in a state of intrinsic motion, like a vortex ring, or a stellar system in astronomy, we must consider these radiating vibrations to take place around a steady state of motion which does not itself radiate, not around a state of rest. Now, not the least of the advantages possessed by the action principle, as a foundation for theoretical physics, is the fact that its statement can be adapted to systems involving in their constitution permanent steady motions of this kind in such a way that only the variable motions superposed on them come into consideration. The possibilities as regards physical correlation of thus introducing permanent motional states as well as permanent structure into the constitution of our dynamical systems have long been emphasised by Lord Kelvin; the effective adaptation of abstract dynamics to such systems was made independently by Kelvin and Routh about 1877; the more recent exposition of the theory by Helmholtz has directed general attention to what is undoubtedly the most significant extension of dynamical analysis which has taken place since the time of Lagrange.

Returning to the molecules, it is now verified that the action principle forms a valid foundation throughout electrodynamics and optics; the introduction of the æther into the system has not affected its application. It is, therefore, a reasonable hypothesis that the principle forms an allowable foundation for the dynamical analysis of the radiant vibrations in the system formed by a single molecule and surrounding æther; and the knowledge which is now accumulating, both of the orderly grouping of the lines of the spectrum and of the modifications impressed on these lines by a magnetic field or by the density of the matter immediately surrounding the vibrating molecule, can hardly fail to be fruitful for the dynamical analysis of its constitution. But let it be repeated that this analysis would be complete when a formula for the dynamical energy of the molecule is obtained, and would go no deeper. Starting from our definitely limited definition of the nature of a dynamical system, the problem is merely to correlate the observed relations of the periods of vibration in a molecule when it has come into a steady state as regards constitution, and is not under the influence of intimate encounter with other molecules.

It may be recalled incidentally that the generalised Maxwell-Boltzmann principle of the equable distribution of the acquired store of kinetic energy of the molecule among its various possible independent types of motion is based directly on the validity of the action principle for its dynamics. In the demonstrations usually offered the molecule is considered to have no permanent or constitutive energy of internal motion. It can, however, be shown, by use of the generalisation aforesaid of the action principle, that no discrepancy will arise on that account. Such intrinsic kinetic energy virtually adds on to the potential energy of the system, and the remaining or acquired part of the kinetic energy of the molecule may be made the subject of the same train of reasoning as before.

Let us now return to the general question whether our definition of a dynamical system may not be too wide. As a case in point, the single principle of action has been shown to provide a definite and sufficient basis for electro-dynamics; yet when, for example, one armature of an electric motor pulls the other after it without material contact, and so transmits mechanical power, no connection between them is indicated by the principle, such as could by virtue of internal stress transmit the pull. The essential feature of the transmission of a pull by stress across a medium is that each element of volume of the medium acts by itself, independently of the other elements. The stress excited in any element depends on the strain or other displacement occurring in that element alone; and the mechanical effect that is transmitted is considered as an extraneous force applied at one place in the medium, and passed on from element to element through these internal pressures and tractions until it reaches another place. We have, however, to consider two atomic electric charges as being themselves some kind of strain configurations in the æther; each of them already involves an atmosphere of strain in the surrounding æther which is part of its essence, and cannot be considered apart from it; each of them essentially pervades the entire space, though on account of its invariable character we consider it as a unit. Thus we appear to be debarred from imagining the æther to act as an elastic connection which is merely the agent of transmission of a pull from the one nucleus to the other, because there are already stresses belonging to and constituting an intrinsic part of the terminal electrons, which are distributed all along the medium. Our action criterion of a dynamical system, in fact, allows us to reason about an electron as a single thing, notwithstanding that its field of energy is spread over the whole medium; it is only in material solid bodies, and in problems in which the actual sphere of physical action of the molecule is small compared with the smallest element of volume that our analysis considers, that the familiar idea of transmission of force by simple stress can apply. Whatever view may ultimately commend itself, this question is one that urgently demands decision. A very large amount of effort has been expended by Maxwell, Helmholtz, Heaviside, Hertz, and other authorities in the attempt to express the mechanical phenomena of electrical action in terms of a transmitting stress. The analytical results up to a certain point have been promising, most strikingly so at the beginning, when Maxwell established the mathematical validity of the way in which Faraday was accustomed to represent to himself the mechanical interactions across space in terms of a tension along the lines of force equilibrated by an equal pressure preventing their expansion sideways. According to the views here developed, that ideal is an impossible one. If this could be established to general satisfaction, the field of theoretical discussion would be much simplified.

Digitized by Google

This view that the atom of matter is, so far as regards physical actions, of the nature of a structure in the æther involving an atmosphere of æthereal strain all around it, not a small body, which exerts direct actions at a distance on other atoms according to extraneous laws of force, was practically foreign to the eighteenth century, when mathematical physics was modelled on the Newtonian astronomy and dominated by its splendid success. The scheme of material dynamics, as finally compactly systematised by Lagrange, had therefore no direct relation to such a view, although it has proved wide enough to include it. The remark has often been made that it is probably owing to Faraday's mathematical instinct, combined with his want of acquaintance with the existing analysis, that the modern theory of the æther obtained a start from the electric side. Through his teaching, and the weight of his authority, the notion of two electric currents exerting their mutual forces by means of an intervening medium, instead of by direct attraction across space, was at an early period firmly grasped in this country. In 1845 Lord Kelvin was already mathematically formulating, with most suggestive success, continuous elastic connections, by whose strain the fields of activity of electric currents or of electric distributions could be illustrated, while the exposition of Maxwell's interconnected scheme, in the earlier form in which it relied on concrete models of the electric action, goes back almost to 1860. Corresponding to the two physical ideals of isolated atoms exerting attraction at a distance, and atoms operating by atmospheres of æthereal strain, there are, as already indicated, two different developments of dynamical theory. The original Newtonian equations of motion determined the course of a system by expressing the rates at which the velocity of each of its small parts or elements is changing. This method is still fully applicable to those problems of gravitational astronomy in which dynamical explanation was first successful on a grand scale, the planets being treated as point masses, each subject to the gravitational attraction of the other bodies. But the more recent development of the dynamics of complex systems depends on the fact that analysis has been able to reduce within manageable limits the number of varying quantities whose course is to be explicitly traced, through taking advantage of those internal relations of the parts of the system that are invariable, either geometrically or dynamically. Thus, to take the simplest case, the dynamics of a solid body can be confined to a discussion of its three components of translation and its three components of rotation, instead of the motion of each element of its mass. With the number of independent co-ordinates thus diminished, when the initial state of the motion is specified, the subsequent course of the complete system can be traced; but the course of the changes in any part of it can only be treated in relation to the motion of the system as a whole. It is just this mode of treatment of a system as a whole that is the main characteristic of modern physical analysis. The way in which Maxwell analysed the interactions of a system of linear electric currents, previously treated as if each were made up of small independent pieces or elements, and accumulated the evidence that they formed a single dynamical system, is a trenchant example. The interactions of vortices in fluid form a very similar problem, which is of special note in that the constitution of the system is there completely known in advance, so that the two modes of dynamical exposition can be compared. In this case the older method forms independent equations for the motion of each material element of the fluid, and so requires the introduction of the stress—here the fluid pressure—by which dynamical effect it passed on to it from the surrounding elements: it corresponds to a method of contact action. But Helmholtz opened up new ground in the abstract dynamics of continuous media when he recognised (after Stokes) that if the distribution of the velocity of spin at those places in the fluid where the motion is vortical be assigned, the motion in every part of the fluid is therein kinematically involved. This, combined with the theorem of Lagrange and Cauchy—that the spin is always confined to the same portions of the fluid—formed a starting-point for his theory of vortices, which showed how the subsequent course of the motion can be ascertained without consideration of pressure or other stress.

The recognition of the permanent state of motion constituting a vortex ring as a determining agent as regards the future course of the system was, in fact, justly considered by Helmholtz as one of his greatest achievements. The principle had entirely eluded the attention of Lagrange and Cauchy and Stokes, who were the pioneers in this fundamental branch of dynamics, and had virtually prepared all the necessary analytical material for Helmholtz's use. The main import of this advance lay, not in the assistance which it afforded to the development of the complete solution of special problems in fluid motion, but in the fact that it constituted the discovery of the types of permanent motion of the system, which could combine and interact with each other without losing their individuality, though each of them pervaded the whole field. (We may compare G. W. Hill's more recent introduction of the idea of permanent orbits into physical astronomy.) This rendered possible an entirely new mode of treatment; and mathematicians who were accustomed, as in astronomy, to aim directly at the determination of all the details of the special case of motion, were occasionally slow to apprehend the advantages of a procedure which stopped at formulating a description of the nature of the interaction between various typical groups of motions into which the whole disturbance could be resolved.

The new train of ideas introduced into physics by Faraday was thus consolidated and emphasised by Helmholtz's investigations of 1858 in the special domain of hydro-dynamics. In illustration let us consider the fluid medium to be pervaded by permanent vortices circulating round solid rings as cores: the older method of analysis would form equations of motion for each element of the fluid, involving the fluid pressure, and by their integration would determine the distribution of pressure on each solid ring, and thence the way it moves. This method is hardly feasible even in the simplest cases. The natural plan is to make use of existing simplifications by regarding each vortex as a permanent reality, and directly attacking the problem of its interactions with the other vortices. The energy of the fluid arising from the vortex motion can be expressed in terms of the positions and strengths of the vortices alone; and then the principle of action, in the generalised form which includes steady motional configurations as well as constant material configurations, affords a method of deducing the motions of the cores and the interactions between them. If the cores are thin, they, in fact, interact mechanically, as Lord Kelvin and Kirchhoff proved, in the same manner as linear electric currents would do; though the impulse thence derived towards a direct hydro-kinetic explanation of electromagnetics was damped by the fact that repulsion and attraction have to be interchanged in the analogy. The conception of vortices, once it has been arrived at, forms the natural physical basis of investigation, although the older method of determining a distribution of pressure stress throughout the fluid and examining how it affects the cores is still possible; that stress, however, is not simply transmitted, as it has to maintain the changes of velocity of the various portions of the fluid. But if the vortices have no solid cores, we are at a loss to know where even this pressure can be considered as applied to them; if we follow up the stress, we lose the vortex; yet a fluid vortex can nevertheless illustrate an atom of matter, and we can consider such atoms as exerting mutual forces, only these forces cannot be considered as transmitted through the agency of fluid pressure. The reason is that the vortex cannot now be identified with a mere core bounded by a definite surface, but is essentially a configuration of motion extending throughout the medium.

Thus we are again in face of the fundamental question whether all attempts to represent the mechanical interactions of electro-dynamic systems, as transmitted from point to point by means of simple stress, are not doomed to failure; whether they do not, in fact, introduce unnecessary and insurmountable difficulty into the theory. The idea of identifying an atom with a state of strain or motion, pervading the region of the æther around its nucleus, appears to demand wider views as to what constitutes dynamical transmission. The idea that any small portion of the primordial medium can be isolated, by merely introducing tractions acting over its surface and transmitted from the surrounding parts, is no longer appropriate or consistent: a part of the dynamical disturbance in that element of the medium is on this hypothesis already classified as belonging to, and carried along with, atoms that are outside it but in its neighbourhood—and this part must not be counted twice over. The law of Poynting relating to the paths of the transmission of energy is known to hold in its simple form only when the electric charges or currents are in a steady state; when they are changing their positions or configurations their own fields of intrinsic energy are carried along with them.

It is not surprising, considering the previous British familiarity with this order of ideas, that the significance for general physics of Helmholtz's doctrine of vortices was eagerly developed in this country, in the form in which it became embodied through Lord Kelvin's famous illustration of the constitution of the matter, as consisting of atoms with separate existence and mutual interactions. This vortex-atom theory has been a main source of physical suggestion because it presents, on a simple basis, a dynamical picture of an ideal material system, atomically constituted, which could go on automatically without extraneous support. The value of such a picture may be held to lie, not in any supposition that this is the mechanism of the actual world laid bare, but in the vivid illustration it affords of the fundamental postulate of physical science, that mechanical phenomena are not parts of a scheme too involved for us to explore, but rather present themselves in definite and consistent correlations, which we are able to disentangle and apprehend with continually increasing precision.

It would be an interesting question to trace the origin of our preference for a theory of transmission of physical action over one of direct action at a distance. It may be held that it rests on the same order of ideas as supplies our conception of force; that the notion of effort which we associate with change of the motion of a body involves the idea of a mechanical connection

Digitized by Google

through which that effort is applied. The mere idea of a transmitting medium would then be no more an ultimate foundation for physical explanation than that of force itself. Our choice between direct distance action and mediate transmission would thus be dictated by the relative simplicity and coherence of the accounts they give of the phenomena; this is, in fact, the basis on which Maxwell's theory had to be judged until Hertz detected the actual working of the medium. Instantaneous transmission is, to all intents, action at a distance, except in so far as the law of action may be more easily formulated in terms of the medium than in a direct geometrical statement.

In connection with these questions it may be permitted to refer to the eloquent and weighty address recently delivered by M. Poincaré to the International Congress of Physics. M. Poincaré accepts the principle of least action as a reliable basis for the formulation of physical theory, but he imposes the condition that the results must satisfy the Newtonian law of equality of action and reaction between each pair of bodies concerned, considered by themselves; this, however, he would allow to be satisfied indirectly if the effects could be traced across the intervening æther by stress, so that the tractions on the two sides of each ideal interface are equal and opposite. (*Cf.* also Hertz on the electromagnetic equations, § 12, *Wied. Ann.*, 1890. The problem of merely replacing a system of forces by a statical stress is widely indeterminate, and therefore by itself unreal; the actual question is whether any such representation can be co-ordinated with existing dynamics.) As above argued, this view appears to exclude *ab initio* all atomic theories of the general type of vortex atoms, in which the energy of the atom is distributed throughout the medium instead of being concentrated in a nucleus; and this remark seems to go to the root of the question. On the other hand, the position here asserted is that recent dynamical developments have permitted the extension of the principle of action to systems involving permanent motions, whethether obvious or latent, as part of their constitution; that on this wider basis the atom may itself involve a state of steady disturbance extending through the medium, instead of being only a local structure acting by push and pull. The possibilities of dynamical explanation are thus enlarged. The most definite type of model yet imagined of the physical interaction of atoms through the æther is, perhaps, that which takes the æther to be a rotationally elastic medium, after the manner of MacCullagh and Rankine, and makes the ultimate atom include the nucleus of a permanent rotational strain-configuration, which as a whole may be called an electron. The question how far this is a legitimate and effective model stands by itself, apart from the dynamics which it illustrates; like all representations, it can only cover a limited ground. For instance, it cannot claim to include the internal structure of the nucleus of an atom or even of an electron; for purposes of physical theory that problem can be put aside, it may even be treated as inscrutable. All that is needed is a postulate of free mobility of this nucleus through the æther. This is definitely hypothetical, but it is not an unreasonable postulate because a rotational æther has the properties of a perfect fluid medium except where differentially rotational motions are concerned, and so would not react on the motion of any structure moving through it except after the manner of an apparent change of inertia. It thus seems possible to hold that such a model forms an allowable representation of the dynamical activity of the æther, as distinguished from the complete constitution of the material nuclei between which that medium establishes connection.

At any rate, models of this nature have certainly been most helpful in Maxwell's hands towards the effective intuitive grasp of a scheme of relations as a whole, which might have proved too complex for abstract unravelment in detail. When a physical model of concealed dynamical processes has served this kind of purpose, when its content has been explored and estimated, and has become familiar through the introduction of new terms and ideas, then the ladder by which we have ascended may be kicked away, and the scheme of relations which the model embodied can stand forth in severely abstract form. Indeed, many of the most fruitful branches of abstract mathematical analysis itself have owed their start in this way to concrete physical conceptions. This gradual transition into abstract statement of physical relations, in fact, amounts to retaining the essentials of our working models while eliminating the accidental elements involved in them; elements of the latter kind must always be present, because otherwise the model would be identical with the thing which it represents, whereas we cannot expect to mentally grasp all aspects of the content of even the simplest phenomena. Yet the abstract standpoint is always attained through the concrete; and for purposes of instruction such models, properly guarded, do not, perhaps, ever lose their value; they are just as legitimate aids as geometrical diagrams, and they have the same kind of limitations. In Maxwell's words, "for the sake of persons of these different types scientific truth should be presented in different forms, and should be regarded as equally scientific whether it appear in the robust form and the vivid colouring of a physical illustration, or in the tenuity and paleness of a symbolical expression." The other side of the picture, the necessary incompleteness of even our legitimate images and modes of representation, comes out in the despairing opinion of Young ("Chromatics," 1817), at a time when his faith in the undulatory theory of light had been eclipsed by Malus's discovery of the phenomena of polarisation by reflection, that this difficulty "will probably long remain to mortify the vanity of an ambitious philosophy, completely unresolved by any theory": not many years afterwards the mystery was solved by Fresnel.

This process of removing the intellectual scaffolding by which our knowledge is reached, and preserving only the final formulæ which express the correlations of the directly observable things, may, moreover, readily be pushed too far. It asserts the conception that the universe is like an enclosed clock that is wound up to go, and that accordingly we can observe that it is going, and can see some of its more superficial movements, but not much of them; that thus, by patient observation and use of analogy, we can compile, in merely tabular form, information as to the manner in which it works and is likely to go on working, at any rate for some time to come; but that any attempt to probe the underlying connection is illusory or illegitimate. As a theoretical precept this is admirable. It minimises the danger of our ignoring or forgetting the limitations of human faculty, which can only utilise the imperfect representations that the external world impresses on our senses. On the other hand, such a reminder has rarely been required by the master minds of modern science, from Descartes and Newton onwards, whatever their theories may have been. Its danger as a dogma lies in its application. Who is to decide, without risk or error, what is essential fact and what is intellectual scaffolding? To which class does the atomic theory of matter belong? That is, indeed, one of the intangible things which it is suggested may be thrown overboard in sorting out and classifying our scientific possessions. Is the mental idea or image, which suggests, and alone can suggest, the experiment that adds to our concrete knowledge less real than the bare phenomenal uniformity which it has revealed? Is it not, perhaps, more real in that the uniformities might not have been there in the absence of the mind to perceive them?

No time is now left for review of the methods of molecular dynamics. Here our knowledge is entirely confined to steady states of the molecular system: it is purely statical. In ordinary statics and the dynamics of undisturbed steady notions, the form of the energy function is the sufficient basis of the whole subject. This method is extended to thermodynamics by making use of the mechanically available energy of Rankine and Kelvin, which is a function of the bodily configuration and chemical constitution and temperature of the system, whose value cannot under any circumstances spontaneously increase, while it will diminish in any operation which is not reversible. In the statics of systems in equilibrium or in steady motion, this method of energy is a particular case of the method of action; but in its extension to thermal statics it is made to include chemical as well as configurational changes, and a new point appears to arise. Whether we do or do not take it to be possible to trace the application of the principle of action throughout the process of chemical combination of two molecules, we certainly here postulate that the static case of that principle, which applies to steady systems, can be extended across chemical combinations. The question is suggested whether extension would also be valid to transformations which involve vital processes. This seems to be still considered an open question by the best authorities. If it be decided in the negative, a distinction is involved between vital and merely chemical processes.

It is now taken as established that vital activity cannot create energy, at any rate in the long run, which is all that can from the nature of the case to be tested. It seems not unreasonable to follow the analogy of chemical actions, and assert that it cannot in the long run increase the mechanical availability of energy—that is, considering the organism as an apparatus for transforming energy without being itself in the long run changed. But we cannot establish a Carnot cycle for a portion of an organism, nor can we do so for a limited period of time; there might be creation of availability accompanied by changes in the organism itself, but compensated by destruction and the inverse changes a long time afterwards. This amounts to asserting that where, as in a vital system or even in a simple molecular combination, we are unable to trace or even assert complete dynamical sequence, exact thermodynamic statements should be mainly confined to the activity of the existing organism as a whole; it may transform inorganic material without change of energy and without gain of availability, although any such statements would be inappropriate and unmeaning as regards the details of the processes that take place inside the organism itself.

In any case it would appear that there is small chance of reducing these questions to direct dynamics; we should rather regard Carnot's principle, which includes the law of uniformity of temperature, and is the basis of the whole theory, as a pro-

Digitized by Google

perty of statistical type confined to stable or permanent aggregations of matter. Thus no dynamical proof from molecular considerations could be regarded as valid unless it explicitly restricted the argument to permanent systems; yet the conditions of permanency are unknown except in the simpler cases. The only mode of discussion that is yet possible is the method of dynamical statistics of molecules introduced by Maxwell. Now, statistics is a method of arrangement rather than of demonstration. Every statistical argument requires to be verified by comparisons with the facts, because it is of the essence of this method to take things as fortuitously distributed except in so far as we know the contrary, and we simply may not know essential facts to the contrary. For example, if the interaction of the æther or other cause produces no influence to the contrary, the presumption would be that the kinetic energy acquired by a molecule is, on the average, equally distributed among its various independent modes of motion, whether vibrational or translational. Assuming this type of distribution to be once established in a gaseous system, the dynamics of Boltzmann and Maxwell show that it must be permanent. But its assumption in the first instance is a result rather of the absence than of the presence of knowledge of the circumstances, and can be accepted only so far as it agrees with the facts; our knowledge of the facts of specific heat shows that it must be restricted to modes of motion that are homologous. In the words of Maxwell, when he first discovered in 1860, to his great surprise, that in a system of colliding rigid atoms the energy would always be equally divided between translatory and rotatory motions, it is only necessary to assume, in order to evade this unwelcome conclusion, that "something essential to the complete statement of the physical theory of molecular encounters must have hitherto escaped us."

Our survey thus tends to the result that, as regards the simple and uniform phenomena which involve activity of finite regions of the universal æther, theoretical physics can lay claim to constructive functions, and can build up a definite scheme; but in the domain of matter the most that it can do is to accept the existence of such permanent molecular systems as present themselves to our notice, and fit together an outline plan of the more general and universal features in their activity. Our well-founded belief in the rationality of natural processes asserts the possibility of this, while admitting that the intimate details of atomic constitution are beyond our scrutiny and provide plenty of room for processes that transcend finite dynamical correlation.

ABERDEEN ELECTRICITY ACCOUNTS.

We have pleasure in giving an abstract of the Aberdeen electric lighting accounts for the year ending July 31, 1900. A comparison between the figures given and those for the previous year tells its own tale; the progress shown reflects great credit upon the Corporation and the enterprise of their able engineer, Mr. J. Alex. Bell, who, taking into consideration the extensive tramway scheme undertaken by the Corporation, must have accomplished an immense amount of work during the financial year ending July 31, 1900. In connection with the figures given it will be noted that under expenditure accounts an item of £169 is included in the £415. 13s. 10d. for mains and service repairs. This £169, we understand, is for outlay for men's time and material in carboning and attending to the harbour lamps, and therefore should not be included in the work's costs. The price charged the Tramways Committee for current is also entered up. The arrangement made was that the department should supply the Tramways Committee with current at cost price, including interest and sinking fund. The following particulars, not included in the accounts, may be of interest: Capacity of dynamos installed = 1156kw.; maximum load = 765kw.; Number of 33-watt lamps connected during year: arcs, 1,830; incandescents, 9,529; motors, 18,709—total connections for year, 30,068. Total number of motors now on mains, 63; total horse-power of motors coupled to mains, 192·58; grand total of consumers now coupled in 33-watt lamps, 71,995. The maximum load includes tramway supply, but the lamps, motors, etc., connected does not include tramway data. These figures constitute a record for Aberdeen, so far as connections and output are concerned, and there is every indication that next year will be quite as satisfactory. One point in favour of the supply is, perhaps, that the price of gas has been raised 2d. per 1,000 cubic feet, while the Electric Lighting Committee have decided to keep the price of electrical energy per unit at the present figure.

Dr.	Revenue Account.	£	s.	d.
Fuel		2,428	12	9
Oil, waste, water, and engine-room stores		295	17	7
Wages at generating station		931	15	1
Repairs on buildings		35	12	8
Repairs on plant		320	3	11
Main and service repairs*		415	13	10
Meter repairs		6	11	5
Rents and feu duty		75	18	3
Taxes		663	15	6
Management		66	13	4
Engineer's salary (proportion)		250	0	0
General establishment charges and engineer's travelling expenses		216	9	9
Stationery and printing		118	5	9
Insurance		38	11	1
Inspector's wages		27	16	0
Auditor's fee		15	0	0
Compensation for damages		39	9	0
Bad debts		50	13	6
Abatements		65	1	5
		6,062	0	10
Balance carried to net revenue account		8,149	3	0
		£14,211	3	10

* In this is included £169 for time and material attending harbour arc lamps.

Cr.	£	s.	d.
Sale of current, per meter	11,815	14	10
Public lighting	993	7	9
Traction	1,093	2	2
Hire of motors	8	19	1
Attendance on harbour lamps	300	0	0
	£14,211	3	10

General Balance Account.

Liabilities.	£	s.	d.
Amount borrowed on mortgage	76,768	0	0
Amount of mortgages redeemed by sinking fund	5,185	0	0
	81,953	0	0
Reserve fund	2,609	17	0
Amount due to sundry creditors	1,291	2	1
Amount deposited in security for current	124	18	0
Temporary loans	6,722	0	0
Balance due to bank	8,026	11	0
	£100,727	8	1

Assets.	£	s.	d.
Amount expended on works, £101,240. 8s. 3d.; less depreciation written off, £7,874	93,366	8	3
Sundry debtors for current supplied, £4,949. 12s. 8d.; and miscellaneous, £277. 3s. 3d.	5,941	15	11
Stores on hand at July 31, 1900	1,106	5	7
Reserve fund invested	312	18	4
	£100,727	8	1

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units			1,005,505
Quantity sold	Public lamps	64,637	
	Traction	131,173	846,012
	Private consumers, by meter	650,202	
Quantity used on works			28,933
Total quantity accounted for			874,945
Quantity not accounted for			130,560

Number of public lamps—76 arc, 80 incandescent.

SOUTH SHIELDS ELECTRICITY WORKS.

The accounts of the South Shields electricity works, just issued, show a total expenditure on capital account to March 31, 1900, of £88,686. 14s. The revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Revenue Account.

Dr.	Generation of Electricity.	£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£922 14 10			
Oil, waste, water, and engine-room stores	229 0 0			
Wages at generating stations	794 0 7			
Repairs and maintenance: buildings, £5. 3s. 10d.; engines, boilers, and other machinery, £255. 12s. 11d.	260 16 9			
		2,206	12	2
	Distribution of Electricity.			
Repairs, maintenance, and renewals of mains		47	3	10
	Public Lamps.			
Attending and repairs	400 14 5			
Renewals of lamps	6 16 0			
		407	10	5
Rates and taxes		287	11	0

Digitized by Google

Management Expenses.

Salaries—viz.: engineer's department, £490; accountant and clerical staff, £211. 15s. 3d.		701	15	3		
Stationery and printing		58	13	2		
General establishment charges		122	0	8		
					882	9	1
Law expenses					28	13	8
Insurance, etc.					92	6	1
Total expenditure					3,952	6	3
Amount carried to net revenue account					4,043	5	3
					£7,995	11	6

Cr.	£	s.	d.
Sale of current per meter at 3·85d. per B.T.U.	6,335	3	7
Public lighting	1,453	11	7
	7,788	15	2
Rental of meters and other apparatus on consumers' premises	203	1	1
Rents receivable	3	15	3
	£7,995	11	6

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	74,102	12	7
Sundry creditors	1,873	4	0
Net revenue account—balance at credit thereof	210	17	6
Sinking fund account	4,679	17	2
Cables suspense account	108	0	6
Borough treasurer: capital account, £14,584. 1s. 7d.; on revenue account, £912. 14s. 10d.	15,496	16	5
	£96,471	8	2

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	88,686	14	2
Stores on hand at March 31, 1900: coal, £87. 10s.; oil, waste, etc., £185. 4s. 9d.	272	14	9
Sundry debtors for current supplied to March 31, 1900	2,720	6	7
Other debtors	108	0	6
Securities held (cost price)	4,679	17	2
Cash in hand—engineer	3	15	0
	£96,471	8	2

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			634,464
Quantity sold	Public lamps	107,800	501,839
	Private consumers by meter	394,039	
Quantity used on works			16,417
Total quantity accounted for			518,256
Quantity not accounted for			116,208
Number of public lamps			63
Total maximum supply demanded (kilowatts)			500

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Hampstead.—The Vestry invite tenders for various plant for their central station, Lithos-road, Finchley-road. Tenders by Sept. 27.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the lighting of the town by electricity for 30 years by Nov. 2 (concession).

Plumstead.—The Vestry invite tenders for the supply and erection of various plant and machinery for electricity works. Tenders by Sept. 19.

Perth.—The Commissioners invite tenders for meters (direct-current) and cut-outs. Tenders by Sept. 15. Details in our advertisement columns.

Nottingham.—The City Council invites tenders for the construction and erection of a new power station at St. Ann's Well-road. Tenders by Sept. 21.

Philippopolis (Bulgaria).—The Town Council invite tenders for erection and working of electric lighting and working of tramways. Tenders by Nov. 4 (concession).

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for electricity supply mains. Tenders by Oct. 3. Details in our advertisement columns.

Melton (Suffolk).—The Visiting Committee of the Suffolk County Lunatic Asylum invite tenders for wiring and fittings. Tenders by Oct. 5. Details in our advertisement columns.

Horton (Surrey).—The Asylums Committee of the London County Council invite tenders for the installation of boilers, engines, dynamos, etc., at the Horton Estate, Epsom, Surrey. Tenders by Sept. 22.

Whitehaven.—The Water and Lighting Committee of the Corporation invite tenders for the supply and erection of a switchboard at their electric lighting station. Tenders by Oct. 13. Details in our advertisement columns.

Fulham.—The Vestry invite tenders for the supply and erection of plant for unloading and storing coal at their electric lighting works, Townmead-road, Fulham. Tenders by Sept. 25. Details in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for steam and water pipes, feed pump, water softener, etc., at their Sculcoates-lane generating station. Tenders by Sept. 27. Full details in our advertisement columns.

Tunbridge Wells.—The Corporation invite tenders for the supply and delivery of high and low tension cables. Specification and full particulars can be obtained from Mr. Horace Boot, borough electrical engineer. Tenders by Sept. 20.

Dublin.—The Corporation invite tenders for electric motors and pumps for Ringsend drainage works. Specifications may be obtained at the office of the consulting engineer, Mr. Chatterton, 6, The Sanctuary, Westminster. Tenders by Oct. 3.

Manchester.—The Tramways Committee invite tenders for the supply of two steel boilers for heating purposes, cast-iron pipes, etc.; rubber rings, bolts and nuts, steel stanchions, etc.; 100 car trucks. Tenders by 18th inst. Details in our advertisement columns.

Limerick.—The Town Council invite tenders for erection and completion of an electric generating station building at Frederick-street, Limerick. Drawings and specification may be seen at the office of Mr. J. J. Peacocke, B.E., city surveyor, Town Hall, Limerick. Tenders by Oct. 4.

Walthamstow.—The Council invite tenders for the supply, delivery, and erection of electric lighting plant and apparatus, consisting of gas plant, gas-engines, dynamos, switchboard, booster, balancer, and measuring instruments. Tenders by Sept. 25. Details in our advertisement columns.

Dundalk.—Tenders are invited by the Urban District Council for a transfer of their electric lighting order for the purpose of supplying electricity for public and private lighting and energy for manufacturing purposes within the urban district of Dundalk. Tenders by Sept. 18. Details in our advertisement columns.

Eastbourne.—The Corporation invite tenders for the supply and erection of a water-tube boiler, with fittings, feed pump, etc., a 400-kw. steam alternator, with exciter (vertical enclosed high-speed engine), and main switchboard and connections. Tenders by Oct. 4. Particulars appear in our advertisement columns.

Devonport.—The Corporation invite tenders for supply and erection of (Part 1) two vertical engines; (2) two 300 kw. generators, balancer, battery, booster, and motor; (3) switchboard for electric lighting and traction; storage battery and travelling crane (10 ton). Tenders by Sept. 26. Details in our advertisement columns.

London, E.C.—The Commissioners of H.M. Works and Public Buildings invite tenders for the enlargement of Block E of the telegraph factory at Mount Pleasant, E.C. Drawings, specification, and a copy of the conditions and form of contract may be seen on application to Mr. J. Wager, at H.M. Office of Works, etc. Tenders by Sept. 18.

Middleton and Castleton (Lancs.).—The British Electric Traction Company invite tenders for the construction of light railways in Middleton and Castleton, near Manchester (length in all about seven miles). Drawings may be seen at the offices of the Engineer to the Company, Lennox House, Norfolk-street, Strand. Tenders by 15th inst.

Dundee.—The Dundee Gas Commissioners invite tenders for: (1) overhead travelling crane; (2) economiser; to be supplied and erected at the electric lighting station, Dundee. Specifications, plans, and forms of tender may be had on application to Mr. Walter H. Tittensor, city electrical engineer, Dunhope-crescent-road, Dundee. Tenders by 26th inst.

London, S.W.—The London County Council invite tenders for the supply within 12 weeks of the order being given of the mains required in connection with the electric light installation for the Victoria embankment and Westminster Bridge. Particulars may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 24th inst.

Sunderland.—The Corporation invite tenders for the supply of (A) triple-expansion, high-speed, direct-current steam dynamos; (B) Lancashire boilers; (C) feed pumps. The several specifications and forms of tender can be obtained on application to the borough electrical engineer, Mr. J. F. C. Snell, A.M.I.C.E., Dunning-street, Sunderland. Tenders by 21st inst.

Brighton.—The Council invite tenders for the supply and delivery of 2,000 tons of steel girder tramrails, 78 tons of steel fishplates, 90 tons of steel joists. Specifications and form of tender and all necessary information may be obtained on application at the office of Mr. Thos. B. Holliday, tramways engineer, Town Hall, Brighton. Tenders by Oct. 1.

Aberdeen.—The Electric Lighting Committee invite tenders for supply of (1) two 200-kw. direct-coupled continuous-current generators and one 120-kw. balancing set; (2) one 420-kw. direct-coupled continuous-current generator. Specification and form of tender can be obtained from Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen. Tenders by Sept. 29.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and laying of electricity supply mains and accessories. Specifications and form of tender may be inspected at the office of the city engineer, Mr. Spencer Harty, M.I.C.E., City Hall, Dublin, and at the offices of Mr. R. Hammond,

Digitized by Google

consulting engineer to the Corporation, 64, Victoria-street, S.W. Tenders by Oct. 4.

Maxborough.—The Council invite tenders for the supply and erection of a Lancashire boiler; two 50-kw. steam dynamos, balancer and boosters, feed-water heater, and feed pump; switchboard and connections; storage battery; mains; a five-ton hand travelling crane; and for adapting public street lamps from gas to incandescent electric. Tenders by Sept. 15. Details in our advertisement columns.

Brighton.—The Corporation invite tenders for the supply and delivery of 25 electric motorcars. The work is divided into three sections, and contractors may tender in respect of all or any one or more of such sections—viz.: (Section 1) 25 electric motorcar bodies; (2) 25 electric motor trucks; (3) 25 electric motor electrical equipments. The specification and form of tender and all necessary information may be obtained on application at the office of the tramways engineer, Mr. Thos. B. Holliday, Town Hall, Brighton. Tenders by Oct. 1.

Blackpool.—The Tramway Committee invite tenders for the construction of a single and double line of tramways in Waterloo-road, Whitegate-drive, Raikes-road, Church-street, Abingdon-street, Talbot-road, and Central drive The respective lengths will be about one mile single and 2¼ miles double The contract will include the laying of rails, points, etc., excavating, concreting, paving, etc. The Corporation will provide all the materials. Drawings may be seen and specifications and bills of quantities obtained on application to Mr. J. Wolstenholme, borough engineer, Town Hall, Blackpool. Tenders by 17th inst.

RESULTS OF TENDERS.

City of London Union.—The Board have accepted the tender of Messrs. Newsome, Pincking, and Walton, of 1, Crutched-friars, at £430, for lighting the offices by electricity.

Rochdale.—The General Purposes Committee have accepted the tender of Mr. G. L. Adamson, Ohm Works, Rochdale, for the wiring and fittings required in connection with the electric lighting of the town hall.

Middlesbrough.—The Electric Lighting Committee have accepted the tender of Messrs. Tattersall and Smith, Middlesbrough, subject to the confirmation of the Council, for the wiring of the municipal electricity works.

Portsmouth.—The Tramway Committee have accepted the following tenders with regard to the building and plant for the new power station: Messrs. Dick Kerr, and Co., plant, £29,656; Mr. J. W. Perkins, building, £10,515.

Nuneaton.—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, London, E, have secured the contract for the storage battery required by the Nuneaton and Chilvers Coton Urban District Council for their electric lighting extension.

Cardiff.—The Electrical and Lighting Committee have accepted the tender of Messrs. Lace and Sons, of Cardiff, at £1,379, for supplying a quantity of steam pipes and a pump at the electric light works, and that of the British Insulated Wire Company, at £607. 11s. 5d., for high-tension cables.

Bradford.—The Council have accepted the following tenders: Messrs. Humphries and Moulson, Bradford, excavators', masons' work, etc., £4,780; Mr. S. Rushworth, Bradford, plumbers' work, £540; Messrs. Bradley and Krischke, Bradford, concretors' and plasterers' work, £435; Messrs. Mavor and Coulson, Glasgow, 12 months' supply of motors at following prices: 4½-h.p. £39. 10s. each, 7-h.p. £48 each, 10-h.p. £59 each.

Nuneaton.—The Council have accepted the following tenders: Messrs. Babcock and Wilcox, new boilers, about £1,060: Hart Accumulator Company, accumulators, £1,063; Mr. E. Carrington, switchboard, £391; Messrs. Clarke, Chapman, and Co., exchanging existing armature, £66; Nuneaton Engineering Company, travelling crane, £120. The Council will also purchase testing instruments at a cost of about £50, a new engine and dynamo at a cost of about £1,900, and an economiser at a cost of about £320.

Aberdeen.—The Tramways Committee have received the following tenders for steel poles, bases, and brackets: Macartney, McElroy, and Co., 53, Victoria-street, Westminster, S.W. (accepted); R. W. Blackwell and Co., London; Walsall Electric Company, Walsall; McDowall, Steven, and Co., Glasgow; Lowdon Bros. and Co., Dundee; J. Russell and Sons, Limited, Wednesbury. The same committee have also accepted the tender of Messrs. M'Lellan, Glasgow (representing German manufacturers) for rails.

Darlington.—The Corporation have received the following tenders for the supply and delivery of arc lamp-posts and brackets in connection with the electric lighting of the borough:

Mackenzie Bros., Edinburgh Foundry, Slateford-road, Edinburgh (accepted)	£378	17	6
J. and A. Law, Glasgow	428	15	0
Rowland, Carr, and Co., 6 and 8, Lime-street-square, London, E.C.	477	15	0
J. Allan and Son, Elmbank Foundry, Glasgow	485	12	6
T. E. Kershaw, Nuneaton	490	0	0
W. A. Baker and Co., Limited, Newport, Mon.	767	7	6
Maxim Electrical and Engineering Export Company, 65, 66, and 67, Gracechurch-street, London	1,181	5	0

Aberdeen.—The Electric Lighting Committee have received the following tenders: (1) Cables—British Insulated Wire Company, Limited, Prescot (accepted); Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, Westminster, London, S.W.; Callender's Cable and Construction Company, Limited, 90, Cannon-street, London, E.C.; St. Helens Cable Company, Limited, Warrington; W. T. Henley's Telegraph Works Company, Limited, 27, Martin's-lane, Cannon-street, E.C.; W. T. Glover and Co., Limited, Trafford Park, Manchester; Western Electric Company, Limited, North Woolwich, London, E.; Telegraph Manufacturing Company. Limited, Helsby. (2) House main fuse boxes—A. Spark, 35, Summer-street, Aberdeen (accepted); Keighley Electrical Engineering Company, Limited, Keighley; Reason Manufacturing Company, Limited, Gloster-road, Brighton; Callender's Cable and Construction Company, 90, Cannon-street, E.C.: British Insulated Wire Company, Limited, Prescot; General Electric Company, Limited, London. (3) Meters—S. Z. de Ferranti, Limited, Hollinwood (accepted); Chamberlain and Hookham, Birmingham; General Electric Company, Limited, London; Schattner Electric Meter Company, Timberhill, Norwich; Reason Manufacturing Company, Limited, Gloster-road, Brighton; Electrical Company, Limited, Dashwood House, New Broad-street, London, E C.

Hanley (Staffs).—The Corporation have received the following tenders for electric lighting works and plant. Accepted tenders: Hughes and Lancaster, Ruabon, Shone ejector chambers, £864; W. Williams, Etruria, Newcastle road to Etruria intercepting sewer £480 (conditionally), Keeling's-road to Prime-street intercepting sewer £870 (conditionally); T. Godwin, Hanley, Trent Bridge widening, abutment, £235.

Boiler-house requirements. Section A.—Two Lancashire boilers.			
W. Arnott and Co., Glasgow	£2,260	0	0
R. Taylor and Sons, Marsden	2,029	0	0
Finkers, Limited, Hyde	2,010	0	0
J. and J. Horsfield, Dewsbury	1,935	0	0
W. R. Renshaw and Co., Stoke	1,895	0	0
E. Danks and Co., Oldbury (accepted)	1,660	0	0
Section B.—Water tank and pumps.			
Davie and Horne, Glasgow	585	0	0
Hunt Bros., Oldbury	395	0	0
Wheeler Condenser Company, London	393	10	0
Phœnix Foundry Company, Derby	387	10	0
E. Danks and Co.	387	10	0
G. Fletcher and Co., Derby	386	0	0
W. R. Renshaw and Co.	384	10	8
J. Whitley and Co., Leeds	374	0	0
T. Shore and Sons, Hanley (accepted)	323	0	0
Section C.—Fuel economiser.			
Phœnix Foundry Company	676	10	0
E. Danks and Co.	550	0	0
Clay Cross Company	489	0	0
E. Green and Son, Manchester (accepted)	473	18	0
W. R. Renshaw and Co.	459	0	0
J. Carter and Sons, Stalybridge	434	2	0
A. Lowcock, Shrewsbury	417	12	0
Section D.—Smoke fans.			
W. R. Renshaw and Co.	177	0	0
Davidson and Co., Belfast (accepted)	165	0	0
Section E.—Feed-water heater.			
Davie and Horne (No. 2)	527	0	0
Phœnix Foundry Company	365	0	0
E. Danks and Co.	327	10	0
J. Wright and Co., Tipton	293	0	0
W. R. Renshaw and Co.	275	18	5
Davie and Horne (No. 1)	250	0	0
Edwards and Barnes, London	249	15	0
T. Shore and Sons (accepted)	219	10	0
I. Storey and Sons (No. 2), Manchester	210	0	0
I. Storey and Sons (No. 1)	196	0	0
Wheeler Condenser Company	196	0	0
G. Fletcher and Co.	171	0	0
Section F.—Forced-draught furnaces.			
W. A. Grainger, London	356	0	0
Horsfall Destructor Company, Leeds	306	0	0
W. R. Renshaw and Co	290	0	0
Meldrum Bros., Manchester	275	0	0
Wilton Furnace Company, London (accepted)	252	10	0
A. Pillatt and Co., Nottingham	231	0	0
Section G.—Coal conveyor.			
Graham and Morton, Leeds (push plate)	492	0	0
Spencer and Co., Melksham (No. 1)	476	0	0
Bennis and Co., Bolton	369	0	0
Spencer and Co. (No. 2, spiral)	340	0	0
New Conveyor Company, Smethwick (push plate) (accepted)	258	0	0
S. S. Stott and Co., Haslingden (spiral)	166	0	0
Barry, Henry, and Co., Aberdeen (spiral)	145	0	0
Section H.—Specialities. Mechanical stokers.			
Meldrum Bros.	285	0	0
Bennis and Co. (No. 1)	480	0	0
Bennis and Co. (No. 2)	320	0	0
J. Proctor, Burnley	308	0	0
Wilton Furnace Company (accepted)	190	0	0
Grease separator.			
J. Wright and Co., Tipton	160	0	0
Building for new boilers.			
A. Ward, Hanley	844	0	0
W. Stedman, Hanley	840	0	0
H. Leonard, Hanley	815	0	0
W. H. Johnson, Hanley	770	14	9
T. Godwin	705	0	0
C. Cornes and Sons, Hanley (accepted)	649	10	0

Digitized by Google

BUSINESS NOTES.

TRACTION.

Cheltenham.—We understand that the proposed electric tramway to the top of Cleeve Hill is to be commenced next month.

Crewe.—The Town Council have endorsed the recommendation of the Electric Light Committee to provide a scheme of electric tramways.

Aberdeen.—The Corporation have adopted a revised and increased scale of wages for tramway conductors, drivers, and inspectors.

Louth.—The County Council have received an order in Council extending the time for the completion of the Dundalk electric tramway system.

Johnstone.—It is reported that the Paisley Town Council will probably apply for an order to provide tramways for that burgh and to connect with Johnstone.

Brankseme.—The work of construction of the electric tramway was commenced in the Brankseme district on Aug. 13, and a considerable length has been laid along the western end of the Ashley-road.

Jungfrau Railway.—The works upon the Jungfraubahn have been at a standstill for some months. The expense of the undertaking, as the experts now declare, would be tenfold greater than was originally estimated.

Bradford.—The Town Council on Tuesday adopted the minutes of the Tramways Committee which included a resolution instructing the city surveyor to extend the Whetley-hill tramway as a double line to the end of Godwin-street.

Aspull.—The Wigan Corporation Electric Light and Tramway Committee propose to extend the tramway system from Wigan to Aspull. Plans and written particulars are about to be forwarded to the District Council for consideration.

Bowness.—A meeting of the inhabitants was held on Friday night with the object of showing opposition to the tramway proposals. A resolution condemnatory of the scheme was adopted, and a committee appointed to formulate opposition.

Darwen.—At a recent meeting of the inhabitants of Hoddlesden and district a resolution was passed in favour of trams running between Darwen and Hoddlesden, and a deputation will be sent to the Town Council urging them to push the matter forward.

Kirkcaldy.—The Town Council on the 10th inst. adopted the recommendation of the Tramway and Electric Lighting Committee to widen parts of the High-street so that the tramcars could be run both ways. The cost of purchasing property, etc., for improvement, as estimated by Prof. Kennedy, is £20,800.

Roundhay.—The new electric launch for Roundhay Park lake, which is being built to the order of the Leeds Corporation, is expected to be ready for launching on the Thames about Monday next. The vessel, which will hold 45 passengers, will be named the "Mary Gordon," as a compliment to the present lady mayoress.

Queensbury.—At Monday's meeting of the District Council a letter was read from the Bradford Tramways Committee stating that the material for the construction of the tramways to Queensbury was on order, and that it was their intention to proceed with the work immediately. It was decided to advertise for tenders for the alterations at Priestly Hill.

North Woolwich.—The scheme for connecting North Woolwich and Ilford by means of an electric tramway was advanced another stage on Tuesday evening, when the foundation stone of the electric station at East Ham was laid. When the West Ham, East Ham, and Ilford schemes are completed the electric tramway area will cover upwards of 25 miles.

Leith.—The Town Council have appointed a Tramways Committee to consider the advisability of laying tramways within the borough, and also to consider and, under the direction of the Council, to deal with any question that may arise in connection with the tramways proposed to be laid within the borough by the South Lancashire Tramways Company.

Dublin and Lucan Electric Railway Co.—The traffic returns for the week ending Sept. 8, 1900, were £125, as compared with the week ending Sept. 1, 1900, of £104, showing an increase of £21. The total receipts (10 weeks to Sept. 8, 1900) are £1,181, as compared with the corresponding period of 1899 of £960, showing an increase of £221. (Received too late for classification.)

Stourbridge.—Trial trips have been made along the Kingswinford Electric Tramway during the last few days, and the opening of the line for public traffic will take place shortly. Some new cars for this and the connected branches have just been delivered at the Stourbridge goods Depôt, and they differ from those which have been running on the Dudley and Stourbridge line in being two-deckers.

Standish.—The Wigan Corporation Electric Light and Tramway Committee propose to run electric trams along Wigan-lane, past Boar's Head, and on to Standish, and also to Standish Lower Ground as far as the Royal Oak Inn. The Standish District Council, however, are not prepared, as the roads are at present circumstanced, to allow the Corporation to run electric trams in the Standish districts, but they would favour a proposal which included the widening of these roads.

Workington.—The minutes of a special committee meeting of the whole Council, adopted on Tuesday, contained a resolution refusing to entertain the proposition for granting a concession to Messrs. Dick, Kerr, and Co.'s combination for obtaining powers to construct an electric tramway between Whitehaven and Maryport, and to appoint representatives to attend a proposed conference among the Whitehaven, Maryport, and Workington authorities on the subject. The question was referred by the Council, in committee, to the committee already appointed to consider electric lighting.

York.—At the half-yearly meeting of the York Tramways Company last week, the chairman (Mr. Joseph Kincaid, M.I.C.E., Westminster) remarked that the Corporation had applied to the Board of Trade for power to acquire the undertaking by purchase. There was some advantage to the company in throwing upon the Corporation the onus of doing what was necessary to satisfy the requirements of the vehicular traffic, because the purchase of the tramways by the Corporation would involve a considerably higher figure under present prices of materials than it would last year or the year before. The report and accounts were adopted, and a dividend of 6 per cent. was declared.

Sheffield.—A double line of rails is to be laid on Penistone road from Owlerton Bridge to Burnell-road, instead of a single line as previously agreed. The committee being desirous of proceeding with the tramway along Shoreham-street at an early date, have expressed the opinion that the street should be paved with wood between the track and 18in. on either side. The city surveyor is to prepare plans to provide for emergency exits for the cars at Tinsley and Queen's-road car depôts. The Board of Trade have at last approved of the electric traction on the Abbeydale route and on the London-road route to Queen's-road. Half a dozen cars are being fitted with the "ever dry" seats as an experiment.

Accrington.—A very short time may witness the conversion of the Accrington tramways into electric cars of the latest and approved type. The Corporation will be asked to provide a complete equipment on the overhead system, including the cars, and the tramway company is to work the line for the remaining 6½ years of their lease, charging the present rental, and in addition a certain percentage in the way of interest upon the outlay entailed by the conversion from steam to electric traction, the company, of course, purchasing its electricity for motive power from the Corporation. The Corporation would then take over the present rolling-stock of the tramways company at a valuation.

Colchester.—The Mayor, Aldermen Sanders, Elwes, Wicks, Egerton-green, Paxman, Goody, and Butcher, and Councillors Marshall, Marriage, Benham, Egerton-Green, Barritt, Moore, Greenwood, Littlebury, Grimes, and Nash have been appointed as a special committee to prepare and submit a scheme for tramways, and to take all such proceedings as may be needful in connection therewith, and with the application for a provisional order if the Council adopt a scheme. It has also been decided that as soon as the committee are in a position to present a scheme the Mayor be desired to summon a meeting of the Council in accordance with the Board of Trade rules for the earliest possible date in order that the scheme may be considered.

Wigan.—The question of making a cash offer, etc., for the Wigan and District Tramways Company's undertaking has been deferred until the Routes' Committee has reported on the lines proposed to be constructed and worked by the Corporation. The Pemberton Urban District Council having desired that the gauge of the tramway from the market place to Adams' Bridge should be altered from 3ft. 6in. to 4ft. 8½in., which would enable the Wigan tramways to be connected directly with the projected system of the South Lancashire Tramways Company, the Corporation have replied that they do not intend to alter the gauge, the whole question having been carefully considered before the tramways now being constructed had been decided upon.

Dudley.—At the meeting of the Town Council on Tuesday it was stated in reply to whether any information had been received as to the starting of the trams to Netherton, that it was entirely a matter for the Board of Trade. The Electric Traction Company had sold the tramways to Netherton and Stourbridge to the Dudley, Stourbridge, and District Tramway Company. When Mr. Trotter inspected the wires and the electrical apparatus on behalf of the Board of Trade, he was content to allow the company to commence running, but it was part of the conditions that Colonel Yorke should inspect the permanent way, and the new company declined to work the lines until the other company could turn them over with the sanction of the Board of Trade.

Brighton.—The surveyor and Mr. Holliday are preparing an estimate, with plans, sections, and specifications, for laying the concrete bed, the tram rails, and wood paving blocks, in the several streets in which the tramways are to be constructed, the same to be divided into sections for separate districts. The specification for motorcars, prepared by Mr. Holliday for double-decked cars for the tramways, has been approved, and tenders have been invited for the supply of 25 cars in accordance therewith, with the option to the Corporation to order five additional cars of the same description at some later date at the same price. Specifications for the quantity of rails and fishplates required for the tramways (about 2,000 tons) have also been approved. The engineer and Mr. Holliday are about to prepare estimate of cost of levelling the land required for the car-shed, and of the cost of construction of the car-shed.

London United Tramways.—The company hope to start the service of electric cars between Hammersmith and Kew Bridge in about a month from the present date. Formal notices have been served upon local authorities this week by the London United Tramways Company, Limited, of their intention to apply to Parliament in the ensuing session for a great extension of their

Digitized by Google

authorised system of tramways. The scheme embraces the construction of over 60 miles of tramways in three counties—viz.: 23 miles in Surrey, 20 miles in Middlesex, and 20 miles in the County of London. The centre of the proposed extension will be the Broadway, Hammersmith, from which main lines with feeders will radiate in various directions. In the county of London the extensions will reach and serve the districts of St. Pancras, St. Marylebone, Paddington, Kensington, Fulham, Hammersmith, and Putney. In the county of Middlesex the extensions affect the parishes of Ealing, Brentford, Southall, Heston and Isleworth, Twickenham, Hampton, Teddington, Hanworth, Sunbury, and Hampton Wick. In the county of Surrey the places affected are Barnes, Richmond, Kingston, Malden and Coombe, Surbiton, Esher and the Dittons, and East Molesey.

Railway Concessions in Spain.—The Spanish Government has recently granted a number of railroad concessions for standard, narrow-gauge, and electric roads. Amongst them are a concession granted to the Sociedad Minera de Villaodrid, of Villaodrid, for a narrow-gauge railroad line from Puente Nuevo to the mining districts of Puerto Estrecho, in the north of Ripadeo. A large iron shed for storing ore is to be built in connection with this line. The Sociedad Ferrocarrilly Minas de Berga, of Berga, has a concession for a railroad between Olvan and Guardiola, to connect with the Manresa to Berga line; the latter, a narrow-gauge railroad, is 51 miles long, metre gauge, 11 engines, 19 passenger and 96 freight cars. A concession has been granted for an extensive net of electric railroads between Almeria, Benahadux, Rioja, and Tabernas. The Compania Vasco-Asturiana has a concession for the extension of its present system to Ujo and Trubia. A syndicate of Orense financiers has a concession for narrow-gauge railroads from Orense to the Portuguese frontier, passing over Barbadanes, Celanova Allaviz, Sandianes, Ginzo de Limia, Trasmovas, Coaledvo, Illadviz, Villara, and Verin. Considerable quantities of rolling-stock and material will be ordered abroad.—*Railway News.*

Sunderland.—About 25,000 passengers were carried on the Sunderland tramways on Saturday. The Royal Assent having been given to the Houghton and Sunderland Electric Tramways Bill, a start will be made at once with the preliminary work. The line will commence at Grangetown, on the southern boundary of Sunderland, and will pass through the populous colliery villages of Ryhope, Tunstall, New Silksworth, New Herrington, Philadelphia, Newbottle, Houghton-le-Spring, Hetton-le-Hole, and Easington-lane. There will also be branch lines, the total mileage being about 20, and the population of the district 60,000, exclusive of Sunderland. It is also proposed to extend the line across the Wear at Pensher to Workington and Usworth, affording communication with Newcastle. The overhead trolley system will be used, and it is proposed to carry goods by day and night in special trucks The various local bodies in the district have given their sanction to the scheme, which has been promoted by the United Kingdom Tramways, Light Railway, and Electrical Syndicate.

Electric Railways in London.—The correspondent of the *Daily Telegraph* wired from New York on Wednesday as follows: "According to Mr. Bernard M. Baruch, of the A. A. Houseman Company, Mr. Charles T. Yerkes has purchased the franchise and all the rights of the Charing Cross, Euston, and Hampstead Railroad, and has formed a syndicate of American capitalists to build a tunnel railroad under the streets from Charing Cross to Hampstead Heath; also an extension of two miles from Camden-road to Kentish Town. Mr. Yerkes's agents reported that the road, if built, promised good returns. Mr. Yerkes, on receiving the assurance that several friends in New York and Chicago would help him to finance the scheme, went to London and bought the company's rights. Mr. Baruch said that the 12,000 000dol needed to build the road would all be American capital. The road will probably have 10 stations and four tracks, two for express and two for local trains. Electricity will be the motive power. It is estimated that connecting railroads will bring the Charing Cross-Hampstead line within the reach of 150,000 persons." The *Daily Mail* says the news is possibly intended for consumption on the other side of the Atlantic, for it is well known in London railway and financial circles that Mr. Yerkes possesses no such rights as are here ascribed to him.

Maidstone.—Mr. Stephen Sellon has just issued his report with regard to the promotion of a scheme of electric trams for Maidstone. From a *résumé* which appeared in the *Kent County Standard* we gather that he examined six routes, all starting from High-street, which are defined as follows: (1) 1 mile 7 furlongs 5·50 chains to the Fountain Inn; (2) 5 furlongs 4 chains to the athletic ground; (3) 5 furlongs to the back of the Sessions House; (4) 6 furlongs 4·50 chains to Turkey Mill; (5) 1 mile 2 furlongs to the cemetery; (6) 7 furlongs 9 chains to Tovil—total length, 6 miles 2 furlongs 3 chains. The estimate for it all would be £40,721. A portion of this is allotted to the supply of wood paving, and also a double line in some parts; leaving out the double line, £1,016 would be saved in capital cost. Mr. Sellon quotes the width of certain streets in the towns where electric trams and light railways have been authorised. The narrowest points in these are: Gateshead, 18ft. 3in.; Coventry, 19ft. 6in; Ashton, 20ft. 2in.; Greenock, 18ft.; Croydon, 18ft.; Merthyr, 18ft. 6in.; Stourbridge, 16ft.; Dover (narrowest width of Snargate-street), 15ft. 4in., with a gauge of 3ft. 6in.; Reading, 18ft. 10in. The gross earning capacity of a system of tramways such as he suggests for Maidstone would be fairly represented, he thinks, by £7,200 per annum (liable to increase year by year). The working expenses should be about 50 per cent., which, after allowing for depreciation and repairs, would leave a profit of £2,900. On this he assumes a net profit for the first year of £457, after deducting interest on loan and contribution to sinking fund. He says, in conclusion, that he has taken a pessimistic view of the profits, and has taken a lower figure than is earned by the horse tramways in Chester, a town with a population about equal to that of Maidstone, and with only 2¼ miles of tramway, which does not in any way properly serve the town. He is also taking a gross earning capacity of some £3,000 per annum less than that of Dover.

Up to Date.—From an interview with the secretary of the Central London Railway Company, which recently appeared in the *Daily Chronicle*, we quote as follows: "Before the line was opened," he said, "we expected that on Sundays we should have practically no travellers. Happily our anticipations have not been realised, for we get crowds of people going to and from Hyde Park, Kew Gardens, Richmond, and other popular resorts. Of course, this may be merely a summer traffic, but we hope it will continue in the winter. As to a later and earlier service of trains, I don't think the general manager could arrange such conveniences just now, for every night the line from Shepherd's Bush to the Bank is thoroughly examined, the lifts are tested, the signal-boxes are inspected, and the 100 or more carriages are taken to the car-shed to be overhauled. We are, indeed, most careful to prevent any mishap. I saw some time ago the question raised as to what would happen if an accident occurred in the tunnel between two stations. The person who asked this forgot that the travellers in the train could get out from either end, and that there would be no danger so far as the electricity is concerned, for the current can be switched off between any particular section. There has been an enquiry as to the temperature of the railway. This remains steady at 55deg. This summer the Central London Railway has proved itself to be the coolest place in the metropolis. In the winter the temperature will be as in the summer, for the outer air does not affect the earth so low down as our tunnel, the depth, as you know, being an average of 60ft. In an attempt to make the line popular with people living at Acton, Ealing, and other districts beyond Shepherd's Bush, we erected sheds for the storing of cycles, and charge 2d. a machine. On the first morning we had from 15 to 20 cycles. Last Monday there were no fewer than 96. We have now decided to have a proper and a larger building for the convenience of cyclists. A faster train service is not possible yet. We are waiting for more rolling-stock, and when we get the carriages we shall run trains every three instead of every four minutes as now."

LIGHTING AND GENERAL.

Middlesbrough.—It is expected that the electric lighting will be started early in October.

Bradford.—The Electricity Committee intend to apply for borrowing powers amounting to £56,315 for extension purposes.

Alfreton.—The Town Council are promoting a scheme for an electric light installation, which, however, is not yet definitely settled.

Darlington.—It is reported that as soon as the electrical engineer has been appointed the work of wiring private houses will be proceeded with.

W. T. Glover and Co.—The preference share transfer books of this Company will be closed from the 17th inst. to the 29th inst., both inclusive, for the preparation of dividend warrants.

Hunsworth.—The District Council have decided to receive a deputation from the Northern Counties Electric Lighting Company at the next meeting with reference to their proposal to apply for a provisional order to supply electric light in the district.

Langton.—Mr. H. P. Boulnois has held an enquiry into the application of the Corporation for sanction to borrow £28,500 for purposes of electric lighting, and for approval of the use of certain land situate at the Corporation gasworks as a site for a generating station.

Douglas.—At a meeting of the Town Council on Wednesday the reason for the delay in the electric lighting scheme was enquired into. The Chairman of the committee replied that they had been waiting in expectation of the tramway concern being offered for sale by the liquidator. He promised that the committee would have an early meeting and submit a report.

Cleethorpes.—At the monthly meeting of the Urban District Council on Wednesday it was decided to serve notice upon the tramways company, who are building an electric lighting station, to sell to the Council the portion of land acquired by them for that purpose, and any additional land required for the erection of a plant for the lighting of Cleethorpes by electricity. It was stated that the cost would be over £30,000.

American Agency.—The McGuire Manufacturing Company, of Chicago, said to be the oldest electric truck manufacturers in the United States, are about to establish a factory in Great Britain. They have opened branch offices at 5, Warwick-court, High Holborn, where any information concerning their line can be obtained. Pending the establishment of a factory in this country, orders will be supplied from the Chicago works.

Paris Exhibition Awards.—The Campbell Gas-Engine Company, Limited, Halifax, have received a gold medal for their exhibit of gas and oil engines at the Paris Exhibition, and in addition to this no less than seven members of their staff, foremen and workmen, have been awarded silver and bronze medals for the work which they have done in connection with the exhibit.—Messrs. Stern Bros., of London and Glasgow, manufacturers of lamps, have been awarded a grand prix and silver medal.

Digitized by Google

Eaglescliffe.—Yarm-road and the village are to be lighted by electricity.

Change of Address.—The offices of the City and South London Railway Company have been removed from King William-street to 71, Finsbury-pavement.

Aspull.—A special meeting of the Urban District Council will be held next week to discuss the question of obtaining an electric lighting provisional order.

East Molesey.—The Council have decided to obtain experts' advice with regard to the offer made by Edmundson's Electric Corporation to light the district.

Lynton.—The new town hall recently presented by Sir George Newnes has been fitted and connected with the mains of the Lynton and Lynmouth Electric Lighting Company.

Whitby.—The tenders received by the Electric Lighting Committee have been forwarded to Messrs. Preece and Cardew with instructions to advise the Electric Lighting Committee thereon.

Portsmouth.—At the Town Council meeting on Tuesday it was resolved to establish a municipal telephone exchange. It was stated that the rate would be about £5 per annum for each subscriber.

Thornhill.—The District Council have decided not to take any steps at present with regard to the Northern Counties Electric Supply Company's proposed electric lighting order for the district.

Brighton.—The surveyor's plans, elevations, and sections for the proposed electricity station at Southwick have been approved, and the surveyor is about to prepare an estimate of the cost of the work.

Golborne.—The District Council are deliberating with regard to the South Lancashire Tramways and Electric Lighting Company's proposed order for powers to supply electric light along the route of the tramway.

Yeadon.—A well-attended meeting of owners and ratepayers on Monday night endorsed a resolution passed by the District Council to petition the Board of Trade for an extension of the electric lighting provisional order.

Nuneaton.—Application is to be made to the Local Government Board for sanction to borrow a further sum of £2 000 on account of the electric undertaking (making a total of £18,000, instead of £16,000, as stated in the previous application).

Felixstowe.—The Electric Light Works Committee have informed Colonel Jelf, C.R.E., that they are prepared to instal the electric light in the new barracks, and in part of the hospital buildings, as desired by the military authorities.

Branksome.—The Bournemouth and Poole Electricity Supply Company, Limited, have given notice of their intention to lay cables for the supply of power and light in stoneware conduits beneath the pavement on the south side of Ashley-road.

Batley.—The Town Council have agreed to revised plans and estimates for works of electrical energy supply proposed to be carried out by the Corporation, and have resolved that instead of £22,231, as previously decided upon, a sum of £25,602 be applied for.

Personal.—Mr. Edward Dodd, for over 20 years with the late Mr. Edward Pritchard, M.I.C.E., F.G.S., of the firm of Pritchard and Co., civil engineers, London and Birmingham, is now practising as civil and consulting engineer at 37A, Waterloo-street, Birmingham.

W. T. Henley's Telegraph Works Co.—The first batch of letters of allotment and regret for the recent issue of W. T. Henley's Telegraph Works Company, Limited, ordinary and preference shares have been posted. Both classes of shares were largely oversubscribed for.

Eccles.—The rate for electrical energy for motor purposes has been fixed at 3d. per unit. Sanction has been received to the borrowing of £11,950 on electric lighting account. The following new electric cable will be laid: Leeds-road, 422 yards of cable; Brunswick-street, 460 yards.

Goole.—The clerk of the Urban District Council has been instructed to watch the interests of the Council and take the necessary steps with regard to the application by the company for electric lighting powers in Goole urban district, and also as to obtaining a provisional order for the Council investing them with electric lighting powers.

Embankment Lighting.—The building of the generating station near Charing Cross is nearly completed, and the electric lighting of the Victoria Embankment will be commenced about the beginning of November. The whole scheme will probably not be completed before next summer. There will be 144 lamps, divided into nine electrical circuits.

Driffield.—The Urban District Council on Monday decided to inform the Northern Counties Electric Supply Company that they could not consent to their applying for a provisional order to supply Driffield with electric light. The Chairman of the Gas Committee said when the question of providing additional storage for gas was ready for consideration, the committee might deem it best to recommend that a provisional electric lighting order be applied for by the Council.

Thurlstone.—The Guardians intend to instal the electric light at the union. As they have no power to join in the erecting of a plant, they have asked the neighbouring urban district council's to take the matter up and lay down a plant, and they have appointed two representatives to watch their interests and obtain all the information they can. The two Councils have been asked to appoint three members each as a deputation, and to meet with a view to proceeding further with the matter.

Hampstead.—The report on the Hampstead Vestry's electrical undertaking, just issued, states that the capital outlay since the commencement of the undertaking five years ago has been £162 212. The total receipts for the year amount to £30,661, an increase of £6,283 on the previous year. The gross profit amounted to £16,325, of which the repayment of principal of loans and interest absorbed £6,619. The total net profit since the commencement of the undertaking has been £20,586.

Liability of Trade Unions.—Owing to the decision of Mr. Justice Farwell in the Taff Vale case, employers of all kind of labour may now sue trade unions as corporations for damage sustained through the action of their agents. The only surprising feature in the case is that a similar decision has not been arrived at long ago. Trade unions have the right to hold property as corporate bodies, and where the privileges exist the liabilities must lay also. This will assuredly act as a damper upon the zeal of their emissaries.

Pritchett Accumulators.—We are informed that the business relations between Messrs. Pritchetts and Gold and Messrs. Venner and Co., of 6, Old Queen-street, Westminster, by which the latter firm have been sole selling agents for Pritchett accumulators for the past 4½ years, have been dissolved by mutual consent. We have been asked to state that firms who have previously dealt with Messrs. Venner and Co. for Pritchett accumulators, should in future communicate direct with Messrs. Pritchetts and Gold at their works, Feltham, Middlesex.

Carnarvon.—The Joint Committee of the Town Council and the Gwyrfai District Council dealing with the question of the proposed light railway to Dinas Dinlle and the electric lighting of the district have adopted a report, from which it appears that in the event of the promoters failing from any cause to obtain a light railway order, or, having obtained the same, failing to carry out the works, they will transfer to the two Councils the benefit of the electric lighting provisional order on payment of not less than half the costs incurred in obtaining the same.

Llandaff.—The Landaff and Dinas Powis District Council have adopted a report from the Electric Lighting Committee on the notices received from the Penarth Electric Lighting Company for permission to apply for a provisional order to supply the district with electricity. The committee stated that they also had an interview with Mr. Downing (of Messrs. Downing and Handcock), representing the South Wales Electrical Power Company, and recommended that it was not advisable to give any power to companies to obtain provisional orders.

Workmen's Compensation Act.—At Blackburn recently a labourer was fetching water for breakfast when he fell and was injured severely. He claimed compensation under the Workmen's Compensation Act. For the defence it was said that as the man did not fall 30ft. he was out of court; also, that as he was fetching water for breakfast he was not at work at the time. The case was heard last week at the county court, and the judge decided that the man was at work within the Act, and that although the scaffold from which he fell was only actually 29ft. high, the building itself was over 30ft., and this overcame the technical point raised.

Iron and Steel Institute.—Since the original programme of the Paris meeting of this institute was issued some important additions have been made. The members, about 400 in number, and ladies accompanying them, have been invited by Mr. Eugene Schneider to a reception at the Le Creusot Pavilion in the Exhibition on Sept. 18, and by the Commissioner-General and Mrs. Jokyll to a reception at the British Royal Pavilion on the following afternoon, Sept. 19. The members have also been invited to visit on Sept. 20 the works of the Compagnie Française des Métaux at St. Denis. This company manufactures steel tubes, but its operations are devoted chiefly to the working of copper.

Sheffield.—The Electric Light Committee have recommended a number of increases in salary to take place as from Dec. 1, 1900. A three years' agreement is to be prepared by the town clerk in each case, to terminate on Dec. 31, 1903. The chairman of the Electric Light Committee (Alderman Styring), the deputy chairman (Councillor Harrison), and Councillor Maxfield, along with the chief engineer and manager (Mr. Fedden), are to visit the Paris Exhibition and to inspect the electric lighting machinery there; and they have also been authorised to visit Frankfort and such other places they may think desirable with a view of inspecting and making enquiries as to the installations at those places.

Dudley.—At the Town Council meeting on Tuesday it was said, in regard to the increase in the prices which would be charged for public lighting after the 29th inst., that for years the Corporation had been trying to purchase the gasworks, but on every occasion they had endeavoured to do so they had failed, owing to the price asked being so large. Before the conclusion of the present year the inhabitants of the town would be able to choose between gas and electric light. He hoped that the burgesses would rally round the Council by taking the electric light and making the scheme a gigantic success. The increase in the cost of public lighting by gas would be about £270 per annum.

Ayr.—The report of Mr. A. J. Fuller, burgh electrical engineer, submitted at the meeting of the Town Council on Monday, stated that 3½ miles of cable had been laid and 72 connections made during the year, the number of consumers being now 372. The annual output from the works had gone up from 297,420 units to 425,639 units, representing an increase of 43 per cent. A substantial reduction had been made in the cost of production, the rate being 1·80 per unit, as against 2·03. With a revenue of £5,244 the department was able to meet working expenses, pay

Digitized by Google

the interest on capital, amounting to £1,530, and still have a surplus of £235 towards paying off the annual sinking fund. But for the unexpected increase in prices they should have been able practically to meet the whole of this sinking fund account.

Birmingham Municipal Technical School.—The winter courses commenced on Tuesday. The physics department, which is under the immediate direction of the principal, comprises classes in physics, electricity, and mathematics. The classes in electricity comprise science courses and technical courses. The instruction given is rendered thorough by arranging both lecture and laboratory work in connection with each class. An important new class in this department is one for the study of design in electrical engineering. In the mechanical engineering department the classes are arranged with the view of providing a fundamental knowledge of the theory and practice of engineering. In addition to the ordinary courses of instruction, special courses are provided dealing with important engineering subjects to meet the wants of civil and mechanical engineers and draughtsmen.

Bury St. Edmunds.—The Town Council have resolved to purchase 20 additional meters. The resident engineer's report, adopted at the last meeting of the Town Council, stated that a supply of current was commenced on Aug. 28, and no stoppage had occurred between sunset and half past 11 at night. When the accumulators were working it was believed the supply would be as near perfect as possible. Many services had been completed, and the remainder would be finished in a few days. Fresh applications had been received for supply of current in St. John's-street. It was, therefore, recommended that the main be extended to that street at a cost of £65. A sketch and estimate of the cost of the proposed new accumulator-house, prepared by the borough surveyor, was submitted. Several further instruments were required at an estimated cost of £40. The police station is to be lighted by electricity.

London Gazette—An adjudication order has been made out *re* F. L. L. Lindsay, Gorphwysfa, Llandegfan, Anglesey. The first meeting in the estate of the above will be held on Sept. 18 at 3 15 p.m. at the Ship Hotel, Bangor, and the public examination on Oct. 4 at 12 15 p.m. at Magistrate's Room, Bangor.—Adjudication orders have been made out *re* R. Foster, Bradley House, Nelson, Lancs., and W. Baker, 27, Ormerod-road, Burnley, Lancs. (trading as R. Foster and Co., at Adlington street, Burnley, also trading as the Nelson Electrical Engineering Company, Stobb-street, Burnley).—The last day for receiving proofs in the estates of E. J. Paterson, 125, Queen's-road, Finsbury Park, London, and C. F. Cooper, Norbiton Lodge, Kingston-on-Thames, Surrey (carrying on business as Paterson and Cooper, at the European Works, Pownall-road, Dalston), is Sept. 22. Mr. E. C. Moore is trustee.

Worcester.—From Sept. 29 the charges for electric current will be as follows: To private consumers, 6½*d.* and 3*d.* per unit; for the waterworks motors, 1½*d.* per unit; for the public arc lamps, an additional £2. 2s. per year for an all-night lamp, and an additional £1. 1s. for a half-night lamp, and for the public incandescent lamps an additional 5s. per annum. The increase is due to the great advance in the price of fuel. The committee's estimates for 1900 include an extra sum of £1,000 for coal. The Council have agreed, in consideration of Lloyds Bank and the rector and churchwardens of St. Nicholas permitting the erection of an electricity transformer chamber on the space between the bank and St. Nicholas church, and permitting the Council and its officers to have access through the gates fronting the Cross, to indemnify the bank and the rector and churchwardens against damage to their property from fire or explosion at the transformer chamber, and to pay the bank the annual acknowledgment of 5s.

Tiverton.—The Town Council have adopted the minutes of the Lighting Committee stating that they had received the report of the electrical engineer appointed by the Council on the electric lighting of the town. He gave three alternative schemes for working installations—viz., by water, steam, or gas power, with estimates of the probable cost of working, from which it appeared that the water scheme was the only one which gave promise of yielding a profit from the commencement. The committee felt it was advisable before reporting fully to the Council to ascertain if the water power scheme could be carried out, and as it would be necessary to obtain the sanction of the Board of Trade to the construction of a weir across the river, the Mayor and borough surveyor had laid the matter before the Board of Trade, with whom a considerable correspondence had taken place, and they were still conferring. The committee felt nothing more could be done until the Board of Trade's decision was given, and they would then submit Mr. Adams's report with their own recommendations for the Council's approval.

Newport.—At Tuesday's meeting of the Newport Town Council the Chairman of the Electric Lighting Committee proposed that the supply of electrical energy for power should be under the sole direction of the present committee. He asked for a definition of work, protesting against the dual control exercised now, and suggested reducing charges to induce smaller consumers to make use of electric motive-power. The chairman and others thought the matter might be dealt with in November next, when the new committees were appointed, and favoured the formation of a new committee to cover the whole work of generation, distribution, and use, now undertaken partially by the lighting and traffic committees. It was acknowledged that some friction had taken place between the two committees. After a long desultory discussion, it was eventually decided to give an instruction to the Selection Committee for the appointment of a new committee, which would really supplant the present two committees. Mr. H. F. Parshall was appointed engineer for the tramway traction and electric scheme. His estimate for a power station capable of running 35 cars was £85,000.

Hammersmith.—At the Vestry meeting on Wednesday a letter was read from the London United Tramways, Limited, stating their intention to apply to Parliament for power to construct tramways along (1) Askew-road, Paddenswick-road, and Dalling-road, to connect with the existing tramway in King-street, with that in Glenthorne-road; (2) Scrubbs-road, Wood-lane, Shepherd's Bush-road, Brook-green-road, and Fulham Palace road; (3) from Uxbridge-road Station, along Richmond-road, Netherwood-road, to Shepherd's Bush-road; (4) from Uxbridge road Station, along Norland-road, Latimer-road, Bramley road, Lancaster-road, Portobello-road, etc., to Royal Oak; (5) connecting Nos. 1, 2, and 3 at Broadway, and proceeding along Bridge-road, across Hammersmith Bridge to Barnes and Richmond; (6) from Hammersmith Broadway, along Hammersmith-road to Kensington Church; and stating that there would be certain improvements, street widenings etc., involved in the construction of these tramways, and that Mr. Clifton Robinson would be pleased to attend and discuss the scheme with the committee at any time they may make it convenient for the purpose.

West Ham.—At last week's meeting of the Guardians a letter was read from the Local Government Board acknowledging the receipt of a letter informing them of the circumstances in connection with the acceptance by the Guardians, subject to the conditions specified in their letter of June 30, of the tender of Messrs. Frank Suter and Co., Limited, of 66, Berners-street, for carrying out certain works in connection with the proposed installation of an electric lighting system at the workhouse. It was stated that, having regard to the fact of the estimated cost of the proposed installation, based upon the provisionally accepted tender, being so largely in excess of the original estimate—viz., an increase of £1,875, or over 40 per cent.—the Board thought the Guardians would do well to consider whether it would not be advisable to abandon the proposal to provide electrical generating apparatus at the workhouse, where there was but insufficient space for it, and either continue for a while to use gas as an illuminant or else enter into an agreement with the West Ham Town Council for the supply of electricity from the street mains. As regarded the latter alternative, the Local Government Board were advised that wherever there was a public supply of electricity available it was preferable for a Board of Guardians to use that supply for the workhouse than themselves to provide a private system of generating apparatus, thereby incurring all the responsibility and cost of increased labour, repairs of machinery, consumption of coal, etc., besides the risk of requiring increased boiler power. It was requested that the matter might be reconsidered by the Guardians in the light of the foregoing remarks.

Battersea.—At the meeting of the Vestry on Wednesday the following report was submitted by the Finance Committee: "Your committee beg to report that, in accordance with the resolution of the Vestry of July 25, they made application to the Public Works Loan Board for a loan of the sum of £5,147 for electric arc lamps and posts. The Board state, however, that they cannot entertain the application, having regard to the limited amount placed at their disposal by Parliament, and to the amount of loans which they have already granted; they further state that they can hold out no hope that they will ever be in a position to entertain an application by the Vestry for a loan. Your committee, therefore, recommend that application be made to the London County Council for a loan of the sum in question, and for an amount of £20,000 further on account of the amount sanctioned by the Council, in respect of the general electric lighting scheme." The Electric Light Committee reported that they had considered as to the laying of electric mains on both sides of certain roads so as to prevent opening up the roads for the purpose of supplying electrical energy to lamps and consumers on the opposite side of the road to which the mains are laid, and recommended that mains, arc-light leads, etc., be laid in Battersea Park-road at an additional estimated cost of £960; in Lavender-hill, at an estimated additional cost of £285; and in Lombard-road, etc., at an estimated cost of £1,300. The committee further recommended that the charge for lighting purposes be 5½*d.* per unit, and for motor purposes 3*d.* per unit, with a rebate at the rate of 1 per cent. per 1,000 units up to a total consumption of 10,000 units per annum, and above that a rebate at the rate of 0·66*d.* per cent. per 1,000 units up to 20,000 units per annum.

LIGHT RAILWAYS.

At the monthly meeting of the Dukinfield Town Council the clerk reported that the enquiry by the Light Railway Commissioners into the Hyde and Dukinfield light railway was fixed to be held at the Town Hall, Hyde, on Sept. 27.

The Commissioners will hold their enquiry regarding the projected Kidderminster and Bewdley electric railway line on Oct. 17, and not on Sept. 17, as previously announced.

A letter from the Beeston Urban District Council, asking whether the Nottingham Corporation would be likely to favour the construction of a light railway between Beeston and Nottingham is before the Tramways Committee of Nottingham.

The Commissioners have informed the Pemberton District Council that they will hold, on the 26th inst., a public enquiry at

Digitized by Google

the Wigan Municipal Buildings into the application for an order to authorise the portion of the Wigan light railways described as Railway No. 1, the application so far as it related to the remaining portions described as Railways Nos. 2 and 3 having been withdrawn by the promoters.

At the quarterly meeting of the Worcestershire County Council last Monday the Chairman urged that strong action should be taken to enforce their views upon the Board of Trade in the cases of applications to construct light railways in the county, so that adequate precautions against danger to the public might be secured. Their recent experience had been that it was useless to appeal against the orders of the Light Railway Commissioners, and he suggested that the matter should be brought to the attention of the County Councils' Association, which appeared to be the only body having any weight with the Board of Trade. This was unanimously agreed to,

A public meeting was held last week at Kingsclere with the object of promoting a light railway, passing through Kingsclere, and which will connect on the west with Highclere (on the Didcot, Newbury, and Southampton line), and Basingstoke an the east, connecting it with the South-Western main line. Resolutions were passed acknowledging the need of the railway, and pledging the meeting to support the application to the Light Railway Commissioners.

The Board of Trade have, we learn, recently confirmed the undermentioned light railway orders: (1) South Staffordshire Light Railway Order, 1900, authorising the construction of light railways in the boroughs of Wolverhampton and Wednesbury and the urban districts of Willenhall, Darlaston, Coseley, and Bilston, in the county of Stafford; (2) Barnsley and District Light Railway Order, 1900, authorising the construction of light railways in the borough of Barnsley, and the urban districts of Worsborough and Monk Bretton, in the West Riding of the county of York; (3) Gateshead and District Light Railway Order, 1900, authorising the construction of light railways in the municipal and county borough of Gateshead, and the urban district of Whickham, in the county of Durham; (4) South Staffordshire Light Railway (Extensions) Order, 1900, authorising the construction of light railways in the urban districts of Bilston, Willenhall, and Coseley, in the county of Stafford; (5) Bromsgrove Light Railways Order, 1900, authorising the construction of light railways in the county of Worcester, between Bromsgrove Railway Station, Bromsgrove Town, and Lickey End; (6) Peterborough and District Light Railways Order, 1900, authorising the construction of light railways in the county of Northampton, in the city of Peterborough, and the parishes of Walton and Peterborough Without, in the rural district of Peterborough.

At a recent meeting of the Blackburn Town Council a report was received from the Electricity and Tramways Committee, stating that having considered the report of the electrical engineers on the question of giving running powers to the proposed Blackburn, Rishton, and Whalley, etc., Light Railway Company over certain of the tramway lines in Blackburn; as to the supply of electricity to the company for working part of the proposed tramways of the company; and as to supplying electricity to the district of Rishton for lighting and power purposes, they recommended: (1) That the company be granted running powers from Furthergate, along Burnley-road, to the borough boundary, on condition that the company grant similar running powers to the Corporation over the company's lines from the borough boundary to the Rishton boundary at Hyndburgh Brook, on terms to be mutually arranged. The current for working the tramways to the borough boundary to be supplied by the Corporation. (2) That the Corporation offer to supply current to the company for working the proposed tramway within the district of Rishton on the following terms: the price to a minimum of 1½d. per unit metered at the works of the Corporation, at a pressure of 500 to 550 volts, and the company to agree to take or pay for a minimum quantity per annum. The company to provide such gear as may be required for the supply of the current to their tramways, and to provide such feeder and return cables as may be required, the Corporation to lay such of these as are within the borough at the expense of the company. (3) That in the opinion of the committee it is not advisable for the Corporation to obtain power for supplying electricity for lighting and power purposes within the district of Rishton. It was further recommended that the town clerk arrange for the insertion of clauses in the proposed order giving the Corporation the option of purchasing so much of the light railway as will be situate within the district of Rishton at a price to be fixed by an arbitrator appointed by the Board of Trade, in the event of (1) the liquidation of the company, (2) the borough of Blackburn being so extended as to include Rishton, and providing that in the latter event the purchase by the Corporation shall not annul the exercise of running powers by the company over any of the proposed tramways for the period for which the order may be granted. The report was adopted.

The Light Railway Commissioners have intimated that a public enquiry will be held at Brackburn Town Hall on Sept 25 as to the expediency of granting the Blackburn, Whalley, and Burnley light railways an order to authorise the construction of the above-named light railways.

At a meeting of the Elland District Council it was agreed that the seal of the Council be affixed to a communication approving the Deanhead light railway scheme, which the Council considered a necessity for the district.

The Port Madoc Urban District Council at a recent meeting expressed themselves in favour of the scheme proposed by the Manchester syndicate for an electrical light railway from Port Madoc to Beddgelert.

PROVISIONAL PATENTS, 1900.

SEPTEMBER 3.

15665. Improvements in and relating to automatic frogs for the overhead equipment of electric tramways. Edmund Philip Grove, 42, Hayes-road, Bromley, Kent.

15637. Improved electro-mechanical device for motorcars and the like. William Phillips Thompson, 322, High Holborn, London. (Eugenio Cantono, Italy.)

15612. Improvements relating to electric incandescent lamps. Louis Jean Paul Hollub and Henry Mignal, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 4.

15761. Improvements in electrolitical apparatus. Joseph Matthews and William Davies, 77, Colmore-row, Birmingham.

15716 Improvements relating to electric storage batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Rushton Bowker, United States.) (Complete specification.)

15713. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, or the like. Robert Hacking, 111, Hatton-garden, London

15717. Improvements relating to electric railways working on the closed conduit system. Léon Dion, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15718. Improvements relating to the preparation of conducting material chiefly designed for the manufacture of brushes for dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Jesse B. Fay, United States.)

15721. Improvements relating to telephone systems. Henrik Tore Cedergren and Gottlieb Magnus Teodor Piltz, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15725. Improved means and appliances connected with electric arc lamps. Charles Bean King, jun., Eric Rivers Smith, and John James Rathbone, 166, Fleet-street, London.

15730. An improved material or composition suitable for use as an electrical cement and insulator. Edwin Tatham, 47, Lincoln's-inn-fields, London.

15746. Improvements in arc lamps. Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

15748. Improvements in or relating to electric switches, fuses, and other apparatus in which destructive electric arcs are liable to be formed. Gerald William Partridge, 46, Lincoln's-inn fields, London.

15752. Improvements in and relating to electroliers, pendants and fittings or connections therefor. Hugo Hirst and George Henry Ide, 165, Queen Victoria-street, London.

SEPTEMBER 5.

15774. An improved electrical signalling apparatus for fire alarms and other purposes. Walter Clar, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

15793. Improved electric travelling contact appliances for establishing telephonic and signal communication on railways between the signalman in the box and the driver of a locomotive. Harry Gulliver and Thomas Crow Fowler, Clun House, Surrey-street, Strand, London.

15818. Improvements in and relating to electrical signalling apparatus. Henry Montague Hozier, C.B., and Alexander William Sharman, 45, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 6.

15864. Improvements in and relating to street lamp fittings for incandescence electric lamps. William Charles Cloete Hawtayne, 73, St. Stephen's-road, Upton Park, London.

15865. Improvements in shades for electrical and other lamps. William Edward Langdon, 73, St. Stephen's-road, Upton Park, London.

15870. Improvements in apparatus for producing electric waves. Tebaldo José Ricaldoni, 46, Lincoln's-inn-fields, London. (Complete specification.)

15872. Improvements in arc lamps. John Lenderyou and Tom Samuel Millward Wyatt, 22, Southampton buildings, Chancery-lane, London.

15874. Improvements in means or apparatus for controlling electrically-driven lifts, hoists, cranes, pumps, or air compressors and for analogous purposes. Jörgen Björnstad, 47, Lincoln's-inn-fields, London.

15888. Improvements in electric meters. John Corry Fell, 1, Queen Victoria-street, London. (William Stanley, United States.) (Complete specification.)

SEPTEMBER 7.

15890. Improvements in electric cable connectors. Stanley Beeton and Mark Barr, Green Bank, Bowden, Cheshire.

15907. Improvements in electric arc lamps. Frederick Booker, 22, Ashchurch-terrace, Shepherd's Bush, London.

Digitized by Google

15918. Improvements in electrical phase transformation. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

15919. Improvements in electric rotary transforming apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States). (Complete specification.)

15920. Improvements in electric furnaces. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

15921. Improvements in electric cut-outs. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William Le R. Emmet, United States.) (Complete specification.)

15951. An automatic switch for groups of transformers with members of various capacity. Alfred Schlatter, 18, Buckingham-street, Strand, London. (Complete specification.)

15965. Improvements in or relating to electric barometers or barometric indicators. Alfred Julius Boult, 111, Hatton-garden, London. (Comte Alberto Miglioretti, Italy.)

SEPTEMBER 8.

16000. Improvements in electric switches. Veritys, Limited, and William Reginald Ridings, 322, High Holborn, London.

16013. Improvements in secondary batteries. Charles Orme Bastian, 77, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Sept. 29.

1899.

17722. Telegraphic apparatus. Crehore and Squier.

18065. Secondary galvanic batteries or accumulators. Lucas and New.

18754. Galvanic batteries. Meyer.

19781. Electrical switches. Hunter.

21876. Magnetic separators. Clark. (Courtney.)

21900. Cord grips for electrical apparatus. Oppenheimer. Actien-Gesellschaft Mix and Genest.)

21901. Porcelain interiors for electric incandescent lamp-holders. Oppenheimer. (Actien Gesellschaft Mix and Genest.)

22271. Manufacture of electrical heating appliances of high electrical resistance capable of sustaining high temperatures. Vogt.

22330. Process of manufacturing carbons for electrical and electro-chemical and other purposes. Pohl.

1900.

2240. Telephones. Ducretet.

7631. Electric clocks. Lake. (Dudley.)

8226. Plates for secondary batteries. Schmitt.

9767. Coupling or connecting electric conductors, cables, and the like. McTighe.

10128. Voltmeters. Duncan.

10124. Alternating-current wattmeters. Duncan.

12870. Trolley for overhead electric traction. Johnson, Palmer, and Coenen.

13200. Arc lamps. Ackermann.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Sept. 8	735	631	+ 104	10,952	9,591
Birmingham Tramways Co.	,, 8	4,636	4,500	+ 136	158,358	*c* —
Blackburn Corp'rat'n	,, 7	487	481	+ 6	16,136	14,148
Blackpool Corporatn.	,, 6	1 403	1,051	+ 352	20,588	15,878
Blackpool-Fleetwood	,, 8	1,395	1,335	+ 60	14,520	14,798
Bradford City Trams	,, 9	679	463	+ 216	11,721	9,535
Bristol Tramways Co.	,, 7	3,629	3,697	- 68	—	—
Carlisle Tr'mw'ys Co	,, 8	191	—	—	2,077*f*	—
Central London Ry.	,, 8	4,647	—	—	27,475*e*	—
City & South London	,, 9	1,457	886	+ 601	15,023	9 439 *c*
Cork E. T. and L. Co.	,, 6	547	498	+ 49	14,742	13,520
Dover Tramways	,, 8	292	293	- 1	7,416	7,074
Dublin U.T., elec. cars	,, 7	4,063	2,311	+1,752	—	—
Dublin S.D. Electric	,, 7	1,133	1 050	+ 117	—	—
Glasgow Corporation	,, 8	9,664	9,455	+ 209	—	—
Halifax Corporation	,, 9	919	750	+ 169	18,467	14,352
Hull Corporat'n E.S.	,, 8	1,287	—	—	28,672*a*	— *a*
Liverpool Corporat'n	,, 15	8,778	7,684	+1,094	268,081	237,880
Liverpool Overhead	,, 9	1,792	1,614	+ 178	17,487 *c*	17,269
Sheffield Corporation	,, 9	2,640	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *d* Since July 5. *e* From July 30. *f* From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	—	—	11-11½
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-65,000	1	—	⅞-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅞-1
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-4¾
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2½-2⅝ xd
—— 4½ per cent. Debenture Stock	100	..	108-111 xd
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-13½
—— 5 per cent. Pref.	5	—	5-5½
Crompton and Co.	2	—	2½-2¾
—— 5 per cent. Debentures	—	—	98-102
Edison and Swan United, Ordinary	3	—	1½-2½
—— 5 per cent. Debentures	5	—	2½-4½
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Certs.	70	..	68-72
Electric Construction	2	—	1½-2½
—— 7 per cent. Cumulative Pref.	2	—	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12-13
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	108-112 xd
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	85-90
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5½-5¾
Willans and Robinson, Ordinary, 1-20,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 20,001-60,000	5	—	6½-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅞-1
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	—	9½-10½
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6½-6¾
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	6½-7½
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	7½-8½
—— 6 per cent. Cumulative Pref.	10	—	12-13
—— 5 per cent. Debenture Stock	100	—	124-129
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	—	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	2	—	1½-1¾
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	99-101
Metropolitan, Ordinary	10	—	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-98
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1½-1¾
—— £5 Shares	5	—	7½-7¾
—— £4½ Shares, New	4½	..	6-6½
Oxford Electric, Ordinary, 1-96 and 407-10,210	5	—	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	—	95-98
South London, Ordinary	3	—	3-4
St. James's and Pall Mall, Ordinary, 101-20,060	5	..	14-15
—— 7 per cent. Pref.	5	—	8-9
Westminster, Ordinary	5	—	12-13
—— 20,001-109,457	2½	—	2½-2¾
Electric Railways.—			
Central London, Ordinary	10	—	10-10½
—— Pref. Half-Shares	5	—	4½-5½
—— ,, deferred	5	—	4½-5½
City and South London, Consolidated Ordinary	100	—	57-60
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	10	..	138-142
—— ,, ,, ,, '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	92 95
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16 xd
Brisbane Tramway	100	—	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary	10	—	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	122-125
—— ,, ,, ,, 1900	100	—	121-124
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	3½-4½
—— 5 per cent. Deb. Stock, Red.	100	—	103-106
—— Prov. Cert., all paid	—	—	96-99
Isle of Man Electric Power, 6 per cent. Pref.	1	—	1/16-⅛
Kidderminster and District Lighting and Traction, Pref.	10	—	9½-10½
New General Traction, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. Pref.	5	—	4½-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-1
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	12-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	98-101
Oriental Telephone and Electric Company	1	—	¾-1½

Digitized by Google

NOTES.

Personal.—We learn that Mr. L. R. Wilberforce, M.A., demonstrator in physics at the Cavendish Laboratory, Cambridge, and university lecturer in physics, has been appointed to the Lyon Jones chair of experimental physics at University College, Liverpool, vacated by the removal of Dr. Oliver Lodge to the University of Birmingham.

Indian Telegraphs.—We have before mentioned what a large amount of valuable work is done by the Government Telegraph Department in India, and we now learn that, in addition to sending messages and building lines for its own use, it supplies the State railway and canal systems with wires, instruments, and the technical direction of their telegraph offices. Thus at the end of the last official year, no less than 56,344 miles of wire and cable were maintained for railways and canals, and 2,374 railway and canal offices had the benefit of the Telegraph Department's technical supervision.

Umpiring by Electricity.—We notice in the *Daily Telegraph* an account of a review by General Brugere of the troops engaged in the military manœuvres at Chartres. In this account our contemporary states that General Brugere, one of the military umpires, went along the lines in a motorcar, behind him being an electric "volturette" with a strong light projector. The latter was brought to bear on the position to be attacked, and it said to have been worked with remarkable efficiency. The searchlight showed every part of the ground and every regiment, both in the attacking and the defending contingents.

South American Tramways. — Electricity is apparently becoming very popular in the South American countries as a motive power for tramways. Thus the Chilian Electric Tramway and Light Company, which has some 42 miles of horse tramways, is soon to convert them into electrical. La Capital Tramways Company, of Buenos Ayres, Argentina, has also acquired the systems of the New and Grand National Tramways Companies, and intends to convert both these systems to electrical traction. La Capital Tramways Company has already spent some very large sums in equipping portions of its line electrically.

Finsbury Technical College.—The evening courses of the Technical College, Finsbury, begin on Monday, Oct. 1. Prof. Silvanus Thompson will open the Monday evening (advanced) course with an introductory lecture on "The Distribution of Electricity," the succeeding Monday evenings until Christmas being devoted principally to the subject of the design of continuous-current dynamos and motors. On Wednesday evenings Dr. E. W. Marchant will lecture on electric currents and methods of measurement. Prof. Thompson will also give a short course of special lectures on Fridays on the "Polarisation of Light."

Aluminium Welding.—It is stated by the *Trade Journals Review* that the great difficulty of welding, which has been the drawback in the use of aluminium, has been overcome. Thus the well-known firm of W. C. Heraeus, of Hanau, near Frankfort-on-the-Main, has now succeeded in welding aluminium without the use of any other metal, solder, or acid. The process is kept secret at present, but it is stated that no seam can be detected, and that the welded pieces can resist blows and temperature variations as well as if they had always formed a whole. If this fact is correct, it will considerably heighten the value of aluminium.

The Birkbeck Institution.—This institution, we learn, commences its new session on Oct. 1. There are both day and evening courses of study, comprising various branches of commercial and technical education. During the recess considerable additions and improvements have been made by the aid of a gift of 2,000 guineas from Mr. F. Ravenscroft, to commemorate his completion of a membership of 50 years. A new reading-room, a new magazine-room, and a social room have been provided, and a well-appointed metallurgical laboratory has been added. A popular lecture or entertainment is given in the theatre every Wednesday evening.

Mining Engineers.—Coal is of great interest just at the present time owing to its high price and in view of the approaching winter. The eleventh annual meeting, therefore, of the Institution of Mining Engineers, which has just been held at Bristol, is of general interest. The secretary's report, read at the opening meeting on Tuesday, showed that the membership numbered 2,393. Papers were read by Messrs. J. and G. E. MacMurtie on "The Geological Formation and Working of the Bristol and Somerset Coalfield," this coalfield including an area of 238 square miles. Other papers were read by Messrs. W. A. E. Assher and E. Gledhill.

Electricity in Brussels.—In a report prepared by Alderman de Potter on the electric lighting of Brussels, it is shown that the city possesses three electricity stations operated either by steam or gas. The most important contains five steam-engines of 500 i.h.p., driving 18 dynamos of 1,100 amperes at 150 volts, besides a battery of accumulators furnishing a discharge of 700 amperes for eight hours. The distribution is carried out by means of underground ducts, the total length of which on Dec. 31 last was over 31 miles. In a certain number of streets the conduits exist under both the footways. The number of lamps installed on Dec. 31, including public lighting, was 84,954.

China Cables.—It is pleasing to hear that the Eastern Extension and Great Northern Telegraph companies have successfully laid and opened for traffic a submarine cable between the towns of Shanghai and Chefoo. This is an important piece of work, as with the cable recently laid between Chefoo and Taku it provides a means of cable communication to Chefoo and Taku which is entirely independent of the Chinese land lines, and without any additional tariffs. These cables may yet prove of valuable assistance to the Allied troops in China, as will probably the lines which the companies also announce as having laid between Chefoo and the British port of Wei-hai-wei, and also between Chefoo and the Russian town of Port Arthur.

The Civil and Mechanical Engineers' Society. We have received the list of meetings and officers of the Civil and Mechanical Engineers' Society for the session 1900-1. The president is this year Prof. Robert H. Smith, the vice-presidents being Messrs. W. M. Bering and W. N. Twelvetrees. The papers to be read during the session, which commences on Oct. 4, are the president's address on "Training to Keep Ahead in the World Competition"; "Patent Law," by Mr. G. F. Emery; "Valve Gears and Valve Diagrams," by Prof. R. H. Smith; "The Case for Electric Power Distribution," by Mr. W. B. Esson; "A Description of the Staines Reservoir Works," by Mr. M. Mawson; "On Authoritative Rules for Unit Stresses in Railway Girders," by Mr. Jas. R. Bell; "On the Proportions of Cylinders for Multiple-Expansion Engines," by Mr. A. Haussen; and "The Storage of Electricity," by Mr. A. H. Allen.

Street Railway Convention.—We gather from the American technical Press that the annual convention of the American Street Railway Association is to be held at the Convention Hall, Kansas, on Oct. 16, 17, 18, and 19.

Digitized by Google

The congress, which promises to be a very interesting one, will be the nineteenth, and a number of very interesting papers are down on the agenda. Amongst these are papers entitled "Double-Truck Cars: How to Equip them and obtain Maximum Efficiency under Varying Conditions," "Comparisons of the Various Systems of Electrical Distribution for Street Railways," "Consolidation of Street Railways and its Effect on the Public," "The Storeroom and Storeroom Accounts," and "Painting, Repainting, and Maintenance of Car Bodies." Friday, Oct. 19, is to be set apart for viewing the exhibits, the annual banquet being held on this evening also. At this banquet the officers-elect are duly installed.

Swiss Electricians.—We notice that it is announced that the combined general meeting of the Association Suisse des Electriciens and the Association des Centrales Suisses d'Electricité is to be held this year at Basle on Oct. 6, 7, and 8. It is proposed on Oct. 6 to hold the general meeting of the Association Centrales Suisses, and on Sunday, Oct. 7, that of the Association Suisse des Electriciens. After this last meeting a banquet and *réunion* is to take place. On Monday, Oct. 8, visits are to be paid to various installations in the neighbourhood. The annual report for 1900 of the secretary of the Association Suisse des Electriciens has just been published. It contains the usual information, but also, in addition, hints as to the establishment and safe working of installations for use with high-tension currents, and a report on the electrical installations at the Paris Exhibition from the point of view of safety. There is also a list of Swiss patents issued in 1899, etc.

A New Electrolytic Cell.—The following abstract, which appears in the *Journal* of the Chemical Society, was contributed by Mr. W. L. Hildburgh to the *Journal* of the American Chemical Society. The abstract reads as follows: "The cell Cu | H_2SO_4 | Pt allows currents of low voltage to pass if the copper is employed as the anode, but if the current is reversed owing to the high polarisation no current passes if the voltage is not too great, and hence such a cell may be used as a rectifier for low-voltage alternating currents. This is not a very efficient arrangement, however, and a better form consists of a plate of platinised platinum, partly in sulphuric acid, partly in hydrogen, and a platinum wire sealed into glass under the acid. The whole is contained in a sealed vessel. Currents may pass from the platinum plate to the platinum wire, generating hydrogen at the wire, which escapes in bubbles, joining the gas above the acid; in the opposite direction, however polarisation occurs, the wire becoming coated with a film of oxygen. For high E.M.F.'s a number of these cells in series may be employed."

Electrochemical Equivalent of Carbon.—The following abstract, which appears in the *Journal* of the Chemical Society, is of a paper contributed by Mr. S. Skinner to the *Proceedings* of the Cambridge Philological Society. The abstract is as follows: "When a solution of potassium permanganate is electrolysed with a carbon anode, 77·86 per cent. of the gas liberated at the anode consists of carbon dioxide, the rest being carbon monoxide and oxygen. The total volume of gas liberated is nearly the same as the volume of oxygen liberated by the same current in a dilute sulphuric acid voltameter. The permanganate ion persists in solution even although a quantity of electricity more than sufficient for its complete decomposition is passed through the cell. The author finds the electrochemical equivalent of carbon to be three times that of hydrogen. A cell may be constructed with a carbon rod in potassium permanganate, and a lead peroxide plate in dilute sulphuric acid, the two electrolytes being separated by a porous pot. The E.M.F. is 0·33 volt, and acts externally from the lead peroxide to the carbon. In this self-acting system carbon is consumed at the ordinary temperature.

Central London v. Metropolitan.—We gave last week a few figures showing the effect of the competition by the Central London Railway on the omnibus receipts. The *Financial Times* now points out that this decrease in receipts has not appeared in the case of the Metropolitan Railway. Figures are given showing the increase or decrease of the receipts of this company for several days of August and September as compared with the same days last year. Thus the receipts for Aug. 8 show an increase of £169, those for Aug. 15 an increase of £66, those for Aug. 22 a decrease of £170, and on Aug. 29, Sept. 5, and Sept. 12 considerable increases were shown. This result, although it was not to be expected that the new line would seriously affect the old, does not quite show the matter properly. For instance, on the District Railway the line from Hammersmith and the stations near by does appear to be affected, as the trains which used to be considerably overcrowded in the morning and evening are now half empty. This must have some effect on the District Company's receipts, and the Metropolitan Railway are to be congratulated if they do not find the same state of affairs on a portion of their line.

An Electrical Hospital.—A peculiar experiment is about to be tried in St. Louis, this being a hospital which is to be fitted up entirely with electricity. The head of the concern is said to be Dr. Heber Robarts, and he states that the hospital will be as nearly a battery as it can be made. It is to be fitted with every kind and variety of electrical apparatus that has anything to do with the generation of electric currents. The expenditure of a large sum of money will be necessary to provide the appliances which will be required, as all of these, says *Electricity* of New York, will be of the most delicate order. The funds needed, however, are apparently forthcoming. The hospital will be a thoroughly legitimate institution, and will not be operated on a cure-all basis. The patients are simply to be treated by electricity and the best results obtained. The staff of the hospital will be regular medical practitioners who have given special attention to troubles which it is almost impossible to treat properly in the old way. The staff have no intention of abandoning medicine in favour of electricity, but state that they are not going to administer it in the same way. They propose to diffuse it through the affected parts by means of electric currents and electrodes.

Electrolytic Deposition.—The following is an abstract of a paper contributed by Mr. Louis Kahlenberg to the *Journal fuer Physikalische Chemie*. The abstract appears in the *Journal* of the Chemical Society, and reads as follows: "In order to test whether Faraday's law is valid for non-aqueous solvents, solutions of silver nitrate in pyridine, aniline, phenyl cyanide, and quinoline were electrolysed, and the weight of silver deposited compared with that deposited from an aqueous solution in the same circuit. The weights respectively were as follows, those from the aqueous solutions being given first: 0·7836 grm., 0·7819 grm.; 0·1788 grm., 0·1780 grm.; 0·1612 grm., 0·1603 grm.; 0·2501 grm., 0·2452 grm. In the quinoline solution there was evidence of a complicated reaction, as the silver was carbonaceous; in the other solvents it was firm and white. Experiments with lead and antimony gave very similar results. The work must be considered as preliminary, but it certainly tends to show that Faraday's law is valid for the non-aqueous solutions. It was found also that silver can be completely deposited in a compact white

Digitized by Google

form from solutions in pyridine, or in aqueous pyridine, by a current of density of from 0·17 to 0·25 ampere per 100 square centimetres cathode area."

Electric Lighting at Budapest.—Some information given by M. de Fodor at the Paris congress on the electric lighting of Budapest will be of interest to all electrical engineers, as giving a new means of improving the load factor of an electric lighting station by means of a variation in price. The nearest approach to Mr. Fodor's system in England is that arranged by Mr. A. Wright at Whitechapel. In fact, we believe that the Whitechapel charges are even more favourable to the consumer than those at Budapest. Mr. Fodor states that it was found that the average number of hours which each lamp connected to the network was used, amounted to 440 per annum. These were divided up amongst the various months in the following way: January, 60 hours; February, 50 hours; March, 36 hours; April, 29 hours; May, 19 hours; June, 12 hours; July, 9½ hours; August, 14 hours; September, 29 hours; October, 50½ hours; November, 64 hours, and December, 67 hours. Under these conditions the author points out that the consumers ought to be encouraged in the months in which the works are least used, and he does this by making a reduction in the case of those lamps which use more than the normal. In the summer months this reduction amounts to 60 per cent. of the standard charge; in the spring and autumn months, to 40 per cent.; and in the winter months, to 20 per cent. By this system no special apparatus is required, and it is stated that it works to the satisfaction of the consumer. It seems to us, however, that the system is a somewhat complicated one.

German Tramway Accidents.—There has, we learn, just been completed by the Society of German Tramway and Secondary Railway Administrations an exhaustive enquiry as to the causes of accidents on electric tramways. The above-mentioned institution comprises about 100 different tramway and light railway undertakings, and its report contains particulars relating to some 58 tramways. The report, which deals with the year 1899, was presented at the society's annual meeting, which, we learn from the *Financial Times*, was held last week in Wiesbaden. From this report we notice that during 1899 accidents occurred to 973 passengers and 871 other persons, or 52·8 per cent. and 47·2 per cent. respectively. Of the total of 1,844 no less than 126 were killed, whilst 147 passengers and 146 other persons were severely injured. The report concludes that, as compared with 1898, there was a diminution last year in the number of accidents arising from persons unlawfully entering or leaving tramcars and from too high a speed being used in passing round curves, and a reduction in the casualties to children was also noticed. The result in the latter case is attributed to the adoption of improved mechanical braking arrangements. There was, however, an increase in the accidents due to collisions, the larger number affecting pedestrians, and especially cyclists. The percentage of accidents on these railways seems to be abnormally high, and one is inclined to think that more care might be exercised by those controlling the lines. We are not told what proportion of accidents occurred owing to electrical matters, but as it is not mentioned we presume it must be very small.

Technical Education.—With the approach of the winter session come the prospectuses of the various technical institutions. Thus we have received the prospectus of the Northern Polytechnic Institute, Holloway-road, N. This prospectus contains a considerable amount of reading matter relating to the various classes which are about to be held in the institute, and also has some good illustrations of the shops, halls, etc., of the building. The classes in electrical engineering are to include three courses, the first for very elementary students, the second for more advanced students, and the third for those who have passed the second course. With each of these courses laboratory work is taken. Mr. Mundella, the lecturer in this section, also has a class for electric wiring and fitting. There are a large number of other classes also in preparation, including both technical and commercial subjects. The principal of the Northern Polytechnic is Mr. J. T. Dunn. We have also received the calendar for the fifth session of the Royal Technical Institute, Salford, of which the principal is Mr. W. Wilson, M.A. In this institute is a very large number of classes which are practically all technical. In the physical and electrical engineering department, in which we are more particularly interested, the lecturers are Messrs. W. B. Burnie, E. S. A. Robson, E. H. Dixon, and M. H. Barnes, and there are classes for elementary and advanced students in electrical engineering, lighting, direct and alternating currents, wiring and fitting, electric traction and motors, central stations and distribution, etc. There are many other subjects taken, and the chief industries of Manchester and Salford are taught in the dyeing, printing, and bleaching department, which deals with the treatment of cotton goods.

Obituary.—We regret to have to record the death of Mr. Abdank-Abakanowicz, who for many years occupied a prominent position amongst the electrical engineers in France. He was born in 1852 in Lithuania, and commenced his technical studies at the polytechnical school at Riga. The deceased went to Paris in 1881, since which time he took an active interest both in the electrical industry and in the technical papers in that city. He was one of the original founders of *L'Industrie Electrique*, and it is from the obituary notice in that paper that we take the following facts. Like other early workers in the field of electricity, Mr. Abdank invented an arc lamp and also a dynamo, but his magnetic call system, which is so largely used on railways, obtained the greatest success of his earliest inventions. In connection with the 1889 exhibition in Paris he was dispatched as commissioner to the United States to induce the large electrical firms of that country to exhibit. The result was that the American section was one of the successes of the exhibition, and the Cross of the Legion of Honour was awarded Mr. Abdank for his labours. It was through this visit that he became connected with Prof. Elihu Thomson, and also with the Thomson-Houston International Company. Accordingly, when the company blossomed forth as the powerful Compagnie Française Thomson-Houston, he was appointed their consulting engineer. In this connection he did a great deal of work in the development of electric traction in France. He was also largely responsible for the establishment of the laboratory at Parc St. Maur. In this some valuable original work has been carried out. We gather from the columns of our contemporary that his colleagues on the staff of the above-mentioned company feel the loss not only of his expert advice, but also of a sincere friend.

A Cyclist's Lawsuit.—We notice in the *Street Railway Journal* for September an account of an interesting law case at Alleghany between a cyclist and a tramway company. The facts were that the plaintiff, an inexperienced cyclist, rode on to the railroad track when a car proceeding on a down grade was right behind him. He started to ride up the track in order to turn off, but had only proceeded some 140ft. when he was struck by the car and thrown down. The judge dismissed the suit for damages against the company on the ground that the plaintiff was guilty of negligence. The judge also stated that he had long been

Digitized by Google

impressed with the belief that the courts should take a firm hold of these cases where men risk their lives by just going before a car or travelling on a track before a car. If the plaintiff could be sustained in his action the result would be that bicyclists would get on to the track of a street railway, plod along that track, and expect that the motorman of the car would stop to let them off rather than hit them; and if this were the law, perhaps one-half the street cars would be delayed in their trips. We are afraid that the judge in question has not considered the other side of his verdict very much. It would seem that if any cyclist happened by chance to cross a street railway track, the motorman of a car coming along has full power to go full speed for that cyclist, and knock him over and perhaps kill him. He would, we should think, receive the judge's commendation for so doing. It seems to us, however, that in this instance we do things better than our American neighbours, in that we have a law making the obstruction of tramway cars a punishable offence. This is certainly not taken much advantage of, but it does not take many examples in the shape of smart fines to make cart drivers and cyclists get off tramway tracks when they hear the gong or whistle of the tramcar. In any case it would seem very peculiar law which allows a man to be seriously injured, or perhaps killed, when a fine of a pound or two would meet the case.

Submerged Accumulators.—A remarkable case of accumulators working while under water is spoken of in the *Scientific American*. The accumulators formed part of the municipal electric plant of Munich, the station of which is situated on an island formed by the Isar, and during the inundations of last year was partially submerged. The batteries of accumulators, which were on the ground floor, were first reached, and were soon entirely covered. One of the batteries was used on the city lighting circuit, and the other was connected in parallel with the dynamos for the traction system. As the tramway service had to be discontinued, the second battery was removed from the circuit, and it was thought that the batteries for the lighting circuit would also have to be cut out, as the flywheels of the engines were half under water, except two. Nevertheless, as it was almost indispensable to light at least the principal streets of the city, it was decided to try to operate the submerged battery. The attempt was successful, and the battery, which had been constructed to give 6,000 ampere-hours with a 600-ampere discharge, was able to furnish 4,000 ampere-hours during the night; the remainder was lost in discharges in the water. Encouraged by this success, the engineers charged the battery on the following day, and the discharge was repeated under the same circumstances. Two days after the water had lowered sufficiently to give access to the battery-rooms. It was found that the density of the acid had fallen, but not to a very great extent; from 22deg. B. it had fallen to 20deg. B. only, there having been scarcely any diffusion. Except for a layer of mud ¼in. thick upon the top of the plates and the connecting rods, the inundation had left scarcely an appreciable trace. It was supposed at the beginning that it would be necessary to replace the acid of the batteries, which represented a considerable expense, as they contained more than 30,000 gallons, but as the acid held its strength, a slight strengthening was all that it required.

Accumulator Traction.—We noted a month or two ago the removal of the last accumulator cars in Chicago, and now we hear of the same thing at Berlin. Thus we gather from the *Financial Times* that, in consequence of many interruptions in the service and of accidents on those sections of the Berlin tramways worked by means of accumulator cars, the German Ministry of Public Works recently appointed a technical commission to investigate the question of the suitability of these storage battery cars for the heavy traffic prevailing in that city. The unanimous report of the commission, which has just been issued, states that accumulator traction still exhibits great imperfections, and that it requires serious deliberation both in regard to security of working and safety of the public. As far as the exercise of tractive force is concerned, the method is far behind the overhead trolley or the underground conduit system; the charging of the batteries has to be too frequently performed, and, if charged from overhead trolley wires, the method also has considerable technical difficulties. The report submits that the batteries are so heavy as to undesirably increase the weight of the tramcars, with the result that, apart from the excessive wear of the rolling-stock, the car bodies are frequently damaged, and lead to interruptions in the traffic. The accumulators are dangerous from a fire standpoint, and in winter time, when the cars are closed, the development of acid fumes is not only oppressive to passengers, but also dangerous to health. On these grounds the commission concludes that storage battery cars are not suitable for the heavy street traffic of Berlin. As a result, it has been decided by Imperial authority to gradually abandon the use of accumulator cars on the Berlin tramways, and to substitute the overhead trolley system, except in special busy sections, where the underground conduit method will be introduced. We are sure that the citizens of Berlin will benefit by the change, and we think that the Public Works Department will also find that by adopting the overhead trolley system the cost of working will decrease.

A Scale of Charges.—The Electric Lighting Committee of the parish of Fulham has recommended the Vestry to accept as their scale of charges one drawn up by their consulting engineer, Mr. Medhurst. The general principle underlying the scale is that the consumer having the best average load should receive electricity at the cheapest rate. The fault connected with it is that the reduction is made on the basis of electricity consumed per 8-c.p. lamp installed. This with anyone looking into the system as a business man, will discourage the use of electric lighting in any place where the lamps are not likely to be used regularly, as such lamps would increase the bill. It is proposed that in Fulham consumers should pay 5d. per unit until the average quantity of 12 units per 8-c.p. lamp fixed has been consumed in any year. Beyond this figure and up to an average of 18 units per lamp, 3d. per unit will be charged, and above the average of 18 units per lamp, 1d. per unit. It is also suggested that the discounts should be deducted during the last quarter of the year, so that there may be, with a good consumer, a great difference in the bills for the March quarter and the December quarter, in spite of the fact that approximately equal quantities of electrical energy are consumed. This course of giving all the reduction towards the end of the year will greatly facilitate the book-keeping and accounts, as during the earlier quarter a flat rate of 5d. per unit will obtain. We think, however, that the extra labour each quarter of working out a compound rate is quite warranted in view of the encouragement which the reductions in the March quarter would give to consumers. The scale will give a cheap supply to the inhabitants of the parish of Fulham, and its only defects are those mentioned above, of which the most important is that of discouraging the use of electric light in the private rooms over shops and in other places where a regular supply is not required. We note, by-the-bye, that the charge for each of the 80

Digitized by Google

are lamps included in the first scheme is to be £20 per annum, and these will replace 163 gas lamps.

The Ostrich.—One of the facts in natural history usually accepted is that an ostrich, when it wishes to hide itself for any reason, puts its head into the sand, and believes that because it can see nothing its large body is effectually hidden. If equal acceptance could only be given to the theory of the transmigration of souls, one would believe that a certain amount of this characteristic of the ostrich existed in the mind of the editor of the *Journal of Gas Lighting*. The characteristic in question is particularly shown in the last issue of the above-mentioned journal, in which the gas affairs at Sheffield are referred to. We gather from the report "that the gas company in that town is exceedingly well managed, and that it has developed incandescent gas lighting to its utmost limits, in that the company now maintain no less than 30,000 two-light meters, which shows that they must supply a very large number of small consumers." The editor of our contemporary adds that the success of the gas company is evidently an explanation of the fact that the Sheffield Corporation are going to light their sewage works with electricity because "there will be small demand for it in the town." Seeing that the consumption of electricity is increasing at the rate of 30 per cent. per annum in Sheffield, a remark of the above kind is distinctly out of place. The particular point, however, in this week's issue of our contemporary to which we would call attention is one respecting "The Future of Light and Power Distribution," which is said to be a "communicated article." We are not quite clear whether the editor believes that his readers are also like the ostrich, but we should have had more faith in the article in question if it had been placed on the advertisement sheets. We have a great admiration for the Westinghouse gas-engine, and also for the way in which the Westinghouse Company manage their commercial business, but we do not care to see their circulars inserted in technical journals under the heading "Communicated Article." The statements in the advertisement in question are, of course, most interesting, but they are not supported by any facts, and particularly we notice that all reference to cost of upkeep of the engines advertised is omitted.

Alloys. — Amongst the papers read at the recent meeting of the British Association at Bradford was one by Mr. F. H. Neville on the "Nature of Alloys." The paper contained an abstract of the report of the British Association Committee on the subject. Thus it was stated that most students believed that certain definite chemical compounds existed in alloys. To prove this, however, certain means must be adopted to abstract the particular compounds. Ordinary chemical means of isolation were of no use under the circumstances. Fractional solution was effective in some cases, and by means of it several distinct metal compounds had been isolated from alloys, such as platinum-tin, copper-tin, zinc-copper, and other compounds. Another method was by observation of the "freezing point"; the molten mixture was cooled down slowly, and the temperature noted at which solid matter began to separate from the liquid. This varied with the proportion of the constituents, and by making many observations with varying proportions, a curve could be obtained of these solidifying temperatures, any irregularity pointing to the formation of something other than a mere mixture. By this means many interesting facts had been indicated which had subsequently been rendered evident by examination under the microscope. Valuable and interesting results had been thus obtained, both in this country and abroad. A remarkable instance of peculiarity was exhibited by mixtures of aluminium and antimony when all the mixtures froze at a higher point than either of the components, and showed two irregularities indicative of two distinct compounds. In these mixtures it appeared that the component that predominated to a considerable extent acted as a solvent to the compound formed with the other component; but as the proportion of the other component was increased the conditions became reversed. Interesting results had been obtained by observing not only the freezing point, but also the point where the whole mass solidified, so that for every mixture the exact composition of the mass from which the compound had separated and of the separated compound was indicated. Röngten-ray photography had also been utilised to demonstrate the formation of these intermetallic compounds. A long list of known and supposed alloy compounds was given in the report, and it appeared that the atomic relations generally held by chemists did not hold in the case of alloys.

Extensions.—The question of extensions in electric lighting stations is one of the utmost importance, as it is impossible to obtain additional machinery at a few months' notice. It, therefore, behoves all engineers responsible for the supply of electric light in towns to look well ahead, and to consider not only what the demand will be each winter, but also the fact that electrical contractors are human, and that a great number of them err by promising and then not keeping up to their specified dates. We believe that if a critical examination were made of all the electric light stations in Great Britain, it would be found that the plant in them was not sufficient at the present time to provide for the winter's load after allowance is made for a reasonable amount of spare. In other words, a chance breakdown, such as cannot be foreseen and prevented even by the best of electrical engineers, may seriously hamper the continuity of supply in certain of our large towns. That this was so during last winter was proved by the lamentable number of cases in which accidents occurred, resulting in a temporary interruption in the lighting owing to the want of reserve plant. It is, of course, rather difficult to persuade the untechnical men on committees that now is the time in which to make preparations for the winter's load of 1901 and 1902. As a case in point, we would mention Gloucester electrical works, which have only recently been opened, and for which extensions were authorised before the original works were completed. We have had some cuttings from the local Press sent to us containing letters from ratepayers which complain of these extensions on the ground that the plant now installed is much more than able to supply the load at present demanded. Assuming that the figures given are correct, we quite believe that this is so at the present time. On the other hand, we should be very surprised if in the winter days the engineer at Gloucester does not need as stand-by some of the additional plant now on order. One of the curious arguments put forward in this correspondence is that the plant depreciates in value through not being used each day. The argument is that the Corporation is compelled to write off for depreciation and repayment a certain sum per annum, and the writers evidently think that the value of the plant on the books varies with this reduction, and that the market value of the plant must be the same. It would be interesting to ascertain what the gentlemen in question think the value of the plant will be when the whole of the present loans have been repaid. On the same lines it would seem that the Corporation electric lighting station would be worth absolutely nothing because it had been completely paid for, but this is not the view which is usually taken in commercial circles.

Digitized by Google

BARNSLEY ELECTRICITY SUPPLY WORKS.

Historians have told us very little of the former position held by Barnsley, from which it may be reasonably inferred that the town was of insignificant moment prior to the advent of modern industries. The origin and growth of the place may be said, with sufficient accuracy for all practical purposes, to have been contemporaneous with the opening up of the rich mineral resources of the district

Exterior View of Works, Barnsley.

In the year 1832 Barnsley could boast of but some 8,000 inhabitants, though even then considered an industrial centre of no mean importance. Apart from coal, wire drawing formerly constituted almost the entire trade of the town, but the treatment of flax, bleaching of linen yarns, weaving of linen cloth, foundry and engineering work were also carried on to varying extents, each of these several industries attaining in turn to considerable importance. Nor must the local glass industry be forgotten, Barnsley having in the past gained a high reputation for the manufacture of black glass bottles. Though several of the industries mentioned above have dwindled appreciably, some almost to extinction, the linen-weaving and engineering industries of the town still flourish.

Staff of the Works, Barnsley.

But to the opening up of the famous coal beds in the immediate neighbourhood must be ascribed Barnsley's present-day importance. The well-known Barnsley seam alone averages from 8ft. to 9ft. in thickness, and yields the best steam and house coal in the world. There are also other seams, such as the Silkstone, the Thorncliffe, and Parkgate, which yield both house coal and gas coal in enormous quantities annually. Besides its ample supply of fuel from local sources, the town is well situated for trade generally, and enjoys the advantage of canal navigation, thus being exceptionally favoured as an industrial centre. Strange to say, the country around is also remarkably fertile, its wheat-growing capabilities being famous. From its open position the town has acquired the name "bleak Barnsley"—not "'black' Barnsley," as usually represented, though the latter designation is certainly equally appropriate.

Following the good example set by many other Yorkshire towns, Barnsley has not been slow to avail itself of the advantages to be derived from the practical application of modern science. One of the most recent examples of the town's enterprise is the Corporation electricity works, a supply from which was inaugurated in February of the present year. Before describing these works in detail a few notes

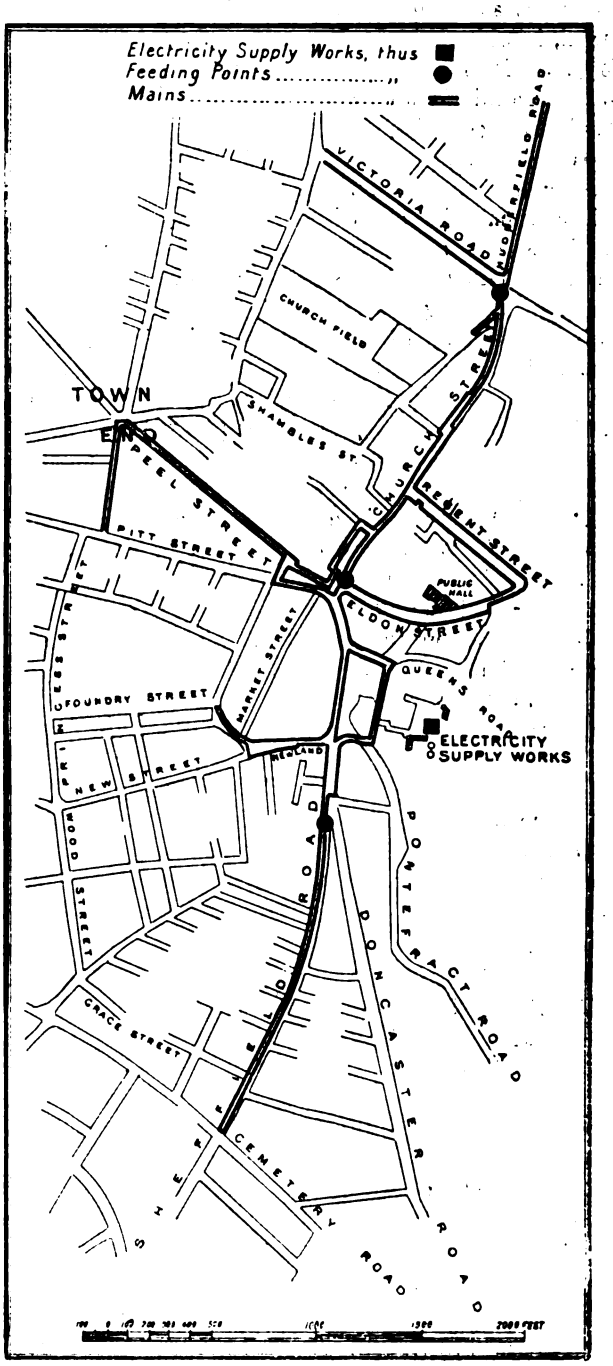
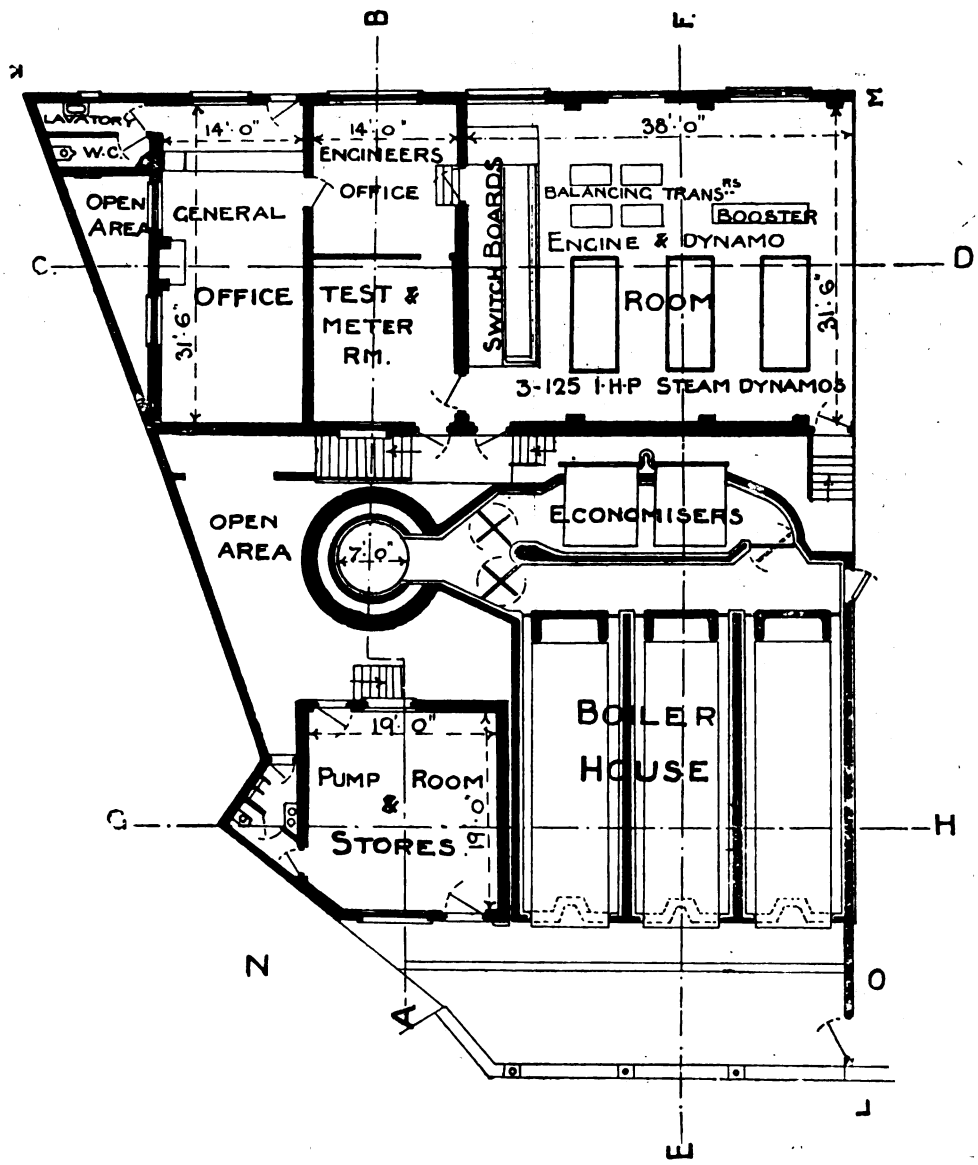


FIG. 1.—Map of Mains, Barnsley.

upon the history of the undertaking may be given. In this connection it should be mentioned that for the last 50 years Barnsley has been lighted by means of coal gas manufactured and supplied by the Barnsley Gas Company, whose works were constructed partly by the late Mr. Thomas Hawksley and partly by the late Mr. John Hutchinson and his son, Mr. Walter Hutchinson. But despite the proximity of Barnsley to the above-mentioned source of excellent gas coal, the price of gas as supplied by the Barnsley Gas Company ranges from 3s. 4d. as a maximum to 2s. 10d. as a minimum, subject in prosperous times to a deduction varying from 2½ to 7½ per cent. In justice to the policy of the gas company in charging these

Digitized by Google

high rates, it should be mentioned that the serious leakages from the gas-mains and services caused by broken and drawn joints, owing to the subsidences of the land from the colliery workings, no doubt heavily handicaps their undertaking. In consequence of the prevailing high price of gas, agitations have arisen at various times during the past 20 or 30 years to induce the local authority, formerly the Local Board, now the Barnsley Corporation, to purchase outright the gas company's undertaking with a view to endeavouring to produce and sell gas at a much lower rate than the company do. Nothing, however, so far as the gas supply is immediately concerned has yet come of these efforts, and the result is that the Barnsley Gas Company still flourishes, although the Corporation have at last established an electric lighting



GROUND PLAN

FIG. 2.—Ground Plan of Station Buildings, Barnsley.

plant not only to compete with the gas company, but to supply a light which many people prefer to that yielded by coal gas. As far back as 1882 the Corporation of Barnsley, partly with a view of influencing the gas company to be more liberal by selling gas at a lower price, and partly with the object of ascertaining how far the electric light would be suitable for street-lighting, made an arrangement with the Brush Electric Light Company to run a number of arc lamps in the streets for 22 nights. This experiment was carried out at a cost to the Corporation of £75 The result, however, was not satisfactory, the old arc lamps flickering and sometimes going out, and not being anything like so steady as was expected. The result was that when the arc lamps went out the shareholders in the gas company were jubilant, and when they were brilliant and steady the spirits of those same shareholders descended to so low an ebb that some of them sold their shares, believing the days of coal gas to be at an end.

However, from the year 1882 to the year 1888 no further progress was made in Barnsley towards the establishment of electric light, but between the years 1889 and 1892 no less than five reports were presented to the Council by Mr. J. Henry Taylor, M.I.C.E, the present borough surveyor, each of which was endorsed and approved by the Council, and it was duly recommended that the electric light be installed within the borough. The first report was practically an elementary treatise upon electricity and electric lighting for the instruction really of anyone interested at that time in electric lighting, but the later reports were of a more intricate and advanced character, going into estimates of probable capital outlay, revenue, and working costs, etc. The result of these reports was that in 1890 the Corporation, assisted by Mr. A. Bromley Holmes, of Liverpool, the late Dr. John Hopkinson, of Westminster, and the borough surveyor (Mr. Taylor) obtained a provisional order for electric lighting within the borough of Barnsley, and immediately afterwards invitations were issued to several companies to send in proposals for the erection of plant, laying of mains, and the running of an electric light station for the town and district. Proposals or tenders were received from the following firms—viz, New Gulcher Company, Manchester Edison-Swan Company, Messrs. Laing, Wharton, and Down, National Electric Supply Company, and the Westinghouse Electric Company. Advised by Mr. Bromley Holmes, the Council decided to accept the tender of the Westinghouse Electric Company

Digitized by Google

for the installation of a plant and the laying of the necessary mains, for the sum of £17,800; the buildings being estimated to cost a further £5,000, making a total estimated expenditure of about £23,000. Unfortunately, about this time financial troubles developed in the United States, where the Westinghouse Company's works were chiefly established, and this company were forced to withdraw their tender, leaving the Corporation again without any immediate prospect of having an electricity supply

S. E. BASTOW.

established. In order, however, to keep up the good feeling towards the electric lighting of the town, and to obtain further information, the Park and Lighting Committee visited various towns in the United Kingdom which had already adopted electric lighting, in the years 1891 and 1892, and presented further reports to the Council. As a result, the Town Council in 1898 appointed Mr. A. Bromley Holmes, M.I.C.E., and Mr. Thomas L. Miller, M.I.C.E., joint engineers to report upon a scheme of electric lighting for the town, but Mr. Bromley Holmes having just then been appointed chief electrical engineer to the Liverpool Corporation, and being practically debarred thereby from private practice, the work thus devolved upon Mr. Miller, who in March of the same year reported in favour of a three-wire direct-current system, with a pressure at consumers' terminals of 230 volts, the estimated capital cost for the establishment of a plant with cables complete for 6,000 8-c.p. lamps, including £3,000 for buildings, being £23,322. 15s., which in the application to the Local Government Board was increased to £25,000. The report being accepted, tenders were invited to the specifications of Mr. Miller for the plant, machinery, and foundations, and Mr. Taylor for the buildings, contracts for the work being placed as follows:

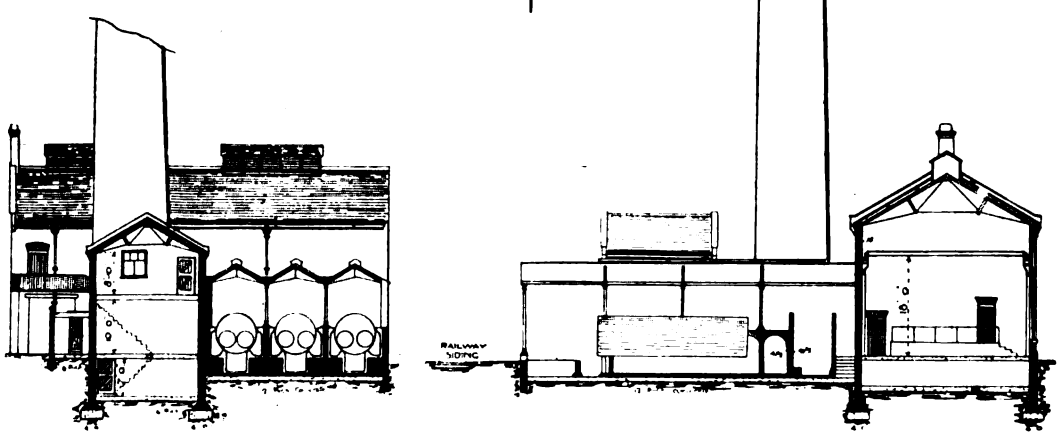
W. Arnold and Co., boiler-house plant	£3,260	0	0
Johnson and Phillips, electrical equipment	7,770	0	0
Pritchett and Gold, batteries	1,319	0	0
British Insulated Wire Company, mains	6,322	4	2
James K. Taylor and Sons and George Mellor respectively, buildings and chimney	3,080	19	8

which, with £1,442. 1s. 2d. for meters, indicators, and engineer's fees, amounts to £23,194. 5s., or £128. 10s. below the original estimate.

Owing, however, to the numerous applications for supply from the time of the commencement of the works to the spring of last year, it was decided in July, 1899, to extend the generating plant and make application to the Local Government Board for sanction to expend a further sum of £3,000, making £28,000 in all, and a supplementary order was placed with Messrs. Johnson and Phillips for a 150-kw. steam dynamo, the cost of which, including foundations, extensions to piping and switchboard, and engineer's fees, amounted to £2,342. 11s. In addition to this, the mains were extended at a cost of £130. 17s. 7d. The accepted tenders for the original scheme and extensions, excluding buildings, amounted to £21,533. 1s. 9d., but the final accounts, including all extras, amounted to but £21,531. 9s. 9d., or £1. 12s. less than the tenders originally accepted. The total cost of the works, including buildings, engineer's fees, etc., has been £26,552. 1s., or £70 78 per kilowatt installed. Regular supply was commenced in February of the present year, and on July 18 last the number of consumers on the books stood at 121, with an aggregate of 8,342 lamps of 8 c.p. or their equivalent connected to the mains.

Most, if not all, of the members of the Council who in years gone by fought and worked hard to get the electric light introduced into the town have passed out of the Council, notably ex-Alderman Blackburn and ex-Councillor Isaac Haigh, who both took a very active and intelligent part in advocating the introduction of the new light. It should be a great satisfaction to them to know that chiefly through their labours the electric light has at last become a reality in the town. The constitution of the present Parks and Lighting Committee is as follows: Councillor Walter Brady, J.P. (chairman), Aldermen T. Wilkinson, J.P. (mayor), C. Wray, J.P., W. Holden, Councillors W. Atkinson, W. H. Carter, J. Charlesworth, W. Foulstowe, R. W. Maddison, and J. S. Rose. Mr. Henry Horsfield is the town clerk.

As has already been mentioned, the constructive electrical engineer to whose plans and specifications the works have been equipped throughout has been Mr. Thomas L. Miller, M.I.C.E., of Liverpool, while the architect for the buildings was Mr. J. Henry Taylor, M.I.C.E., the borough surveyor.



SECTION ON LINE C.H. SECTION ON LINE E.F.

FIG. 3.—Section of Station Buildings, Barnsley.

Digitized by Google

The borough electrical engineer, who acted as resident engineer during the construction of the works, is Mr. Stephen E. Bastow, his chief assistant being Mr. E. A. Barker. Under the able management of Mr. Bastow the undertaking has continued to make rapid progress, and bids fair to become a complete financial success, besides being a benefit to the town in other respects. With regard to the possibilities of the undertaking, it may be mentioned that Barnsley possesses some 42,000 inhabitants, the area and ratable value of the town being respectively 2,386 acres and £88,000. The compulsory area of supply comprises some three miles of streets, constituting what is practically the centre of the town. A good field is offered for motors, the linen mills in the town being large users of power. We understand there is probability of two large mills connecting up to the Corporation's supply mains, an aggregate of upwards of 200 h.p. in motors being in prospect. The policy of the Corporation has been to anticipate the demand by extending the supply mains to probable large consumers of power. The shops, hotels, and private residents are availing themselves of the supply freely. Further, there is every prospect of a traction load being added at no very distant date. Some months ago the Corporation entered into an agreement with the British Electric Traction Company, whereby the latter are to construct tramways in the town within the period of three years, the Corporation to have the option of purchasing the same after 12 months' working. The proposed lines aggregate a length of about five miles. The agreement with the British Electric Company further provides that the necessary energy for working the lines shall be taken from the Corporation, a minimum consumption of 200,000 units per annum to be charged at the rate of 1½d. per unit, with a reduction of ·1 of a penny for every additional 75,000 units consumed. In anticipation of this load, traction type generators have been put down, which serve, meanwhile, for the ordinary requirements of the supply. A small scheme of public street-lighting by means of arc and incandescent lamps has already been adopted. This provides for 15 arc and 30 incandescent lamps, but represents only a small portion of the street-lighting scheme to which it is ultimately proposed to give effect. The present street-lighting by means of gas is managed by the Corporation so far as lamps, mains, and general supervision are concerned, the lamp standards, mains, and accessories being Corporation property. The necessary supply of gas is, however, obtained from the gas company. Electrical energy for lighting purposes is supplied to the ordinary consumer on Wright's maximum demand system, 7d. being charged per unit for the first hour and 3d. afterwards, while to consumers taking more than 10,000 units per annum a preferential rate of 7d. and 2d. is conceded. For power 2d. per unit is charged.

The site upon which the works stand was formerly a part of the manor of Barnsley, and was recently purchased from Sir Hickman Beckett Bacon, Bart., and others, for the purposes of a highways and waterworks depot, and for market accommodation. As will be seen from the accompanying map of the main (Fig. 1), its situation relative to the area of supply is very central. Apart from the latter advantage, the facilities which the site offers for economically coaling the station are also good, a coal siding from the Great Central main line hard by running right into the station yard. There are collieries within a mile of the station, but the present supply is obtained from pits situated at a distance of about three miles. With the coal trade in its normal condition we understand that suitable coal may be obtained at the pit's mouth at from 4s. to 4s. 6d. per ton, but the prevailing abnormal conditions have involved such an advance of prices even at this great centre of supply that 10s. per ton delivered at the works was the rate charged at the time of our visit some months ago, though doubtless local prices have suffered still further increase since then. Compared with prices ruling elsewhere, the price mentioned is, of course, extremely moderate; but, on the other hand, very high when local conditions are taken into consideration. The site of the station, in fact, is situated right over a coalfield, and surface coal was actually met with in excavating for the chimney shaft, while there is any amount of the commodity lower down. Not many stations enjoy such close proximity to a possible source of coal supply. In the event of a serious coal strike and consequent shortage of the supply, it seems quite within the realms of possibility

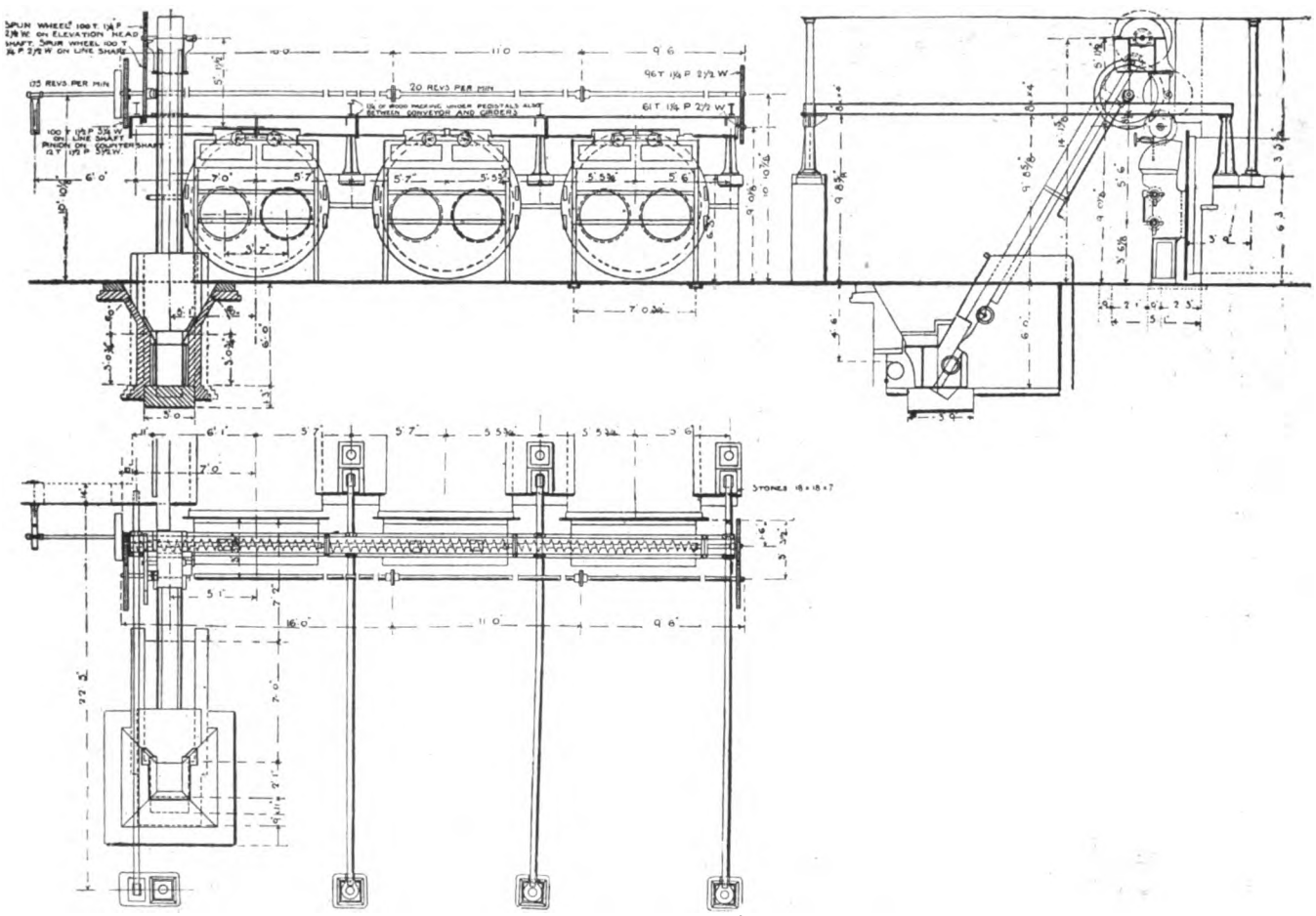


FIG. 4.—Arrangement of Coal Elevators and Conveyors, Barnsley

Digitized by Google

that the station's depleted bunkers might be replenished from the resources of the site, though it would present a curious spectacle to see the staff busily engaged in winning fuel for the immediate requirements of the station. As a set off against the advantages enumerated above, it must be mentioned that no water for condensing purposes is available upon the site selected—a serious drawback to a modern plant of considerable capacity.

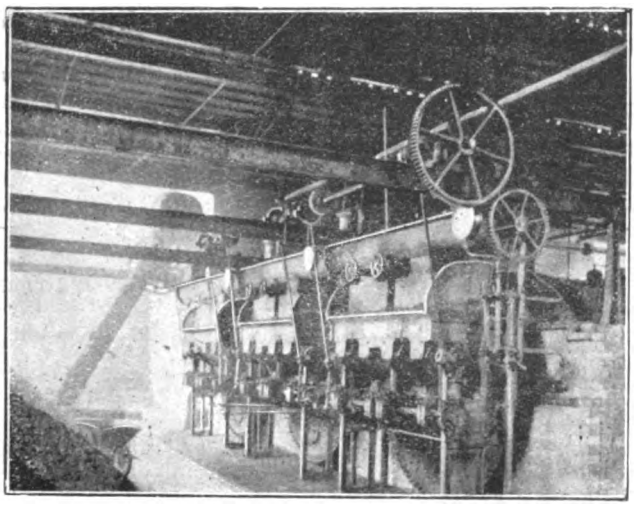


FIG. 5.—View of Boilers fitted with Mechanical Stokers, Barnsley.

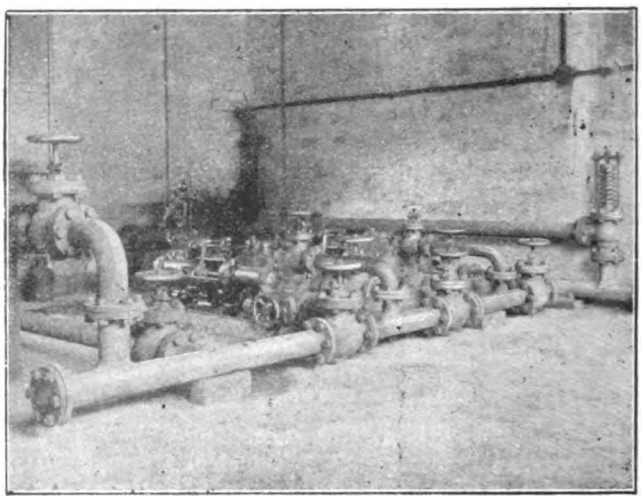


FIG. 6.—Interior of Pump Room, Barnsley.

The generating station buildings comprise a commodious engine and dynamo room, boiler-house, test and meter room, accumulator-room, pump-room and stores, engineer's office, and the usual general offices, etc. For the principal dimensions of these several departments we would refer the reader to the accompanying ground plan and sections (Figs. 2 and 3). The chimney shaft, better shown in the latter figure, has a height of 150ft, and an internal diameter at the base of 7ft. The foundations are of concrete, no piling being used. Great compactness, as will be seen, characterises the general design of the buildings, which are in every way eminently adapted to their purpose, the general arrangement adopted being calculated, moreover, to afford the maximum facilities for future extensions.

The boiler-house equipment includes at present three Lancashire boilers designed for a working pressure of 160lb. per square inch. Each boiler is 28ft. long and 7ft. 6in. diameter inside the outer ring of plates, and possesses two flues, each 3ft. diameter at the furnace end, tapering to 2ft. 6in. diameter at the back end, each flue being fitted with four conical cross tubes. The boiler mountings are of Hopkinson's make throughout. Before leaving the contractor's works each boiler was subjected to a pressure test of 260lb. per square inch. Mechanical means are provided for firing the boiler furnaces in the form of Vicar's mechanical stokers, driven by an 8-h.p. electromotor. The details of the system of elevators and conveyors, with the gearing necessary for driving the same, are shown in Fig. 4, while in a reproduction of a photograph of the apparatus in position (Fig. 5) the mechanically-fed hoppers of the stokers are also shown. The gear is capable of serving six boilers similar to the ones now installed. The coal store is situated immediately in front of the boilers, and, as required, a supply of the fuel is fed into the elevator pit (shown in Fig. 4), from which the buckets of the elevator raise it to the conveyor, which latter in its turn feeds the hoppers of the mechanical stokers. Simplicity and efficiency characterise the arrangement, which ensures minimum labour in handling the coal after it has been unloaded from the coal trucks into the coal store. One of Green's patent fuel economisers is provided in a by-pass of the main flue, as shown in Fig. 2. This economiser, which

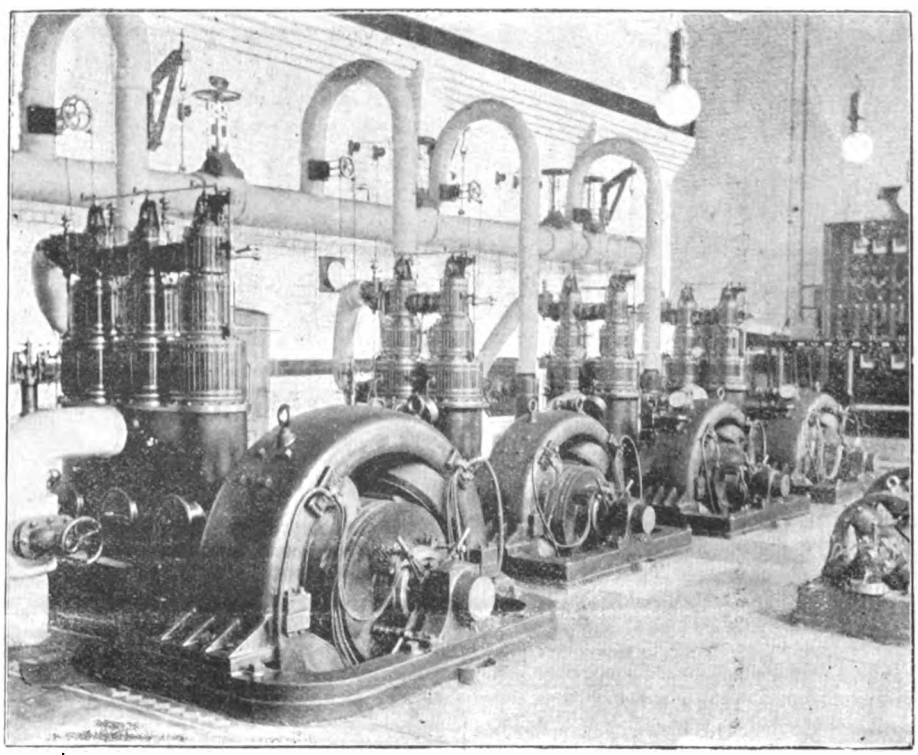


FIG. 7.—Engine and Dynamo Room, Barnsley.

Digitized by Google

is designed for a working pressure of 160lb. per square inch, consists of 192 tubes, each 9ft. long and about 4in. diameter inside. The scrapers are driven by an electromotor. Wing dampers and dampers in the flues serve to direct the waste gases from the boiler furnaces either through the economiser or to the chimney direct. The boiler feed pumps, situated as shown in Fig. 2, are of the Worthington type and make, and two in number. Each is capable of delivering 1,500 gallons of water per hour against the full boiler pressure of 160lb. per square inch. The feed pumps (Fig. 6) are arranged to draw from the hot-well, a separate suction pipe being used for each pump, with connections to either the feed tank or the low-pressure water-main. The delivery pipes are arranged so that the discharge from either pump may be taken direct through feed-water heater, and thence through the economiser to the boilers, or else through the heater and direct to the boilers, or past both the heater and economiser direct to the boilers. A Kennedy water-meter, reading to 10 gallons, is fixed in the line of delivery pipes to the heater, which latter is by Royles, of Manchester, and capable of raising the temperature of 2,000 gallons of water per hour from 55deg F. to 200deg. F. It may also be mentioned that the feed pumps are arranged to take steam from either side of the main range of steam-piping, and to exhaust into the main exhaust pipe to atmosphere, and provide a duplicate feed.

With regard to the steam-piping, a "ring" system with isolating valves has been provided. The pipes in the main ring are 8in. in diameter, being slung from the engine-room and boiler-house walls by means of rods and slings, as shown in Fig. 7. Hopkinson's isolating valves are employed. The main exhaust pipe, of cast iron, is 16in. in diameter, and arranged to lie in a chase formed at the side of the engine foundation. This pipe is connected to the heater above mentioned, and arranged with a by-pass, so that the exhaust steam may be taken through the heater, or direct to the atmosphere, the heater in the latter case being cut out. The clear-water drains from the steam-pipes, etc., are taken to a brick feed tank situated at the side of the chimney shaft, and from which the feed-pump supply is drawn. This tank, it may be mentioned, is covered in and provided with a duplicate supply from the Corporation mains.

We now come to the engine-room equipment, which includes three steam-driven 75-kw. sets, besides the 150-kw. extension set previously mentioned. The engines

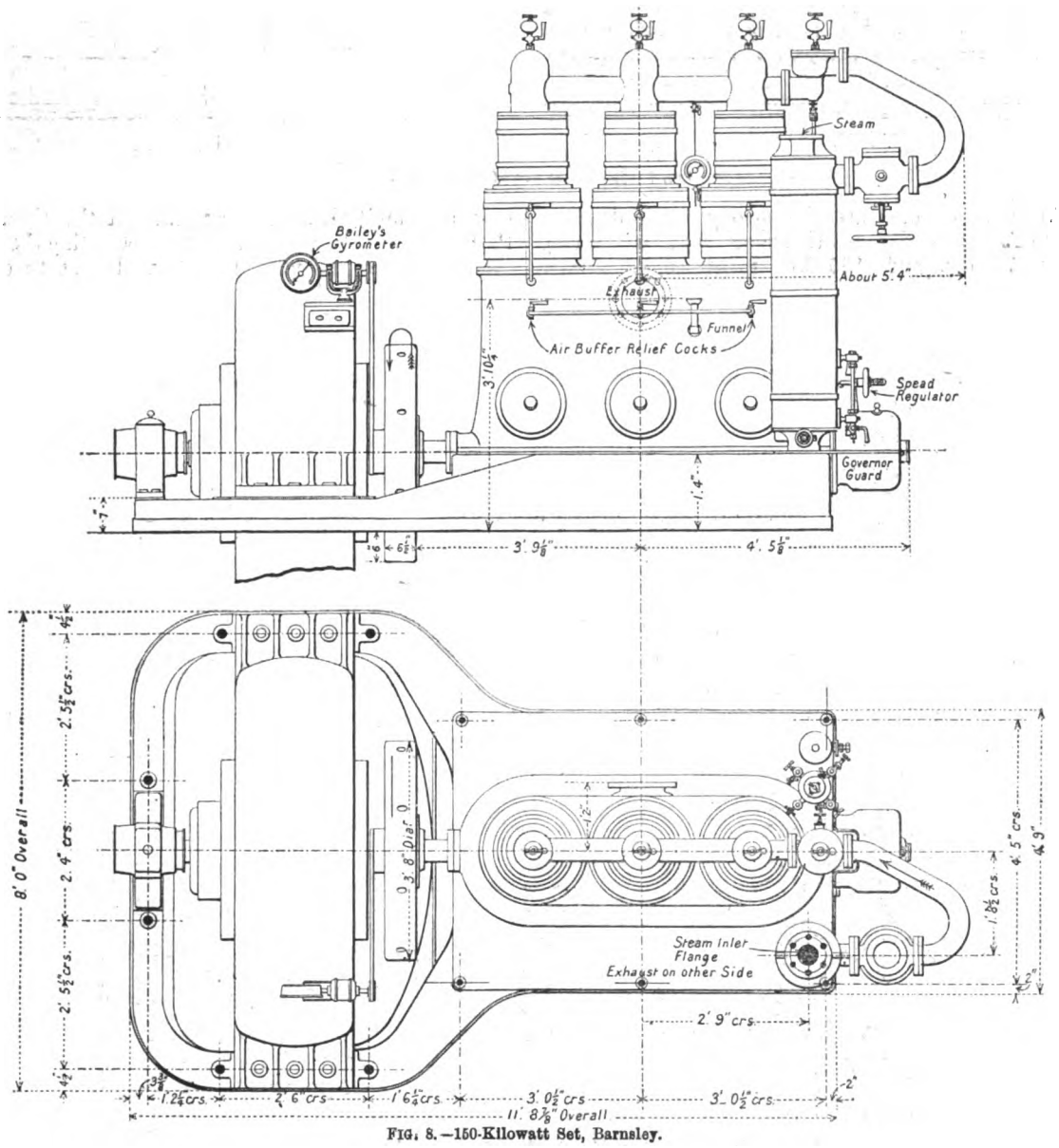


FIG. 8.—150-Kilowatt Set, Barnsley.

driving the 75-kw. generators are of the Willans compound non-condensing type, indicating 100 b.h.p. each when running at 450 revolutions per minute with a steam pressure of 150lb. at the stop valve. They are fitted with automatic expansion gear for regulating the cut-off when running on the anticipated tramway load, and further specially strengthened in order to better adapt them for supplying energy for tramway purposes. Corresponding parts of the engines are interchangeable, the great advantage of which arrangement has been practically illustrated in scores of cases. It was specified that the water consumption of each of these engines at full load should not exceed 26lb. per brake horse-power per hour.

The larger engine is of what is known as Willan's 3 H/s size. It indicates 250 h.p. when running at 380 revolutions per minute with a steam pressure of 150lb. at the stop valve. This engine has also

Digitized by Google

been fitted with automatic expansion gear, and will be used for driving the trams. Fig. 8 shows a plan and elevation of this set, with the principal dimensions. All four engines are direct-coupled to Johnson and Phillips's multipolar traction-type dynamos, giving outputs of 75 kw. and 155 kw. respectively. These dynamos, as will be seen on referring to Fig. 7, are four-polar, and each is arranged to stand on the same bed-plate as the engine driving it. Being required for traction work the machines are, of course, shunt-wound, and have drum armatures. Each of the smaller machines is capable of an output of 75 kw. at an E.M.F. of 460 volts, and is wound to give any E.M.F. between 460 and 520 volts when running at the specified speed of 450 revolutions per minute, the regulation being effected by means of resistance coils and multiple-contact switches in the shunt circuit. Particular attention was given in constructing the armature, the parts being specially strengthened so as to enable the armature to better withstand the stresses brought to bear on the dynamo when used for supplying energy for tramway purposes. It was specified that the temperature of any accessible part of the dynamo should not rise above 60deg. F. above the temperature of the surrounding atmosphere during a six hours' continuous run at full

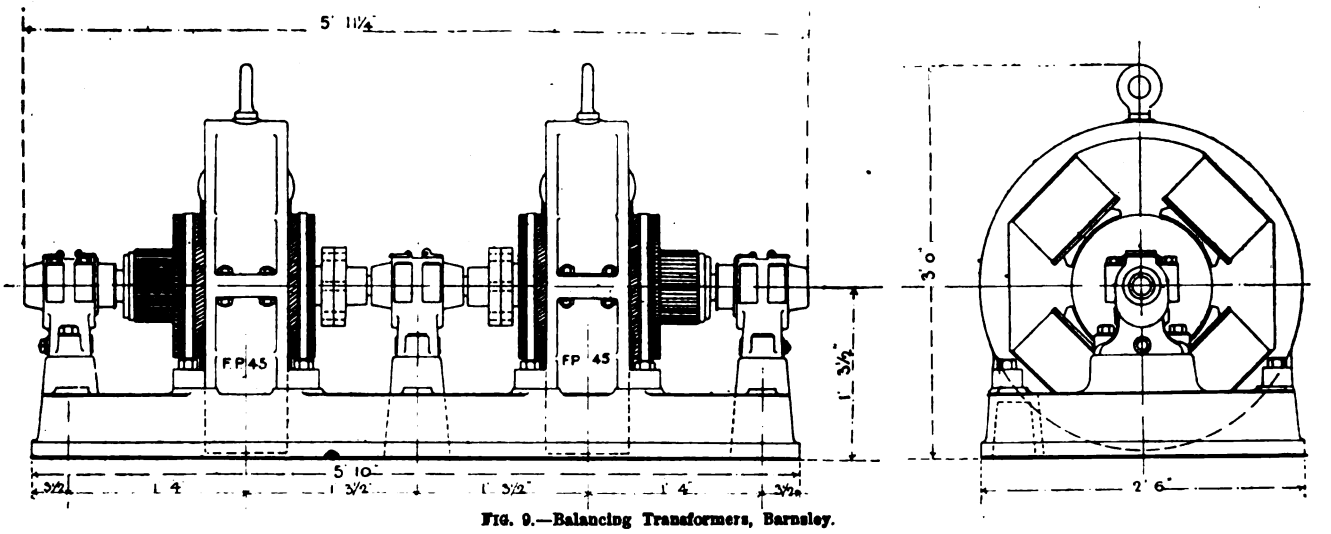


FIG. 9.—Balancing Transformers, Barnsley.

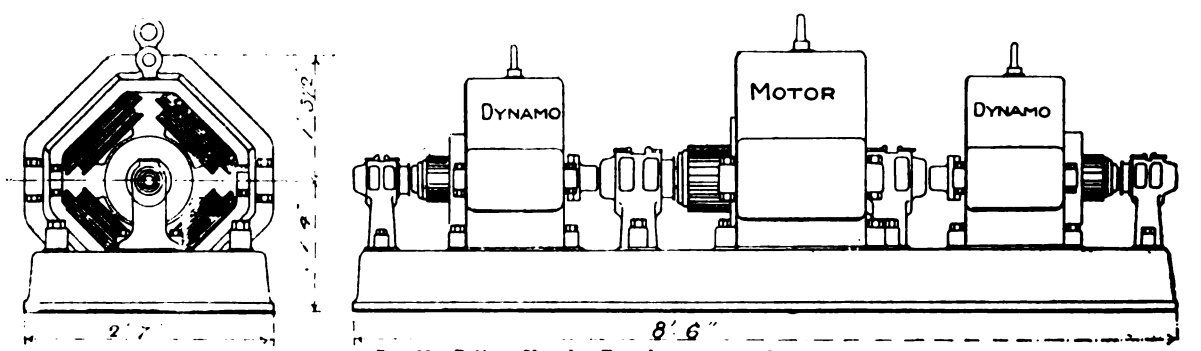


FIG. 10.—Battery Charging Transformers, Barnsley.

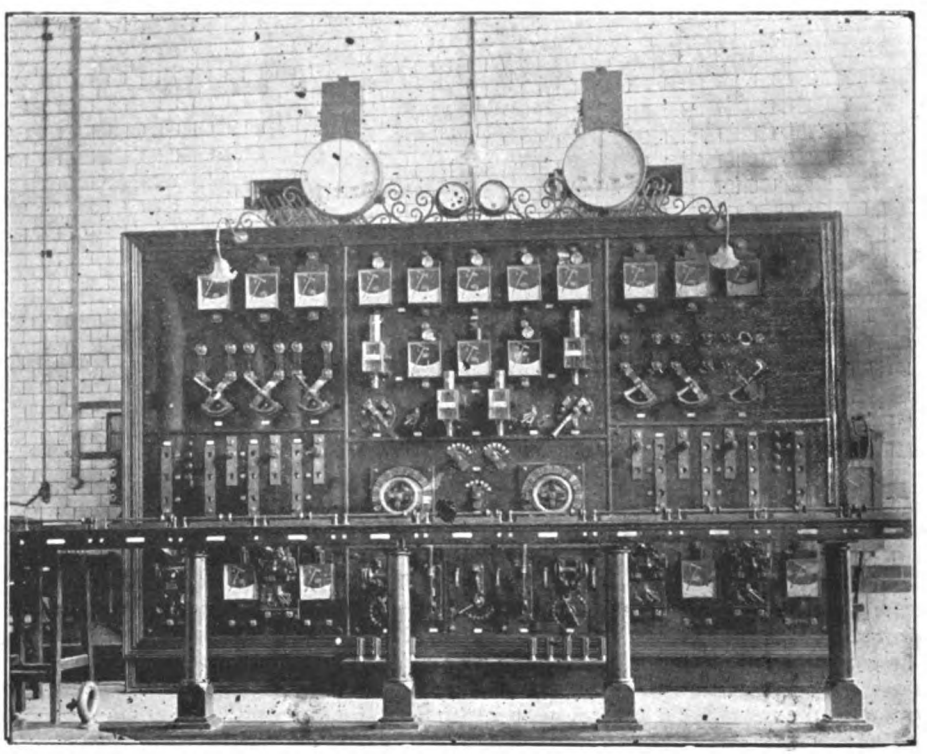


FIG. 11.—Switchboard, Barnsley.

Digitized by Google

load; also, that the combined efficiency of each set, or the ratio of the electrical horse-power at the dynamo terminals to the indicated horse-power developed by the driving engine, should not be less than 81 per cent. The engine-room equipment also includes two balancing transformers. As shown in Fig. 9, each of these transformers consist of two balancing armatures directly connected and working in separate fields. The transformers are connected across the outer mains of the three-wire system at the switch-board omnibus bars, and also to the middle wire. These balancers are each capable of balancing the whole system at any load, so that when there is a current of 75 amperes in either direction in the middle wire, the difference of E.M.F. at the feeding points between the two sides of the system shall not exceed four volts. Two battery-charging transformers or boosters (Fig. 10) are further provided, each of which is capable of an output of 130 amperes at 75 volts. These boosters are designed and arranged to give an E.M.F. of from 10 to 75 volts on open circuit, and also to be capable of running with any current from 0 to 130 amperes at any pressure up to 75 volts. The arrangement of the plant in the station in shown in Fig. 2, except the 155-kw. extension set, which latter is, however, shown in the foreground in Fig. 7.

The switchboard, which was supplied by Messrs. Johnson and Phillips, is erected upon a platform, as shown in Figs. 7 and 11. It is arranged for the connection of four dynamos, four feeders, two batteries, two balancing transformers, and two boosters. The middle wires from the feeder points are brought back and connected in parallel at the station, one middle wire connection only being made on the switchboard. The board consists of three slate panels carried in iron frames and neatly cased on the outside with varnished teak. The instruments and apparatus in connection with the batteries, the balancing transformers, and the boosters are arranged on the centre panel, together with the voltmeters and their switches, while the instruments and apparatus on the negative side of the dynamos and feeders are arranged on the right-hand panel, and those on the positive side on the left-hand panel. Connections to the dynamos are taken from the bottom of the board, and the connections to the feeders from the top of the board. It will be unnecessary to enumerate in detail the instruments, etc., in the circuit of each dynamo and feeder. Ample provision for the future extension of the board has been made, and also for putting the same in connection with the traction switchboard yet to be installed. The centre panel is provided with a battery emergency switch for cutting the battery out of circuit if required. A single-pole throw-over switch enables the battery to be placed either on to the booster circuit to be charged, or on to the mains, as may be required. All resistance coils are placed below the switchboard platform. The switchboard connections are clearly shown in Fig. 12. Before leaving the engine and dynamo room brief mention may be made of the overhead travelling crane, which is capable of lifting eight tons as the ordinary working load. All motions are worked from the ground by means of ropes. A specially

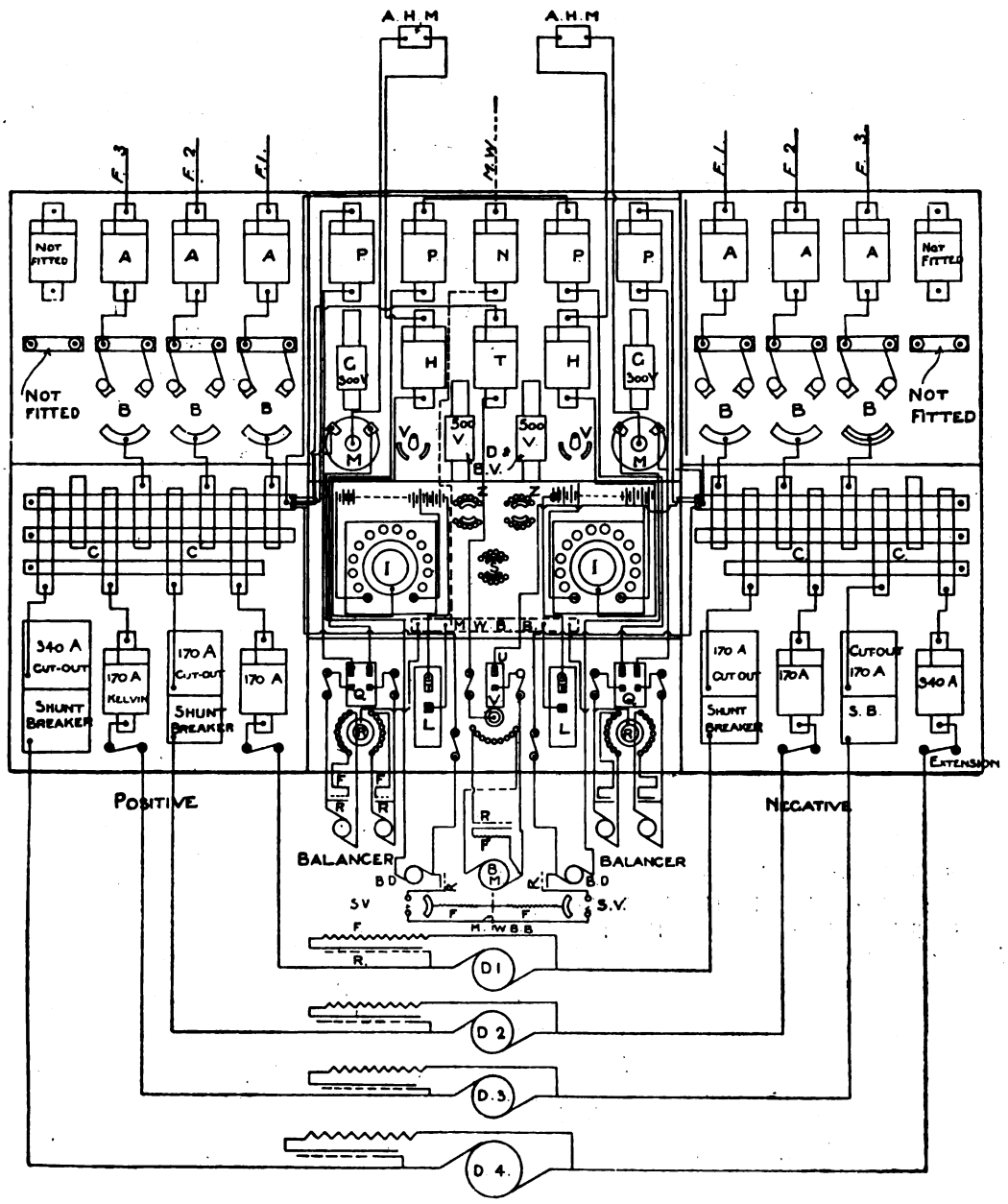


Fig 12.—Diagram of Switchboard Connections, Barnsley.

Digitized by Google

quick lift is provided for loads of one ton and under. The artificial lighting of the engine and dynamo room is provided by Lunar arc lamps.

With reference to the accumulators, it may be mentioned that these were supplied by Messrs. Pritchetts and Gold. The battery (Fig. 13) consists of 260 cells in glass boxes, each cell containing 23 plates, 9in. by 9½in., the positives being ⅛in. and the negatives ⅛in. thick. Both positive and negative plates were formed by the Planté process, and are of the make'rs standard type. The battery is divided into two halves for feeding the three-wire system, and the capacity is 500 ampere-hours at 100 amperes discharge, and 300 ampere-hours at 300 amperes discharge, the E.M.F. per cell at the end of either discharge being not less than 1·86 volts. The cells are mounted on wood trays with oil insulators, and are erected on substantial wood stands in two tiers. The connections between the rows and tiers and between the battery and regulating switches are made with bare copper rod supported on porcelain insulators.

There now remains only the distributing network of mains to deal with. This, together with the feeders, is on the three-wire single-cable system. The whole of the cables were manufactured by the British Insulated Wire Company, and are of their paper-insulated lead-covered type, laid in earthenware troughs filled in solid with bitumen. Three sets of feeders—·5 square inch, ·2 square inch, and ·5 square inch section—leave the electricity

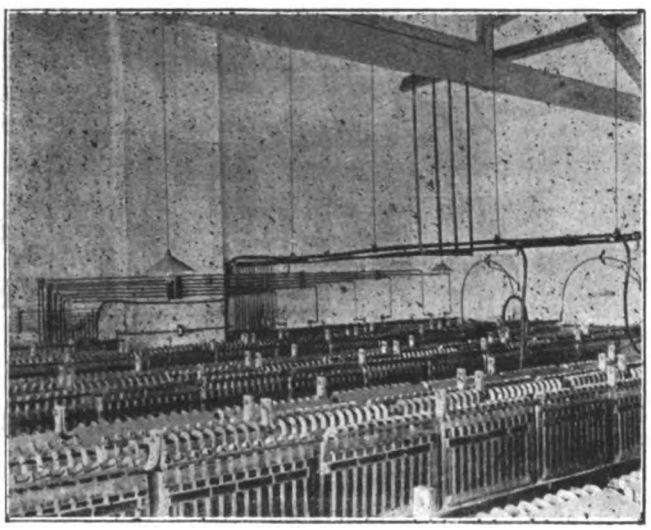


FIG. 13.—Battery-Room, Barnsley.

works, and supply feeding points in Huddersfield-road, Market-hill, and Sheffield-road, as shown in Fig. 1. To each of these feeding points a three-core pressure cable is laid along with the feeders from the station switchboard. The distributing cables are of

(·25 ·15 ·25) (·15 ·10 ·15) (·10 ·06 ·10) square inch section, and supply approximately six miles of streets. Cast-iron junction boxes, placed in brick inspection pits, are spaced over the area of supply, and the distributing network is so arranged as to allow of ample extension. House services, laid on the British Insulated Wire Company's solid system, are connected to the distributor cables by means of special boxes having glands cast to fit into the earthenware troughs.

The street-lighting immediately provided for consists of 15 10-ampere arcs and 30 16-c.p. incandescents, the latter being attached to the arc lamp-posts in pairs. The arcs are to be connected four in series across the outers of the three-wire system. Messrs. Crompton and Co. have secured the order for these lamps. It is proposed to largely extend the system of street-lighting by means of arcs and incandescent lamps at some future date.

It will have been gathered from the above that Barnsley has obtained a very compact and efficient plant at a cost per kilowatt installed which, having regard to the thorough manner in which the work has been done throughout, and the ample provision made for future developments of the undertaking, must be adjudged moderate. Great forethought is evidenced by the design of the station, whereby a plant has been secured which will serve to suit equally well the requirements of a lighting, traction, or ordinary power load.

In conclusion, we have to thank the consulting engineer, Mr. Thomas L. Miller, for his courtesy in according us facilities for collecting most of the information given above.

THE ELECTRIC LIGHTING OF THE CITY OF GLASGOW.

Like London, Glasgow was the scene of some very early attempts at electric lighting. The first one was the lighting of Hengler's Circus by means of the Jablochkoff candle, but the writer cannot fix the date. The next attempt was in 1879, when the British Electric Company illuminated St. Enoch Station with arc lamps, using Gramme dynamos, and Messrs. Crompton and Co., who, about the same time, installed the electric lighting plant in the Queen-street Station of the North British Railway Company. It must be very gratifying to Messrs. Crompton to see their latest type 750-kw. 12-pole dynamos in the new station, in view of the machines which for so many years did such satisfactory work, although built over 20 years ago, in the days when the magnetic principles of dynamo design were not by any means well understood.

About the same time that Messrs. Crompton erected the Queen-street Station plant, Messrs. Muir and Mavor laid down a temporary plant to supply electrical energy for lighting Glasgow Post Office, which was the first post office in the kingdom to be lighted by electricity. Eight years later Messrs. Muir, Mavor, and Coulson proceeded to lay down a high-tension alternate-current system, 2,400 volts, with transformers on consumers' premises transforming to the then orthodox pressure of 100 volts. Seeing the possibilities of electricity supply in Glasgow, Messrs. Muir, Mavor, and Coulson applied for a provisional order for electric lighting, so also did the Corporation, and eventually the private company withdrew in favour of the civic authorities, who afterwards purchased the company's undertaking for £15,000. A remarkable feature about the private company's system was their early recognition of the value of the maximum demand method of charging for energy, the charge being a fixed sum per unit with discounts as the consumption exceeded 300, 500, 1,000 or 1,500 hours maximum demand per annum.

On March 1, 1892, the municipality took possession of the company's undertaking, but as the Board of Trade would not permit the supply of electrical energy by means of overhead cables beyond August, 1893, the city authorities had to lose no time in getting their new station in working order. Acting on the advice of Lord Kelvin, a three-wire low-pressure continuous-current system was adopted, and Prof. A. B. W. Kennedy was appointed consulting engineer to prepare a general scheme. The result was the Waterloo-street station equipped with dry-back marine-type boilers, Willans engines, and Latimer Clark and Crompton dynamos, with a separate street-lighting plant consisting of belt-driven Brush arc-lighting dynamos. All this time the electricity undertaking was managed by the gas engineer, Mr. Wm. Foulis, M.I.C.E., with Mr. Wm. Arnot acting as resident engineer. In 1896, however, the city authorities saw that, to enable the natural process of evolution to take place, the electricity undertaking should be independent of the gas department. Development was now more rapid, and it soon became apparent that greater feeder capacity would be as necessary as generator capacity. To improve the load factor of the station, and relieve the feeders during the hours of maximum demand, two temporary accumulator sub-stations were placed at almost the two extreme ends of the distributing system; these were charged during the early hours of the morning or middle day, and discharged at the peak of the load, a plan which worked well for quite a long time. Meanwhile the committee, advised by their engineer (Mr. Wm. Arnot, M.I.C.E.), turned their attention to the acquisition of sites for two new generating stations, one on the north and the other on the south side of the city, and arrangements were made to erect the necessary build-

Digitized by Google

ings. About this time Mr. Arnot resigned to carry on business as a consulting engineer, and a few months later Mr. W. A. Chamen, of Messrs. Crompton and Co., was appointed resident electrical engineer, and the construction of the new stations pushed rapidly forward under his able supervision.

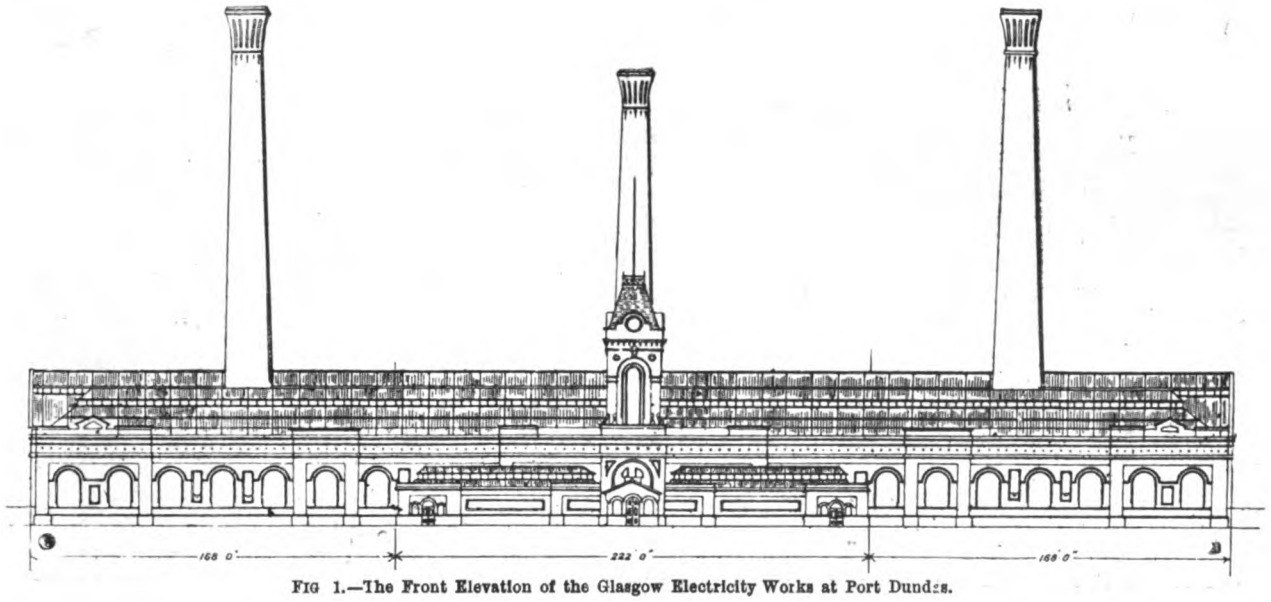


FIG 1.—The Front Elevation of the Glasgow Electricity Works at Port Dundas.

The practical results are seen in the stations which were formally opened on Thursday week, when a distinguished company, including Lord Provost Chisholm, Lord Overtoun, Sir Charles Cameron, M.P., Sir Wm. Arrol, M.P., Mr. David Cooper (manager, Glasgow and South-Western Railway), Mr. John Mathieson (chief commissioner of Victorian Railways), Bailie MacKenzie (chairman of Edinburgh Electric Lighting Committee), Prof. Andrew Gray, Prof. Archibald Barr, Dr. J. T. Bottomley, Mr. Wm. Beardmore (of Parkhead Rolling Mills), and 130 other gentlemen, attended the opening function. The party drove from the municipal buildings to Port Dundas station, where they were received by Bailie Maclay, who in a short speech welcomed the party in the name of the Electricity Committee. Mr. Porter, the building contractor, then presented the Lord Provost with a gold key, and his Lordship, having unlocked the door, declared the works open, and in a short speech congratulated the Electricity Committee on the successful outcome of their exertions.

After having inspected the engine and boiler rooms, the party re-entered the carriages and drove to the south side station at St. Andrew's Cross, where Bailie Maclay performed the opening ceremony with a gold key, presented by Mr. Green, the contractor. After a short speech describing the salient features of the station, Mr. Callender presented Bailie Willock, sub-convener of the Electricity Committee, with several pieces of silver plate as a souvenir of the occasion.

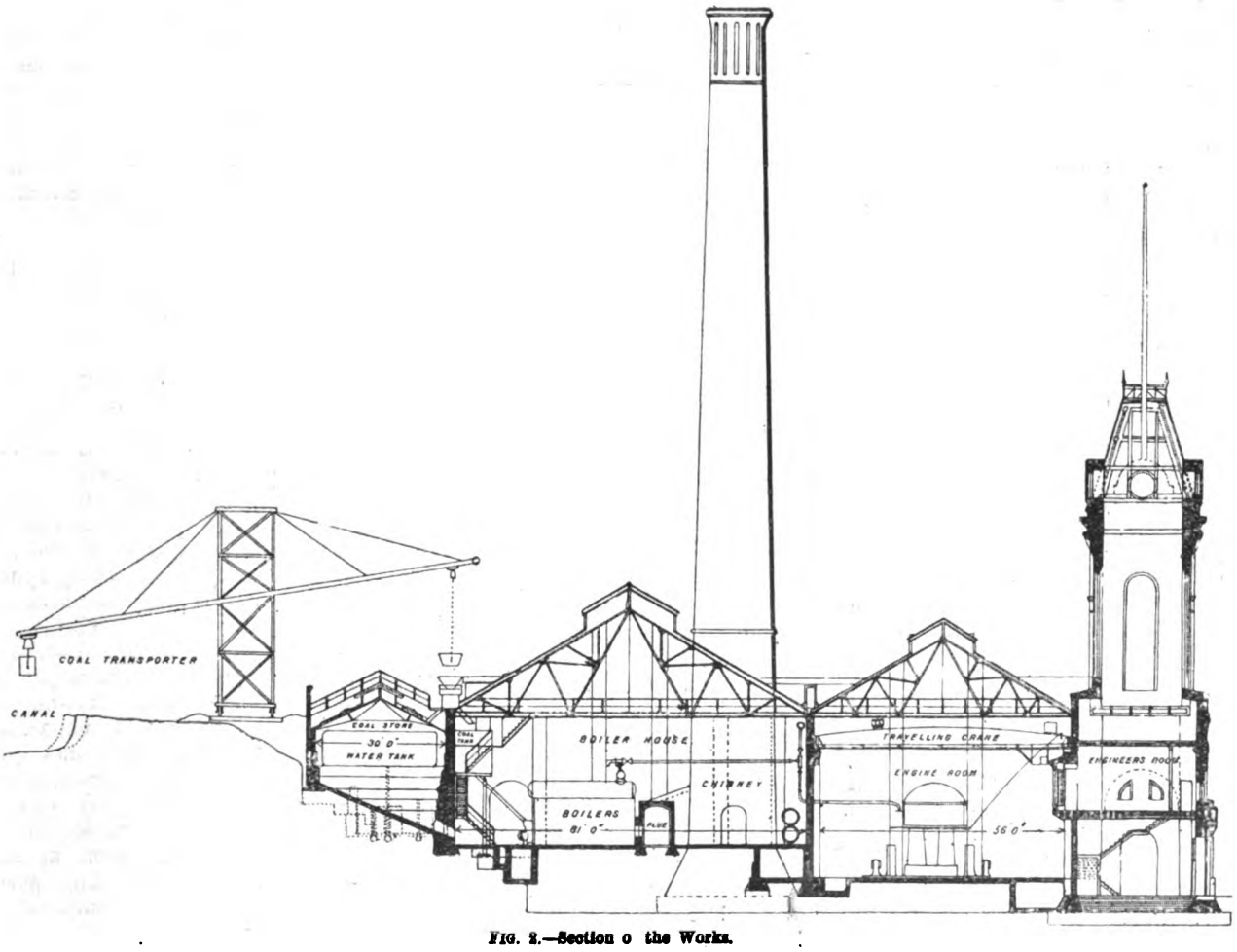


FIG. 2.—Section o the Works.

Digitized by Google

The party then returned to the City Chambers, where a banquet was given in the afternoon, the company numbering about 120. "The Queen" was given by the Lord Provost and duly pledged, after which Bailie Robert Anderson proposed "The Houses of Parliament," to which Lord Overtoun and Sir Charles Cameron replied. Numerous speeches and toasts followed. In the course of one Bailie Maclay, replying for the Electricity Committee, gave the chief engineer and his assistants credit for the indefatigable way they had worked to secure the successful issue of the huge undertaking in supplying the electrical needs of the second city of the Empire. Although an Englishman, Mr. Chamen had taken kindly to Glasgow, and he believed that in technical knowledge, zeal, and enthusiasm Mr. Chamen was not excelled by any other official in the Corporation service, a statement which was received with applause.

The Port Dundas Works.

Through the courtesy of Mr. Chamen and Mr. W. W. Lackie, his chief assistant, we had the pleasure of inspecting the station a short time after the opening ceremony. The works, which are on the north side of the city, are parallel with the Forth and Clyde Canal, which serves as a means of transporting coal to the station, passing as it does through a large portion of the Scotch coal district. The front elevation of the buildings is shown in Fig. 1. Their ultimate length will be 560ft., but at present only the middle portion is constructed. It has a length of 220ft., and at the front is located the engineers' and other offices, surmounted by a tower. Of the three chimney stacks shown only one is built—viz., the middle one, which has a height of 200ft. and a diameter of 11ft. The other two (one of which will shortly be commenced) will have a height of 250ft. and a diameter of 13ft.

Coal is brought to the station in barges, and the Temperley transporter shown in Fig. 2 and 3 lifts the coal in 15cwt. loads and transports it to the bunker. Before being discharged into this it is weighed in a weighing machine made by Messrs. H. Pooley and Co. The transporter may tip the coal either into the bunker or into tanks, which latter are directly connected to the hopper of the mechanical stoker by means of chutes. The transporter will empty a 60-ton barge in about 1½ hours. It is driven by a British Thomson-Houston standard traction motor, and as it has to work intermittently, and also reverse, it is controlled by a British Thomson-Houston controller with magnetic blow-out. The bunker, which is located on the canal bank over a large water-tank, has storage capacity for some 4,000 tons of coal. The coal-tanks, from which the coal falls by gravity to the mechanical stokers, each have a capacity of about 30 tons, and may be filled either from the barges at the wharf or from the bunker by means of the transporter. Should, however, it be considered necessary to work without the transporter, coal may be admitted directly on to the firing floor from the storage bunker; it would thus be possible to supply the boilers for 400 hours without transporting another ounce of coal, provided, of course, the bunker was full to start with. At the time of our visit the bunker was filled, and was being kept as a reserve against contingencies. A ground plan of the works as ultimately to be built is shown in Fig. 4.

Boilers.—The boilers, of which there are 10 installed, are by Messrs. Babcock and Wilcox, and are so well known that detailed description is superfluous. They are fitted with chain grate stokers and superheaters. The heating surface of each boiler is 4,020 square feet, and the working pressure 200lb. per square inch. Steel is used throughout, except the tubes, which are of wrought iron, lap welded. All the boiler fittings are Hopkinson's. Coal is brought down the chutes from the tanks already mentioned to the hopper. The chutes may be seen on the distant boilers in Fig. 5, while the coal-tanks are on the beams seen at the top right side of the photograph. From the hopper the coal falls on to the endless chain grate, which carries it forward into the furnace, the thickness of the fire being regulated by the height of the fire-door. Smokeless combustion is ensured by the slow feed, and the fact that the gases evolved from the fresh fuel has sufficient time to complete combustion before coming into contact with the relatively cold boiler tubes. The fuel is gradually consumed as the grate travels, and on reaching the end of the grate it falls over the dumping plate at the back into the clinker pit. This pit is opened periodically by means of gearing, and the ashes dumped into bogies which run along the ash tunnel. This tunnel traverses the entire length of the boiler-house. The ashes are thus removed without being brought near the firing floor. The bogies are hauled to one end of the tunnel, where at the tipping platform their contents are emptied into carts. The stokers are driven by two British Thomson-Houston enclosed motors of 10 h.p. each, so arranged that they may drive the stokers in one or two groups. The long row of boilers (there will ultimately be about 30) is divided into two long batteries by the pump-room, which at present contains two large feed pumps by Messrs. G. and J. Weir, one double and one single, with another double pump in course of erection. In addition there is a three-throw pump, supplied by Messrs. Wimshurst, Hollick, and Co., and fitted with their friction gear, which was described in our columns a few weeks ago. The city water supply is used in the boilers. No treatment is necessary, as it is an ideal water for water-tube boilers. In order to guard against total failure of the supply there are two water connections to the city mains, in two different streets, these mains entering the station from opposite ends of the building. The engines being condensing, only a small quantity of make-up water is necessary.

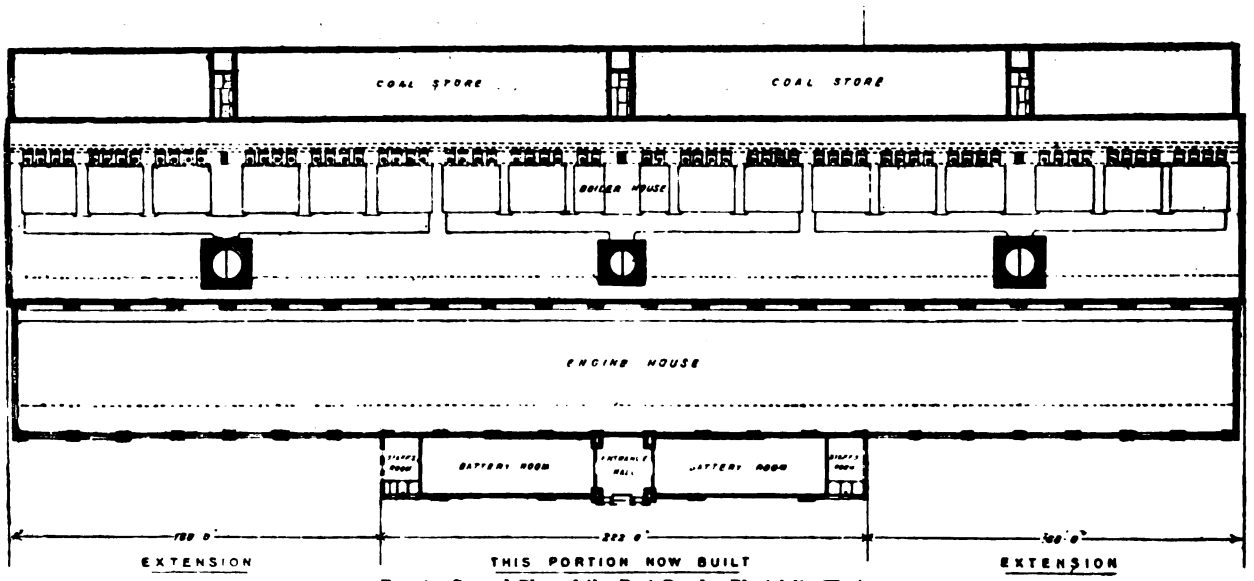


FIG. 4.—Ground Plan of the Port Dundas Electricity Works.

Steam-Piping.—From the boiler a 7in. lap-welded steel main passes across the boiler-room to a short vertical pipe on the wall, which may be divided by the valves as shown in Fig. 2. This vertical pipe connects with the 15in. horizontal steam-main, seen near the spring of the roof (this

Digitized by Google

main runs the whole length of the boiler-house), or it passes down and through the wall to the engine-room. From the arrangement of the valves it will be seen that it is possible to run any engine from the boilers, and to isolate any one of the boilers should that be necessary, all the necessary security being obtained without the use of a steam ring. It is worthy of note also that the steam-pipes are not duplicated. To provide for expansion, U bends are introduced into the middle of the boiler mains as they cross the boiler-house, while the bends in the 15in. steam-main to carry it round the chimney stack provide all the necessary expansion for its length of 200ft. All the pipes are of steel, lap-welded, and made by Messrs. A. and J. Stewart and Menzies. Below the steam-main and close to the floor are two large cast-iron water-mains. These can be seen between the chimney stack and the wall in Fig. 2. These mains are for the purpose of supplying circulating water to the surface condensers. The water is obtained from the canal, and circulated by means of centrifugal pumps. Each engine has a separate condenser, and the water is admitted to it by sluice valves operated from the floor of the boiler-room, one main being for the supply and another for the discharge.

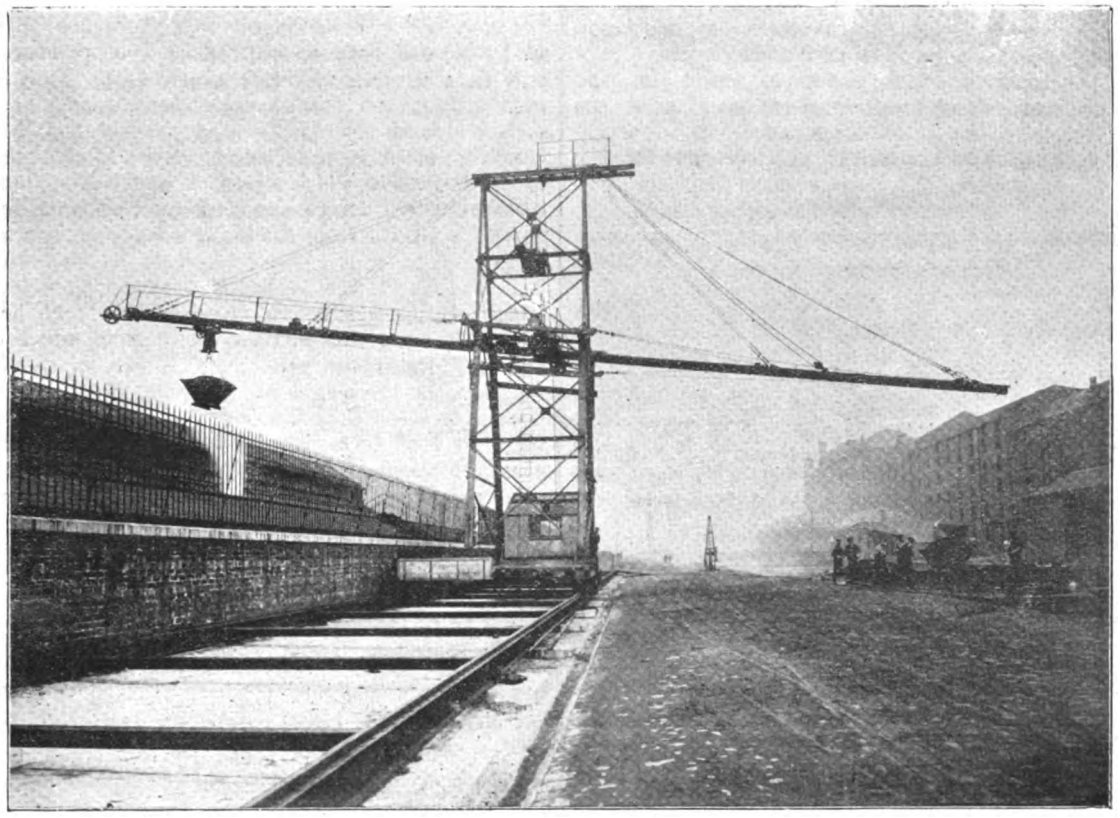


FIG 3.—Temperley Transporter, Port Dundas, Glasgow.

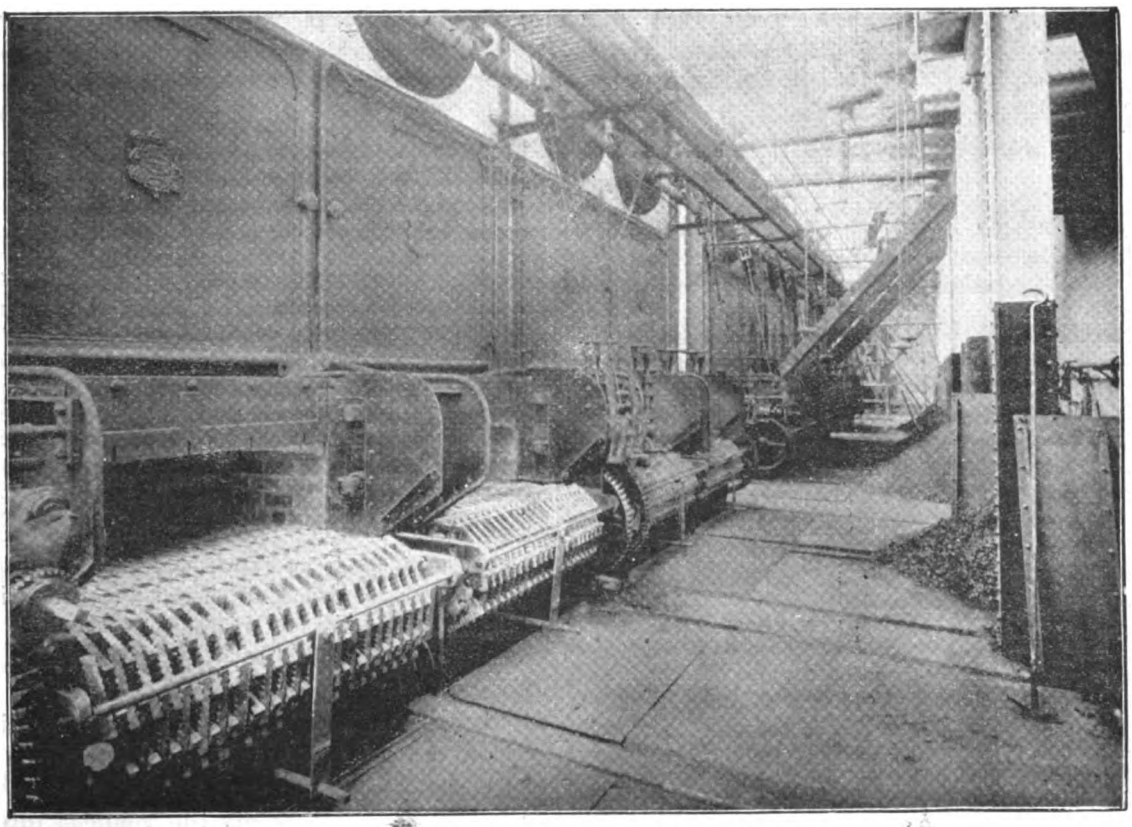


FIG 5.—View of the Boiler Fronts at the Port Dundas Station.

(To be continued.)

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	397	Municipal Trading	419
Barnsley Electricity Supply Works	402	Questions and Answers	421
The Electric Lighting of the City of Glasgow	410	Luton Electricity Works	423
The Southern Railways	414	A High-Voltage Wall Plug	424
Correspondence	415	Contracts for Electrical Supplies	424
Obituary	415	Traction Notes	425
Electric Supply Mains	416	Lighting Notes	427
Fire at the Manchester Post Office	417	Hampstead Electricity Accounts	429
The Evolution of Switch Gears for High-Pressure Alternating Currents	417	Provisional Patents	431
		Traffic Returns	432
		Companies' Stock and Share List	432

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

THE SOUTHERN RAILWAYS.

Readers of the *Times* during the past few days who happened to be compelled to travel upon the southern railway lines will agree with the criticisms against the management, which conduces to waste of time and loss of comfort. It is proverbial that the lines catering for the south-eastern counties are the worst of any radiating from the Metropolis. Perhaps their condition is the result of circumstances beyond the control of the management, and unknown or unappreciated by the outsider. The starting of the twopenny tube has opened the eyes of the 'bus companies to the possibility of competition playing havoc with their daily receipts. Hitherto the competition of underground railways has had little or no effect upon the receipts of 'bus lines. Indeed, it is easy to understand that the new line may only have a temporary effect, and that the mere increase in comfort and convenience will lead to a corresponding increase in the number of travellers. If it does, in the course of time both tube and 'bus will be satisfactorily filled with passenger traffic. On the other hand, if the increase of traffic is not proportionate, then, because of its greater utility, the tube will receive the greater patronage and prosperity to the detriment of the 'bus. Long ago we pointed out that properly-constructed and well-managed tramways catering for suburban traffic against railways would probably take the greater portion of such traffic. If this view is even approximately correct, the wonder is that the railways have not themselves developed this class of traffic. Looked upon as a modified railway, the tramway is a step in upward development so far as suburban traffic is concerned. Compared, however, with the amount of traffic to be dealt with, the conclusion is inevitable that neither railway, nor tramway, nor any increased mileage of them can solve the difficulty. Our only hope is in the rapid extension of motor carriages. Within a radius of ten miles or so motor carriages will render their owners independent of either rail or tramways, their use will save time and money, and increase comfort to the individual, at the same time assisting to clear the streets and render them less insalubrious. Municipal authorities will not learn the lesson that stands clearly before their eyes; they persist in pigheaded wrongdoing. It took years to prove to them that electric lighting was possible, and now it will take years to prove that generating electrical energy upon a very small scale is not so economical as generating on a larger scale. The trail of scent left behind by the oil motor is not conducive to its adoption, but this can and will be mitigated. Already in the large towns upon the Continent motor carriages are plying for hire in competition with cabs, and, so far as can be seen, with satisfactory results. In London the attempt has been made to introduce cabs electrically driven, and failed. No one outside the company ever thought the vehicles introduced could succeed, and not till someone attempts who really understands the problem, and works in conjunction with the supply companies, will it be possible to obtain success. If people will persist in

Digitized by Google

attempting to supply what is not wanted, and supply, too, under the worst possible conditions, why they must fail. To return to the subject of railway reform upon the southern lines, or, indeed, any reform connected with commercial matters. The people who write to the papers about what ought or what ought not to be, too often forget how commercial enterprises have grown up. They have commenced by providing for the wants of the day and extending as requirements demanded. If, however, civilisation progresses too fast, or if the enterprises were initiated under conditions which prevent proportional extensions, the time comes and must come when they cease to provide the accommodation required, and then comes adverse criticism. Probably the southern lines are incapable of the necessary expansion so long as steam is the only motive power employed to adequately meet the requirements of to-day. The troubles, however, may be largely mitigated. Just as the introduction of motor traffic on common roads will assist to increase the capacity of these roads, so the extensive adoption of electricity on existing railways for the suburban passenger traffic would increase their capacity and decrease many of the troubles which are referred to by irate passengers. The trains would be lighter, would save time in starting, stopping, and running, and so enable the companies to economise time during the busiest hours of the day, and run more closely to the time-tables. So far as we can see, the difficulties to adapt existing railway lines for both steam and electricity are not very great, nor would the expense be a stumbling-block. Years hence, when America or the Continent have shown the possibility of a duplicate service, till electricity reigns alone, no doubt we shall in this procrastinating land remain content, and then to follow the leader, though, if report be confirmed, we may for once be leaders instead of followers. It is said that the Great Eastern Railway, pursuing that energetic course which has characterised it of late years, is preparing a scheme to be submitted to Parliament next session for the construction of an electric railway underneath the present track as far as Romford. We sincerely trust this report will be found to be correct, and congratulate the Great Eastern Railway upon its foresight and energy.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—In your issue of the 14th inst. Mr. Dunton accuses me of having unjustly criticised his letter of the 25th ult. This is perhaps only natural, and I need scarcely say that I too felt perhaps an equal injustice after reading his letter of the 8th. Unfortunately for himself, the "gross misrepresentation" on which he apparently bases his accusation in no way affect the main points at issue. I pointed out that (1) the statement which he condemned as slipshod was in reality not slipshod, but a perfectly correct one; (2) that the example described by him for the purpose of proving his contention by *reductio ad absurdum* was not a legitimate one; and (3) that in this very example above mentioned an E.M.F. is induced on the vertical sides of the rectangle, in spite of his statement to the contrary. Should any doubt arise in Mr. Dunton's mind as to the existence of this E.M.F., an electrometer would be useful in clearing up the matter.

In his letter of the 8th inst., your correspondent, in referring to myself, says: "He then goes on to show that the statement to which I object does not imply that there will be a current under such conditions." This is a gross mis-statement of fact. What I actually *did* do was to point out that the statement to which he objected did not imply "that the wire connecting the ends of the conductor referred to should have an equal and opposite E.M.F. impressed on it." So much, therefore, for the "gross misrepresentation."

Mr. Dunton takes exception to a certain sentence in my letter on the ground that the second proposition "contained in it does not follow as a logical consequence of the first." Nor was it intended that it should. While admitting that in this respect the sentence lends itself somewhat to misconstruction, I would point out that the statement of two propositions does not necessarily imply that the one is a deduction of the other.

In spite of Mr. Dunton's views to the contrary, I still hold that the "lines" are graphical representations of the *direction* of the field. The *strength* of the field at any point is represented *not* by the lines, but by the *number* of those lines passing through unit area at that point.

In conclusion, I would say that, while in no way doubting the excellent authority upon which Mr. Dunton has based his contradiction, the authority in question has been misapplied.—Yours, etc., F. JOHNSTON.

Beechcroft, Holywood, co. Down, Sept. 17, 1900.

OBITUARY.

It is with great regret we have to record the death, on Wednesday morning, the 12th inst., of Mr. John Robert Jefferies, of the eminent firm of agricultural engineers, Messrs. Ransomes, Sims, and Jefferies, Limited, of Ipswich, in the prime of his life, being only in his sixtieth year.

Mr. Jefferies (whose portrait we have pleasure in producing) had been a strong vigorous man, as well in body as in mind, but had been somewhat ailing for a short time and became suddenly worse, and on the Tuesday, the day preceding his death, had an operation performed on him by his son in-law (Dr. Ward) and Dr. Herbert Brown, both of Ipswich. The cause of death was appendicitis. Mr. Jefferies was a native of Barford, in Bedfordshire. He

Digitized by Google

went to Ipswich in the year 1856, as a premium apprentice to the Orwell Works, and so attentive and assiduous was he to his duties that he was taken in as a partner by the then firm of Ransomes, Sims, and Head. When the great firm was converted into a private limited company in the year 1884 he became one of the managing directors. At first his prominent position was in the manufactory, but gradually, as some of the partners passed away, he assumed the control of the foreign and colonial departments, whilst his then co-director, Mr. James Edward Ransome, the head of the firm, devoted his time and attention to the home department. As is well known, there is perhaps no firm in the United Kingdom more eminently known than that of Ransomes, Sims, and Jefferies, Limited, and no agricultural engineer throughout her Majesty's Colonies was better known nor more highly respected and appreciated as well for his practical knowledge of business as for his urbanity and courteous manners than the late deceased gentleman. In addition to being a favourite with their many hundreds—aye, even thousands almost of employés, he was much appreciated by the members of the leading engineering firms throughout the country, and no better proof of this could be given than the fact that at his funeral, which took place on Saturday, there were representatives of most of the leading firms of agricultural engineers of the United Kingdom, amongst them being Sir Frederick Howard (of J. and F. Howard, of Bedford), Mr. Thomas Aveling (of Aveling and Porter, of Rochester), Mr. C. Burrell (of Charles Burrell and Sons, of Thetford), and many others. The funeral was a very largely attended one, there being some 50 carriages, and the streets through which it wended its way from his residence, St. Helen's Lodge, to the churchyard were densely thronged. The Orwell Works were closed for the day. The deceased gentleman will be much missed in Ipswich, for, in addition to being beloved by the numerous employés and the leading citizens of his adopted town, he was a prominent member of St. Helen's Church, and for many years a churchwarden. Mr. Jefferies leaves a widow, who is a daughter of the late Mr. Allan Ransome, the former head of the firm, three daughters, and one son, who at the present time occupies a prominent position in the business. *Requiescat in pace.*

ELECTRIC SUPPLY MAINS.

We have received from the Cablemakers' Association a model form of the general terms for a specification for the supply of electric cables and mains, which 11 of the largest firms of cablemakers in this country have adopted. The clauses in question are to take effect from Oct. 1 of this year, and the firms in question ask consulting engineers to include them in their specifications without modification, if possible. We do not know if the manufacturers in question asked any prominent consulting engineers to confer with them when drawing up these clauses, but they are so obviously in favour of the manufacturers that they can hardly be accepted always without question. Thus in clause No. 2, which deals with the guarantee, the manufacturers bind themselves not to guarantee their wares for more than 12 months without an annual charge is made for the cost of making good any defects which may arise. This is, of course, quite a trade matter, as certain of the cable manufacturers have elected to give a five years' guarantee of their cables in order to obtain a large share of work. The third paragraph of the guarantee section, however, reads as follows: "Should the contractor be required under the guarantee to locate and repair any defect which may occur in the cables, a charge for such work to be made by the contractors in all cases where there is no proof that the defect was caused by bad material or workmanship." This is absolutely absurd from the engineer's point of view, or, of course, we should say from the point of view of the local authority or electric lighting company which employs the engineer. In the case of cables with a large sectional area and current capacity, the effect of a fault is, as a rule, so destructive that the arc formed quite destroys the evidence of the original cause of the fault. Hence it would be quite impossible for the engineer to prove in a great many cases that the fault was caused by bad material or workmanship, rather than to defects in laying the cable, etc. The onus of the proof should, we think, lie with the manufacturer.

Clause 6, dealing with the suspension of the works, is fair, in that it makes the purchaser of the cable responsible for the reasonable expenses incurred due to the suspension of the works by the engineer, unless this suspension is due to any fault on the part of the cable contractor. It is not reasonable, as is too often done, to keep the workmen of one contractor on the spot when there is no chance of their completing the work due to either unforeseen troubles connected with the building site or to any other cause over which the cable contractor has no control. The Clause 8, dealing with engineer's certificates, is worthy of support throughout the whole profession, particularly when it undertakes that the purchaser should pay the contractor within one month of receiving the certificate from the engineer that the payment is due. We do not, however,

STANDARD SIZES OF CONDUCTORS FOR ELECTRIC SUPPLY MAINS.
To become operative on October 1, 1900.

Nominal size of conductors in square inches.	No. and diameter of strands.	Resistance in standard ohms per 1,000 yards.			Weight in lbs. per 1 000 yards.	
		Calculated.	Maximum allowable.	Maximum allowable for tinned wires.	Calculated.	Minimum allowable.
·05	7/ 095	·490	·499	·504	580	568
·05	19/ 058	·488	·498	·503	591	580
·1	19/ 082	·244	·249	·252	1 182	1,158
·125	19/ 092	·194	·198	·200	1,488	1 458
·15	19/·101	·160	·163	·165	1 781	1,745
·15	37/ 072	·163	·166	·168	1.776	1 740
·2	37/ 082	·125	·128	·129	2 303	2 257
·25	37/·092	·0997	·102	·103	2 900	2 842
·3	37/·101	·0827	·0843	·0852	3 494	3 424
·35	37/·110	·0697	·0711	·0715	4 145	4 062
·4	37/·118	·0606	·0618	·0621	4 772	4 677
·4	61/ 092	·0605	·0617	·0623	4 781	4.685
·5	61/ 101	·0502	·0512	·0517	5 762	5 647
·6	61/·110	·0423	·0431	·0433	6.836	6 699
·6	91/ 092	·0405	·413	·0417	7 134	6,991
·7	91/·098	·0357	·0364	·0368	8 094	7 932
·75	91/·101	·0336	·0343	·0346	8 597	8.425
·8	91/ 104	·0317	·0323	·0327	9.115	8 933
·9	91/·110	·0283	·0289	·0290	10,200	9,996
1·0	91/·118	·0246	·0251	·0252	11,740	11,510
1·0	127/·101	·0239	·0244	·0246	11,910	11,680

In concentric cables the outer conductors will have the resistance orresponding to the areas as given above.

Digitized by Google

think that the contractors are justified in trying to force the engineer to issue the certificate within 14 days of the presentation of the account. It frequently happens that 14 days is not sufficient to properly check and investigate the account and the points of difference which exist between it and what the engineer admits that the contractor is entitled to. On the whole we think that the clauses will be useful, with the exception of the few points to which we have drawn attention, and any difficulty about these, we think, would be avoided by consultation beforehand with a few of the engineers usually having control of such work. The table of standard cables reproduced herewith is issued with the clauses above mentioned.

FIRE AT THE MANCHESTER POST OFFICE.

About half-past one o'clock on Wednesday afternoon a fire broke out in the telegraph instrument room of the Manchester General Post Office, and before it could be got under had caused so much damage as to completely cut off all telegraphic and telephonic means of communication with the rest of the country. The fire was first discovered in a test-box, behind which were a number of wires. Suddenly flames were seen coming from the box, and immediately the whole apparatus was enveloped in flames. The woodwork in the room being very dry, the fire spread with alarming rapidity, the efforts of the clerks in the room to subdue it making not the least impression. Communication was thereupon made to the Manchester fire brigade, and within a very short space of time several contingents were on the scene. On their arrival, under Chief Officer Mr. Parker, it was found that the whole of the instrument-room on the top floor of the building on the Brown-street side was in flames, and at first sight it appeared absolutely hopeless to prevent the entire destruction of the building. Jets, however, were promptly got to work, and an immense volume of water was at once poured on the burning mass. In the meantime the flames continued to obtain the mastery, and in a very short time the portion of the room in which the outbreak occurred was completely dismantled. The telegraph instruments were, of course, very soon destroyed, and it was not many minutes before the roof fell in in several places. The telegraph wires over the building were dislodged from their supports, and this, coupled with the damage occasioned to the instruments, had the result of completely suspending telegraphic communication between Manchester and elsewhere.

Fortunately, although there were between 200 and 300 operators at work in the instrument-room when the outbreak was first discovered, there was not the slightest sign of panic manifested. Each one left his post and retired to another part of the building in admirable order. The appliances provided at the post office for dealing with emergencies of this character were inadequate to meet the demands made upon them, and had it not been for the timely arrival of the city brigade there can be no question that the whole building would have been doomed. As it was, the supply of water obtained from the main and poured upon the fire, under the direction of Mr. Parker, was sufficiently ample to bring the conflagration into subjection within a comparatively short period, and by two o'clock all immediate danger of any further spread was at an end. The postal authorities at once set about to devise means to remedy the inconvenience to which the public must necessarily be subjected in consequence of the dislocation of telegraphic communication, but for some hours everything was in a state of chaos, and it is impossible to say how soon things may be got to work again. In addition to the supply of water direct from the mains, it was found necessary to get one of the steam-engines to work, and this was the means of putting the finishing touch upon the efforts of the brigade to suppress the outbreak.

The fire, it appears, was caused by the bursting of a spirit lamp which was being used by some employés of the engineering department, who were repairing the wire coils near the test-box. This is the point where all the wires entering the building converge, and is, accordingly, one of the most important spots in the building. The whole of the work of the office, both telegraphic and postal, was for the time being reduced to a state of confusion when the employés re-entered the lower parts of the building. Announcements were, therefore, made, and within a few minutes, that no messages could be accepted for dispatch during the remainder of the day. The telephone department was also closed. Under ordinary circumstances, the inconvenience to the public would have been immense, but it will be all the greater just now in consequence of the pending Election, the arrangements in connection with which had been almost completed by the district superintendent. The department of the engineer-in-chief in London was communicated with at once, and it is hoped that the assistance to be obtained there, as well as from the engineering departments of some of the other principal offices in the country, will enable the Manchester authorities to remedy the effects of the disaster in the course of a week or so.

The building has sustained considerable damage, the whole of the roof of the northern wing having been burned away, and it will be many weeks before it can be replaced. It is hardly possible to exaggerate the enormous inconvenience and loss which must accrue to the business community of Manchester owing to the fire. Merchants and manufacturers are, for the time being, entirely cut off from their customers and from communication with their own mills, which are frequently situated many miles away.

For the above account of the fire we are indebted to the *Standard*. We also learn that at 4.45 p.m. connection between London and the Manchester Stock Exchange was established. The railway company put their wires at the disposal of the authorities. This is the second fire within a comparatively short period caused by a spirit lamp exploding and igniting the insulation on telegraph conductors. The first occurred in a street box in London, and resulted in great inconvenience. The monetary loss, however, to the Post Office authorities was comparatively small compared to that at Manchester. It shows, however, that the engineer's department should look into the design of their spirit lamps, as they at present seem to be far from safe.

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

(Continued from page 374.)

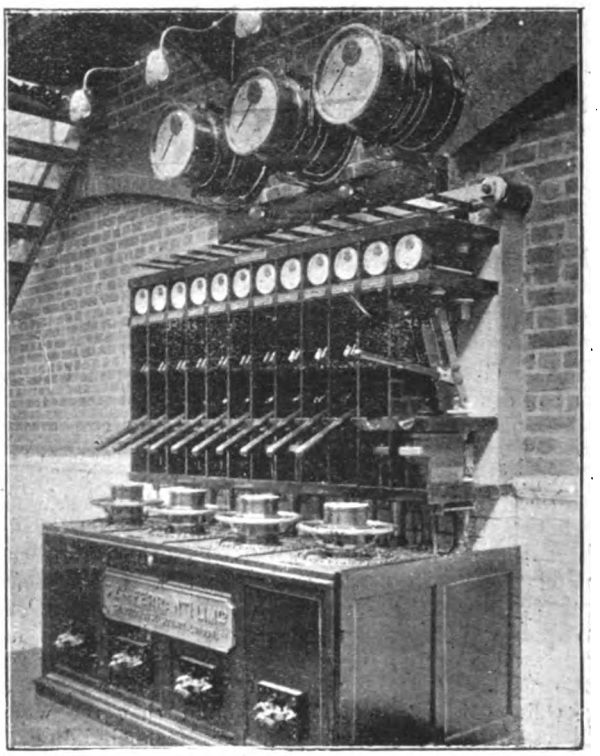
FERRANTI.

The switchboard introduced by Mr. Ferranti is a distinct departure from every other type, and it possesses such marked advantages in its arrangement that it is being almost generally adopted and replacing other gears. The principal features of the board have remained much the same as in the early types, the chief developments having taken place on lines of flexibility, or construction with an aim to standardisation. The gear is composed of four main slates grouted horizontally into the wall for support, and grooved at certain centres (according to power to be controlled—6in. for panels up to 600 kw., 9in. any higher power) for the reception of vertical slates which divide the main slabs into a number of cells. These slates are black enamelled, but the wall behind the compartments is faced with slates which are white enamelled. Each cell is fitted with cable receiver, fuse, switch, ammeter, and 'bus bar fitting, all these being so arranged that they complete the circuit without the aid of rubber cables or any connection behind the wall. Mr. Ferranti was the first engineer to advocate the connection of one conductor of a high-pressure system to earth, and the taking of every precaution to thoroughly insulate the other conductor. He put his suggestion into practice in the construction of his switchboard by connecting the outer conductor to an uninsulated bar beneath the gear, and carrying out all switching, etc., arrangements on the inner, which was most carefully insulated, the 'bus bar being located at the top of the gear.

The first complete board in this country on this principle was erected at Portsmouth in 1894, and the photographs

Digitized by Google

(Figs. 43 and 43A) show two views of the gear. At the top of the board, fixed on the wall, are the voltmeters, each mounted on its own converter, and underneath these are the synchronising lamps. On the high-tension board will



FIGS. 43 AND 43A.—Main Switchboard, Portsmouth Electricity Works.

be seen the inner 'bus bar (carried on shanks sulphured into porcelain insulators cemented in the wall), 'bus bar fittings coupled with spring copper link, ammeter, spring break switch, single contact fuse, and cable receiver. Below this gear is the regulating table carrying rheostat, ammeter and field switch. The resistance wires are placed directly

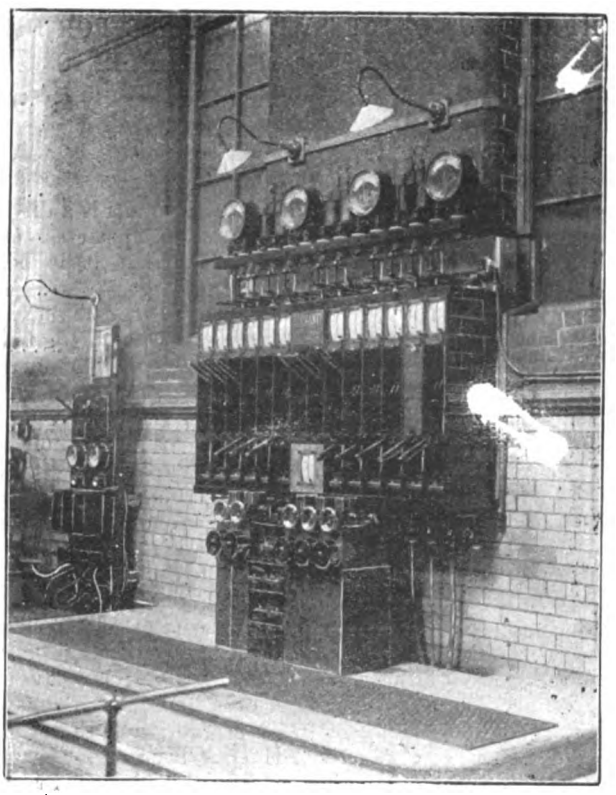


FIG. 44.—Switchboard at Hanley.

underneath the regulating switch and connected to the stops by cables. The ammeter being mounted in the centre of the handwheel of the rheostat, the exciting current could be easily seen during the operation of regulating the volts. The outer of the high-pressure concentric cable is connected to the shell of the receiver and thence to the outer 'bus bar (earthed) by means of a link, the inner of the cable being connected to the panel above. The fuse panel contains contacts into which an oil-break fuse of Messrs. Ferranti's well-known type is inserted. A short-circuiting plug is provided for the removal of the fuse. The switch is of the spring-break class, and is fitted with

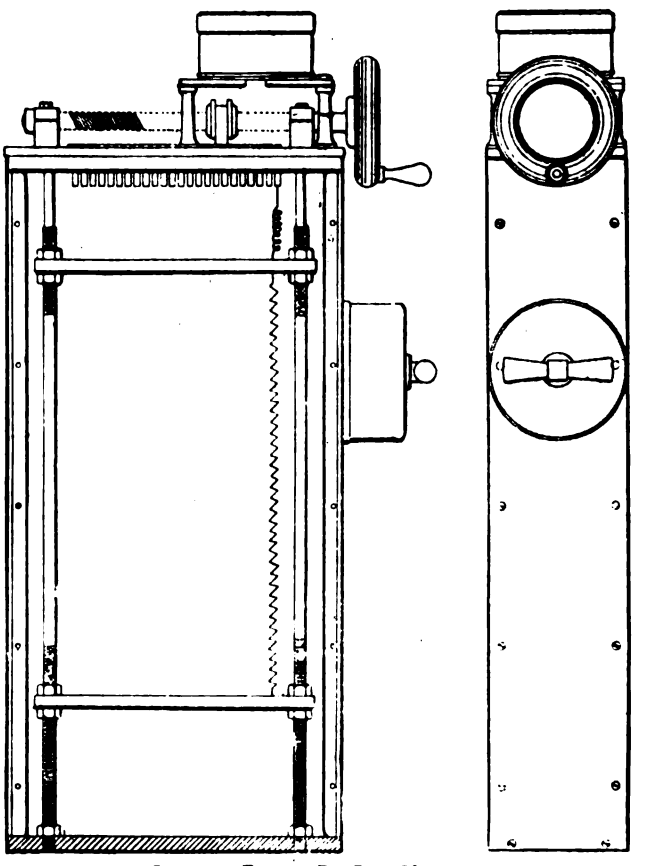


FIG. 44A.—Ferranti Box-Type Rheostat.

half-cock synchronising contact. This may be seen clearly in the side view photograph of the board. The ammeter is a circular one, and is connected to the main fittings by copper rods. Parallel running of the alternators was almost rendered necessary by the inner 'bus bar links, but

Digitized by Google

a certain combination of machines and circuits could be effected if desired.

Fig. 44 illustrates a stage in the development of the board. This was erected at Hanley, and when compared with the Portsmouth gear the differences will be at once evident. High-tension voltmeters and neat synchronisers are mounted on a slate above the main board, and each is arranged that its supports act as terminals, the high pressures being fixed into insulators at the front of the slate, and the earth terminals screwed into a common bar connected to the outer 'bus bar at the bottom of the board. Fine fuses drawn through glass tubes fitted to a suitable handle connect each instrument to its particular bar, and the withdrawal of the fuse makes the examination or removal of either voltmeter or synchroniser a safe operation. The ammeters, arranged to be easily removable, are provided with a bold open scale and large needle. In the fuse panel, duplicate contacts are fitted so that a spare fuse may be inserted or a faulty one removed without interruption of supply. The rheostats are constructed to occupy a similar width as the high-pressure panel, so that each may stand under its own line of apparatus. Fig. 44A will explain the construction of this type, where it will be seen that ammeter and field switch are included in the arrangement. This form of resistance will dissipate up to 300 watts, and the lower slate may be adjusted by nuts to take up any slack in the wires. This switchboard is fitted with two inner bars, which can be connected together by an interconnector switch, so that alternators running in parallel may be separated to supply a number of circuits on either side of the board.

(To be continued.)

MUNICIPAL TRADING.

BY ARTHUR PRIESTMAN.

The following is an abstract of a long paper by Mr. A. Priestman, read before Section F of the British Association at Bradford on Monday, Sept. 11. The author commenced by the assertion that "the subject of municipal trading is ripe for discussion. Anyone acquainted with the municipal work on town councils must be aware of the difficulties continually arising as to how far municipal activity is to be allowed to enter a domain which hitherto has been regarded as the exclusive province of the private trader. The London Chamber of Commerce has recently issued a circular to the provincial chambers asking for information as to what local evidence can be obtained on these points, amongst others: (*a*) whether the rates ought to be put into competition with private capital; (*b*) whether the local authority ought to become traders, by providing services which are not of general use to the whole community; (*c*) what the effect has been on local wage lists of the municipality setting a high standard of wages for the Corporation employés. The answers to these questions are desired in order that a case may be prepared in the interests of private traders. As you are doubtless aware, a Royal Commission has been sitting, which is to make a report to the House of Commons in due course, and upon which future legislation will probably be based. Few people will find cause to quarrel with municipal trading in water, electricity, and gas. What has come to be recognised by most as the rightful domain of municipal enterprise is so well established that we need not stop to consider the arguments for and against its continuance. The cities and towns have risen to their responsibility, and have spent vast sums of money in obtaining the consent of Parliament to their loans after semi-judicial public enquiry. The safeguards against rash or extravagant expenditure by these means appear to be most amply sufficient, and, if anything, err on the side of over-caution. The men on the city councils who are responsible for the civic enterprises in gas, water, and tramlines are in most cases the very men who have taken the most part in the private enterprises of the town, and have themselves become wealthy with the increasing local prosperity, and it is hardly likely that these men (provided they are returned as before) will engage in too rash or dangerous corporate experiments."

The author proceeded to deal with the increased municipal responsibility entailed by trading and on the backwardness of the United States in municipal works. As a mark of the growth of municipal enterprise in this country, Mr. Priestman instanced the amount of debt incurred by the local authorities in England and Wales, which, according to Sir Henry Fowler, was estimated in 1868 at £60,000,000. In 1875 this debt was nearly £93,000,000; in 1885, £173,000,000; and in 1898, £262,000,000. He informs us also that the National Debt in 1898 stood at £638,000,000, and that between the years 1875 and 1898, whilst the National Debt was reduced £131,000,000, the local debt during the same period increased by £170,000,000. But this sum of local indebtedness includes schools, asylums, highways, sewerage, and other necessary expenditure which cannot be classified as strictly municipal trading. Sir Henry Fowler classifies the local indebtedness of 265 municipal boroughs in England and Wales, excluding the London County Council, as follows: £137,000,000 for purposes which local authorities are bound to provide, £36,000,000 for educational and recreative purposes, £87,500,000 for trading, and the remainder for advances for private improvements to be repaid. These trading purposes may be divided into six principal classes: waterworks, gas, markets, tramways, electric lighting, and piers, quays, and harbours. Of the 265 municipal boroughs in England and Wales, but excluding the London County Council, 173 manage their own waterworks, 87 their own gasworks, 204 their own markets, 28 their own tramways, and 55 their own electric light works. But what is most remarkable is that, after paying interest on loans and sinking fund, the margin of profit generally applied to the reduction of rates is only ½ per cent.

The author then treated the subject of municipal buildings for the working classes, etc., and then came to the subject of telephones. On this head, he considered that the charges of the National Telephone Company for the use of their instruments in Bradford were high, being £10 per annum, whilst at a small town like Trondheim in Norway, with 30,000 inhabitants, the subscriber pays for a municipal telephone £3. 10s. per year, a charge which affords a surplus, after paying interest on capital, a reserve of 5 per cent. per year on the capital, and the insurance of employés against death, accident, and sickness. The Bradford Corporation surveyor had very recently estimated the complete cost of establishing a municipal telephone exchange in Bradford, based on the present number of subscribers on the books of the National Telephone Company, at £40 per subscriber, including all buildings, wires, and instruments, so that it is not unreasonable to conclude that the city could afford to supply a telephone service at no greater charge than Glasgow City Council is offering—viz., £5. 5s. per annum per instrument. Now that the newer system is to lay the telephone wires underground, the streets must be interfered with by the Telephone Company, and the municipality cannot grant powers to do this to a private company any more than they can grant powers to a private tramway company. It was never to the public convenience that two authorities should have power to interfere with the streets. Since the fire insurance companies have formed a combination and fixed upon a tariff rate which to most seems a very heavy charge, this will force the trading public to consider whether this monopoly charge must not be resisted. The conclusion of the paper was devoted to the support of municipal trading in its widest sense.

A paper on "Municipal Housing for the Overcrowded," by the Hon. Auberon Herbert, was then read, and the two papers were discussed together. For the report of the discussion we are indebted to the *Bradford Observer*:

Mr. E. Bond, M.P., who opened the discussion, said that the subject dealt with in the papers was one of great importance, and he really wished that the issue had been raised in a clearer form than had been done in the papers. What they had to consider was whether and to what extent they could enlarge the sphere of municipal enterprise, especially in the direction of taking up businesses that were ordinarily carried on by private enterprise for profit. He must say that the reader of the first paper had not clearly drawn any definition of the functions which municipalities should discharge, or which they might be called upon to define in the future. They were all agreed that a municipality should look look after the health of its population, should see that the streets

Digitized by Google

were properly paved and lighted, and should exercise a large number of multifarious functions depending to some extent on local circumstances, but not in any case for the sole purpose of making a profit. In these functions were included the supply of water, gas, and electricity, and they were all agreed that a municipality might well undertake businesses of that kind—businesses which were often carried on, no doubt, by private companies or individuals. The reasons given for that—reasons which he thought absolutely conclusive, at any rate in the case of water—were that it could be shown that by the municipality providing for the supply of water the ratepayer could obtain, without any loss, a supply as good and as abundant as he could obtain by private enterprise, and, further, that a municipality could do this work with almost perfect safety, as it was inconceivable that they could ever reach the stage when they could do without water as a prime necessity of life. Therefore, the municipality in that matter might be pretty sure that it would not become involved in financial disaster. He was rather more doubtful with regard to gas and electricity, because it was not beyond the bounds of probability that some new illuminant might be discovered that would entirely replace gas and even electricity. In such a case, a municipality might find itself in a difficult predicament, and as the members of the corporation were only human and were actuated by similar motive to other human beings, they might hesitate before giving their sanction or encouragement to introduction of anything new that was likely to endanger the capital invested by the municipality in its gas and electricity. He admitted that municipal gas undertakings had, on the whole, turned out well, though there was always the trouble of their being obliged to differentiate between their customers—of their having to decide whether they would supply business men with gas at a cheaper rate, or whether they would devote their energies to bringing the gas at the cheapest rate to the door of the poorer ratepayers. But it seemed to him that the question of profit was in most cases an all-important consideration. Mr. Priestman had pointed out that in the case of Bradford the gas enterprise had been making a large profit that had gone to the relief of the rates, but he was staggered to find that, owing to the increase in the price of coal, the profit this year would be converted into a deficiency. This showed the risks in which a municipality became involved when they embarked in these trading industries. One of the gravest questions arising out of municipal trading was the question of large numbers of ratepayers being in the employment of the municipality. A councillor might represent a district where the council's employés formed a large part of the electorate, and the interests of these employés might at any time be in conflict with the interests of the ratepayers at large. The result would be that there would be a strong inducement to a councillor to favour the interests of the employés at the expense of the ratepayers. In that way the door was opened to municipal corruption. The whole idea seemed to be that persons who otherwise had no special knowledge of the kind of business entered upon were perfectly capable of undertaking the control of any business simply because they were called a municipal corporation. Mr. Priestman seemed to see no limit to the kinds of trading into which the municipality ought to enter; anything that seemed to offer the probability of a profit should be grasped at. He expressed the opinion that every reason that rendered the municipalisation of the water supply desirable applied equally to the milk supply, but he (the speaker) did not agree with this at all. Even if it should be admitted that milk were a prime necessity—though it was not so to the same extent as water—yet the organisation of a milk supply was a far more complicated and difficult thing than that of a water supply, and involved an element of uncertainty that should not be undertaken by a municipality. Another objection to the further extension of municipal trading was the immense amount of work which was thrown upon the members of the corporation. In the case of the London County Council, of which he was a member, it was already found that the mass of work was so great that only a very small part of it could be properly understood by any one member. The result was that they had to rely more and more upon the paid servants of the Council, and though they might be on the whole well served—as he believed they were—by their paid staff, there was always the danger of the work getting into the hands of men who were either incompetent or who would yield to the temptation to corrupt influences. As illustrating the way in which a municipality failed to carry out its trading schemes successfully, he instanced the attempt of the London County Council to provide for the housing of the poorer classes—the people that were dispossessed by the destruction of insanitary rookeries and slums. The London County Council had found it impossible to provide the kind of dwellings required by this class of the people except at a great cost to the ratepayers, which it did not feel justified in incurring. For these reasons he thought they should be desperately on their guard against extending the system of municipal trading. So far from sharing Mr. Priestman's view that the health, wealth, and well-being of the community would be advanced by the extension of municipal enterprise, he was of a directly opposite opinion. He believed the municipalities would find themselves in a financial muddle if they went much further on these trading lines. There was no reason to believe that articles of general consumption could be supplied cheaper, better, or more suitable by the municipalities than they could be supplied by private enterprise. If an article supplied by private traders was unsuitable or unsatisfactory, the purchaser could go elsewhere, but if the municipality possessed a monopoly there was no inducement to supply the best or most suitable article, while the ratepayer would be in the position that he must take the article supplied or go without.

Prof. Silvanus Thompson said that in taking part in the discussion he would confine himself to one small corner of the subject raised, and that was as to the bearing of the electricity question on municipal trading. He would, however, just say that Mr. Priestman's suggestion was that no limit ought to be put upon the growth of municipal trading or to the development of collective enterprises. But he might be permitted to point out that there must be some limit, and he believed that even as regarded tramways and lighting the extent of municipal effort must be limited. With respect to electricity, he was glad to learn that Bradford was almost the first in the field in electrical lighting. They were excellently advised also when they proposed to supply electrical power cheaply to their customers. Again, he thought they were equally well advised when they determined to take over the tramways and to work them by electricity. But he would observe that when they did so they were bound to consider not only the needs of their own town, but the needs also of the districts outside that desired improved communications. They should bear in mind that their tramway system would be of far greater advantage if it were part of a network of tramways covering a large district, as had been done in many instances in America, where there were electric trams extending continuously for 20 or 30 miles. In Bradford they found themselves in possession of horse tramways with a narrow gauge. Why, when they had to relay these lines, did they not alter the gauge so as to make it the same as in the rest of Yorkshire? They would have to pay the penalty for that municipal mismanagement on that point in the future. In five, ten, or fifteen years they would have to take up their lines and relay them of the same gauge as the other Yorkshire lines. He understood that the reason the gauge was not altered was that the committee sought to save the cost of a few old tramcars which could be run until the electric ones were ready. There was now coming before them the far larger question of the supply of electrical power to mills and factories, to large consumers as well as small consumers. To do this they would have to have central stations that would supply electricity on a large scale, for 30,000 h.p., 40,000 h.p., or 50,000 h.p. was likely to be required. If they had a large central station they would be able to send out electricity at a far cheaper rate than if they confined their attention to the same area as for gas or electric lighting. It would be just as if a London vestry proposed to supply gas or water instead of allowing the County Council to provide it for the whole area. In the case of the supply of electricity on a large scale they must have, not the municipality as an area, but the county or a large section of the county. If the municipality did not provide for this, so much the worse for the municipality in the long run. As an illustration of this he referred to the fate of the Lancashire Powers Bill in the last session. That scheme, he said, was well thought out, and proposed the establishment of large centres whence they could carry electric cables through large districts. But certain bodies objected to the powers sought for, such as the power to interfere with the streets and roads, and other authorities objected that they themselves already possessed the powers to supply electricity. But the scheme proposed would not have interfered with any of the rights of those authorities; the proposal was to supply electricity in bulk to the authorities and to others who already possessed the power to distribute it. To get to these people it was necessary to pass through other areas that did not require the supply, but that ought not to have led these intermediate authorities to place themselves in antagonism to the scheme which proposed to supply other persons beyond who did need it. In the case of Bradford were there not urban districts beyond its borders who had as much right to a cheap supply of electricity as had Bradford itself? Why, then, should not Bradford be prepared to co operate with other places in establishing these great central stations? Another point was that the circumstances of different towns and industries varied. In Bradford they had one chief industry, and the various manufactories requiring power began and ceased work at the same time. The consequence was that the demand for electricity was restricted to only a portion of the day, and they required a large amount of costly machinery which would necessarily stand idle for the greater part of its time. But if they had areas of supply covering various industries, in which the times of working overlapped each other, they would be able to work with a comparatively smaller plant, which would run almost continuously, and the out-turn of power would be more regular and consequently cheaper. He, therefore, asked that the question of electrical power should not be regarded as a parochial or local question, but as a far larger question that involved the prosperity of the whole of Yorkshire.

Other speakers followed on the general question, and we regret that we have not space to reproduce their remarks.

Tariffs Remitted.—It is interesting to note that, in view of the electric lighting of Georgetown and New Amsterdam, in British Guiana, the tariff which has up till recently been imposed upon electrical machinery has been removed. Telegraph supplies and tramway material have also been added to the free list. The information is very pleasing, as it not only shows that great efforts are being made in British Guiana to keep up to date, but also that the Colonial authorities look with favour on these efforts.

Digitized by Google

QUESTIONS AND ANSWERS.

[N.B.—Will the gentlemen who sent in questions Nos. 304 and 305 kindly forward their names and addresses, as they cannot be traced? Their initials are "F. H." and "A. S."—ED. *E. E.*]

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

309. Explain, with sketches, all the connections of a balancer-booster on the three-wire direct-current system where the booster is used for battery charging.—F. H. P.

310. Describe a method of determining the current (with a certain temperature rise, say, 100deg F.) which can be carried by high-resistance wires, such as platinoid, rosteéne, tinned iron wire, etc., when used for resistance coils, and when their specific resistance is not known.—F. W. B.

ANSWERS.

Question No. 303.—Explain the use and working of the Kelvin earth-current recorder, with automatic short-circuiting switch. Give diagram of connections.

Best Answer to No. 303 (*awarded* 10*s.*).—A general view of a Kelvin earth-current recorder, with automatic short-circuiting switch, is given in Fig. 1. The recording ampere-meter, R Am, consists of a pair of coils, Am C, fixed in the bracket shown, and a series of small magnets attached to a pivoted aluminium frame not shown in the sketch. A light pointer with an ink pen at its end is fitted to the frame carrying the small magnets, the latter being free to move in the centres of the coils, the pen, of course, moving over a graduated paper slip on the clockwork drum. The automatic switch consists of the horseshoe magnet, H M, having a circular core iron dipping into the coil, S, the height above the coil being adjusted by the milled nut at the top. Below the poles of H M is pivoted an iron keeper, P K, which is pulled up by the magnet when the coil, S, is energised, thus lifting the small catch, T. The switch proper is shown closed in the sketch for the sake of clearness, but in its normal position it is lifted by hand vertically, until the rib, W, cast on the inside of the switch arm engages the catch, T, when it is held securely in that position.

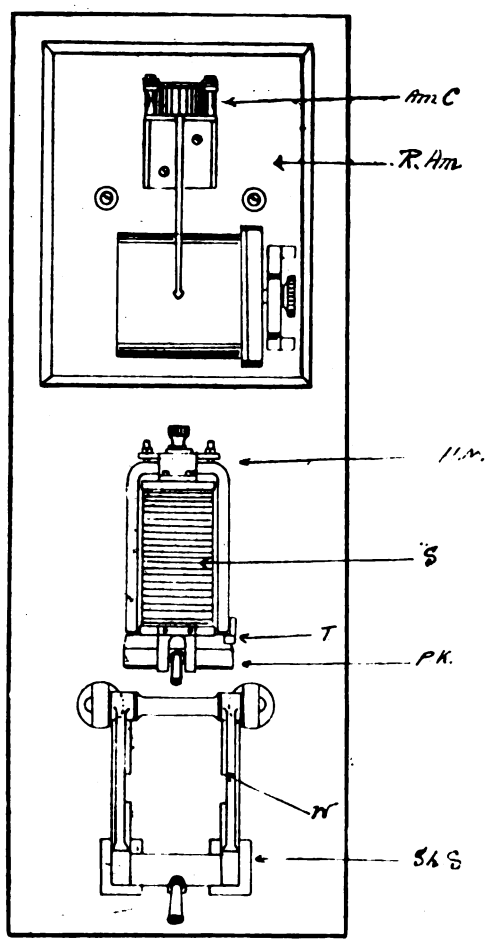


FIG. 1.

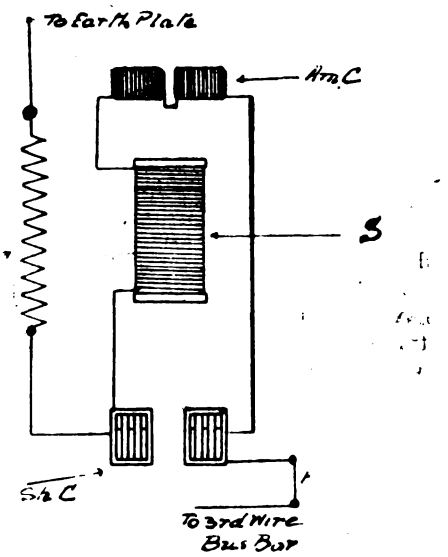


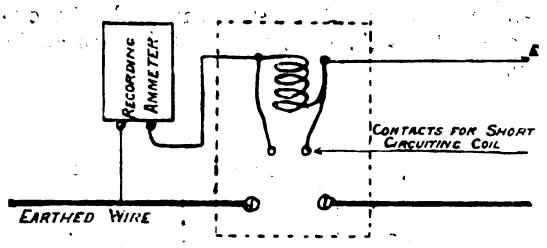
FIG. 2.

A diagram of the connections at the back of the instrument is given in Fig. 2, where Am C represents the ammeter coils, S the actuating coil, Sh C the short-circuiting switch contacts, and Sc R a special series resistance supplied with the instrument to carry about 15 to 20 amperes. The connections are represented for the earthing of the neutral wire of a three-wire system at the station end through the instrument. The action of the instrument should now be quite clear. Thus, supposing the magnet, H M, to have been so adjusted that when five amperes passes through the coil, S, it becomes sufficiently magnetised to raise the keeper, P K, until it lifts the catch, T, and so leaves the switch, Sh S, to fall of its own weight, thus bridging the contacts, Sh C (Fig. 2), the instrument then being cut out, and the resistance, Sc R, put to earth through the fuse, F.

To use the instrument to the best advantage, a three-way switch might be inserted between the fuse, F, and the source of supply, so that by moving the switch, say, to No. 1 contact, the instrument is coupled to the neutral wire, No. 2 to negative main, and No. 3 to positive, the contacts being so set out that they cannot be bridged; or, better still perhaps, a set of three plug sockets to receive the plug connected to fuse, F. By means of this method of connecting, the insulation resistance of the whole network may be taken roughly each day and notes made, so that the gradual development of a slight fault to earth may be watched; also by marking the scale for a positive or negative deflection, the faulty main may be detected. The above may be calculated from the formula $F = \frac{V}{d^1 - d^2} - g$, where F = insulation resistance of the whole network; V, the working pressure between the two mains from which deflections are taken; d^1 and d^2 deflections obtained from, say, middle wire and earth and one of the outers; g = resistance of testing ammeter and its auxiliary resistance. The expression $(d^1 - d^2)$ being the algebraical difference between the two readings, they must, that is to say, be added together if the deflections are to opposite sides of the zero. For a fuller description of the above and similar methods see Raphael's "Localisation of Faults in Mains."—A. H.

Digitized by Google

Answer to No. 303 (*awarded* 5*s*).—The Kelvin earth-current recorder is a simple recording ammeter constructed on the principle of the Thompson galvanometer with an astatic pair of needles, each being surrounded with its own coil, which are wound so as to be traversed by the current in opposite directions; these coils are built up of copper tape. For recording, the usual clock indicating arrangement being attached to the instrument, one terminal of this ammeter is put in contact with the wire to be earthed; the other terminal is connected through the electro-magnetic releasing arrangement of the short-circuiting

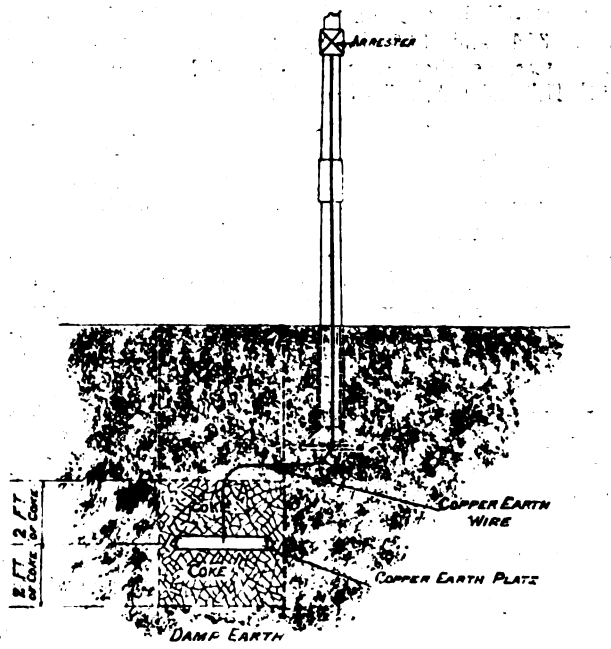


switch to earth. The short-circuiting lever, which consists of an ordinary knife-edge switch, is held out of action by a catch attached to the armature of the electromagnet, round the coil of which passes the current going to earth. The iron core of this electromagnet is so adjusted that when the maximum current allowable passes to earth the armature is attracted, thus raising the catch releasing the switch arm, which falls by its own weight into the contact-pieces, and thus complete the circuit through the switch arm without earth. Further, there is an arrangement on the arm by which the terminals of the coil of the electro-magnet, and therefore the recording ammeter, become short-circuited just before the switch makes contact with the two terminals of the wire that was previously earthed. A diagram of the connections is shown in the accompanying illustration.—J. C. B.

Question No. 304.—What are the best and most useful forms of earth-plates used for lightning arresters?

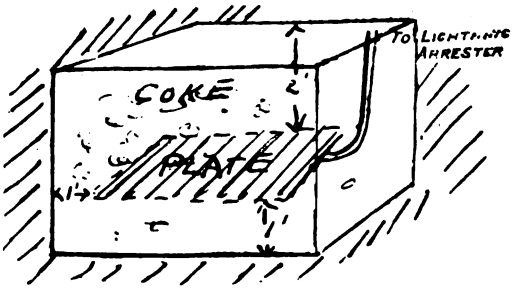
Best Answer to No. 304 (*awarded* 10*s*.).—The entire benefit to be gained by the use of lightning arresters may easily be neutralised by disregarding the importance of providing a good earth connection, so that too great stress cannot be laid upon the absolute necessity of making an efficient connection to earth. How this may be most easily and effectively accomplished will depend upon the nature of the soil at the point at which the arrester has to be earthed. The most desirable place for fixing an earth-plate is in a rich, damp soil, and although this dampness is essential for an efficient connection, the error is sometimes made of thinking that too much water cannot be present, and advantage taken of the close proximity of a pool or stream to totally submerge the plate in water. This is a great mistake, as in reality only a very poor earth contact is made, owing to the high resistance of water. We may also include clay, rock, gravel, sand, and dry earth as being unsuitable substances in which to bury our earth-plate.

The following remarks as to size and method of fixing and connecting an earth-plate may be taken as applying to average cases, although the dimensions are only approximate, and may be often deviated from to suit special requirements; for instance, it may be necessary to bank a large number of arresters together and connect them all to one plate, in which case this must naturally be increased in size. The plate should be made of 16 B.W.G. copper, and be approximately 3ft. square and be well tinned. A hole about 4ft. square should be dug in the ground until permanently damp earth is reached; the bottom of the hole should then be covered to a depth of 2ft. with small crushed coke or charcoal and the earth-plate placed on top of this, and then a further layer of 2ft. of coke, the hole being finally filled in with earth, running water being used to settle. Where it is impossible to find dampness, water should be provided by means of a galvanised iron pipe. The connection from the arrester to the plate should be as short and direct as possible, be made of copper, and well soldered all across the plate. The accompanying sketch roughly illustrates this method of fixing, which is very simple and efficient.

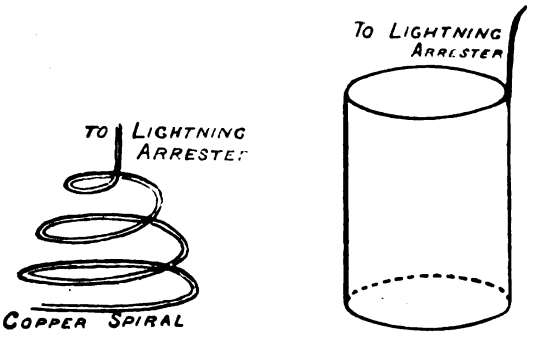


In cases of transmission of power schemes in which barbed wire is stretched from pole to pole above the transmission wires and the poles then earthed, a good connection may be made by burying a galvanised iron plate about 3ft. square at a point as near to the pole as the nature of the earth will allow, the plate and pole being connected by means of barbed wire well soldered to each.—F. A.

Answer to No. 304 (*awarded* 5*s*.).—There are several forms of earth-plates in use with lightning conductors; the most general is a flat copper plate, having an area of about four square feet. This plate is buried in coke, the coke being about 1ft. below, 1ft. round edge, and 2ft. above



the plate. The other forms of plate, which, however, are not in such general use as might be wished, consist of a copper spiral and a copper cylinder. They are buried in coke, and the object they seek to obtain is the tapping of a larger area of earth and the provision of a larger contact surface. The spiral consists of 2in. by ¼in. copper, and the



largest diameter is about 4ft., the height of the coil being also not less than 4ft. The cylinder, besides aiming at a large contact area, also aims at keeping the coke moist, and in such a state that its conductivity is increased. Either of these two forms are preferable to the ordinary flat plate.—A. G. M.

Digitized by Google

Answer to No. 304 (*awarded* 5*s.*).—A thoroughly good earth is really a geological question, and for a building of great importance a specialist on the subject should be consulted. Gas and water pipes should not be used for the purpose, as in dry weather these afford very poor earth connections. The best and most useful form of earth connections consists of a large plate of copper buried in the earth, surrounded with coke, cinders, or carbon, by which the surface of the plate is greatly increased, and a much more intimate contact with the surrounding earth is also made on account of the good conducting properties of the carbonaceous mass. The whole is afterwards saturated with water, thus increasing still further the surface and contact. Further, the copper plate becomes coated with a layer of sulphide by the chemical action, and is thus protected from any further corrosive action of the damp earth. In places where there is a watercourse, such as streams or rivers of sufficient size to be never dry in times of drought, or if lakes or large ponds be near the conductor, it is sometimes thought sufficient to place it in constant contact with the water; but there is always the liability of the metal corroding at the point of the liquid surface, and becoming eaten through, thus breaking the earth connection.—J. C. B.

LUTON ELECTRICITY WORKS.

Last week saw the laying of the foundation-stone of the new electric light works and highways depôt by Councillor Wilkinson, chairman of the Electric Light Committee. The stone bore an appropriate inscription setting forth that it was laid by Councillor Wilkinson, chairman of the Electric Light Committee. The names of the committee and the Council; Mr. A. J. L. Evans, architect; Mr. A. T. Snell, electrical engineer; and the builders were also added. The Mayor (Alderman Hucklesby), wearing his gold chain and robe of office, Mr. T. G. Ashton, M.P., Mr. G. Elliott, aldermen and councillors of the Corporation, representatives of various public bodies, and the borough officials attended. A luncheon followed, at which the usual toasts were proposed and duly honoured. We are indebted to the *Luton Times and Bedfordshire Advertiser* for the following description of the works.

The buildings have a frontage of 122ft. 6in. to St. Mary's-road, and a depth of 64ft., and are set back from the line of street 20ft. The block comprises—on the ground floor, accumulator-room, engine-room, boiler-house, pump-room, coal bunkers and workshop, engineer's office on first floor, and meter stores, etc., on the second. The front elevation to St. Mary's-road is faced with best Luton grey bricks, having panels formed with pilasters of Ibstock, red facings, and moulded bases, the cappings, reckings, and strings being formed with moulded Bath stone. The main entrance into the hall is built with red terra-cotta, having jambs and arch moulded and deeply recessed, also moulded and empanelled spandrils filled in with medallions. The same description applies also to the main entrance into the boiler-house, excepting that the words "Fiat Lux" are added in the spandril panels. Above the entrance a terra-cotta panel embraces almost the whole length of the building, and on this is worked "Borough of Luton Electric Lighting Station." The parapets are surmounted by Bath stone copings with richly-worked pinnacles at feet and apices of the gables. Between the two main gables is placed a large stone panel surmounted by a Grecian double shell hood. On the panel is emblazoned the representation of the borough arms in full relief. The front entrance hall is 8ft. 6in. wide by 16ft. in depth, and floored with pitch-pine wood blocks laid to special design. The walls have a dado of glazed tiles, also of special design. To the left is the drawing office, 20ft. by 16ft., with a floor of similar construction. Communicating with this is the workshop, fitted up with benches, etc.; this room is 20ft. by 16ft., and floored with granolithic paving.

Leaving the workshop, one enters the accumulator-room, 53ft. 6in. by 20ft., with its acid-proof floor laid to gradients, and with channels for quick cleansing. This room is well ventilated by lead-covered louvre frames. The engine-room is next to and communicating with the accumulator-room. Its size is 30ft. by 46ft., and will contain three high-speed engines, each of 1,351 h.p., and dynamos, each 85 kw., with space for future extensions. Here will also be the condensing plant and superheater and steam 42-kw. balancing set with 16-kw. charging dynamo, together with an excellent switchboard and insulating pads and stand. The machinery is to be of the most modern type, and supplied by the best makers. The walls of this room are lined with best white glazed bricks up to about 17ft. in height, and it has a dado of a darker colour of same material, and recessed, having moulded arches over the panels thus formed. The pilasters have moulded cappings, neckings, and bases. The travelling crane is carried on corbels of glazed bricks, running the full length of the room, to which are secured steel runners. This crane has a travelling capacity of six tons, ordinary load. Below the floor levers is a perfect network of pipe and cable trenches covered with iron plates. A clerestory is formed above the line of arcading, giving the north light, which is so desirable in a room of this kind. A skylight running the full length of the room is provided, and this performs the additional office of a ventilator. The height from floor to eaves is 22ft.

The boiler-house is 50ft. by 63ft., and communicates with the engine-house and front entrance hall. It also has a separate entrance in front elevation. Two Lancashire boilers and superheaters, each 30ft. by 8ft., are being placed therein, with economiser. All have special settings of new and approved design. The floor will consist of concrete with granolithic surface. The height from floor to plate is 18ft. The main flue of the boilers is kept at the upper end to allow for any future extension without disturbing the present structure. There is, however, a space reserved for another boiler of similar capacity to those already described, to be filled when occasion should arise. Adjoining the boiler-house is the pump-room, 16ft. by 10ft., which draws the supply of water for the boilers. Over this room is placed the large tank of 6,000 gallons capacity, with cooling tower and access ladder, in all weighing about 30 tons. Immediately communicating with the boiler-house are the coal bunkers, which are so arranged that they can have the coal discharged from ordinary wagons direct, or, if occasion should require, from a siding off the railway which might eventually be constructed. Mechanical stoking could also be applied. The wall of the boiler-house over the large opening into the coal bunkers is carried by an English steel riveted girder, 32ft. long. The material for flooring the pump-room and coal bunkers is precisely the same as used in the boiler-house. The coal bunkers are entered from without by large sliding doors.

The first floor, on which is the chief engineer's office, is reached from the entrance hall by a fire-resisting staircase and landings, having ornamental wrought-iron balusters and richly-moulded mahogany handrail and newel. The latter will be surmounted by a beautifully designed electric lamp. This office is over the drawing office, and is of the same dimensions, being ventilated, lighted, and heated in a similar manner to the room below. The cornices and enrichments will be of special design. This room communicates with a balcony overhanging part of the engine-room, and commands a complete view of everything therein. The second floor, on which are the meter stores, is reached by the continuation of the fire-resisting staircase already described. The buildings are covered with best brindled Broseley tiles on specially designed roof principals, all made of best English steel. A lantern running the full length of the building is constructed in the roof of the boiler-house, having glazed roof, and louvres at the sides for ventilation. The height from the boiler-house floor to this ridge is about 40ft.

The chimney shaft, which stands in the angle formed by the boiler-house and pump-room, but at the same time wholly detached from the main walls, runs to a height of 120ft. above ground level, and weighs about 75 tons; it stands on a bed of solid concrete 25ft. by 16ft. thick. Considerable difficulty was experienced in the process of excavating for the chimney bed, owing to the soft nature of the soil, which necessitated close piles being driven right through to the solid bottom. A good foundation was found at a depth of 25ft. below the surface. The shaft is built to a batter of 1 in 40 with Luton bricks, and lined with firebricks to half its height, with an intervening cavity of 2½in. inside. The whole is built in English bond, and capable of resisting a wind pressure of 42lb. to the square foot. The draught is equal to about 2,000 h.p., which can be considerably increased by forced draught. The shaft is surmounted by moulded necking and corbelled cornices in selected Ibstock bricks, and covered with a cast-iron cap, in sections, bolted together, and weighing 2½ tons. The chimney commences with a square base, and at a height of 26ft. an octagon is formed with broaches at angles of bed. The octagonal form continues to the summit.

At the lower end of the site a cooling pond is to be constructed, and the water from the Lea is to be used for condensing purposes. A few yards away to the north of this pond a well is to be sunk. This well will provide a constant supply of water for the boilers, which is pumped from here to the tank before mentioned over the pump-room. The position of the buildings is so arranged as to admit of very large extensions for the future. A road 36ft. wide is to be formed at the south side of the building, allowing room for carts and trucks, should a siding be constructed. The whole of the foundations, engine and boiler beds, etc., drainage and road-making, will be executed by the Corporation workmen, at an estimated cost of £1,400. The builders are Messrs. Neville Bros., Luton, whose contract amounts to £4,881.

The buildings were designed and will be carried out by the borough engineer (Mr. A. J. L. Evans); the whole of the

Digitized by Google

electrical plant, etc., by Mr. Albion T. Snell, consulting engineer, London.

A HIGH-VOLTAGE WALL PLUG.

The change from low-voltage to high-voltage supply has instigated the manufacturers to pay special attention to accessories suitable for the thus increased voltage, and we have before us a new wall plug, manufactured by the International Electric Company, of 55, Redcross-street, Barbican, London,

E.C., for which it is claimed that as far as insulation is concerned it will answer even the most stringent stipulations of central-station engineers. With this plug arcing, or short-circuiting is stated to be an impossibility, as all the current-carrying parts are deeply embedded in china, and surrounded by the same material, no metal parts being at the back of the china base. The plug itself is provided with a patent porcelain cord grip, and from the point of view of safety the article seems to fulfil all that is claimed by the manufacturers. The plug, of which we give illustrations, is exceedingly cheap, being sold at only 15s. per dozen. We are informed that central-station

engineers and others who are interested can obtain samples free of charge on sending a post-card to the firm.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Rochdale.—Tenders for the supply and fixing of a lift at the infirmary, to be worked by electricity, will probably be advertised shortly.

Hampstead.—The Vestry invite tenders for various plant for their central station, Lithos-road, Finchley road. Tenders by Sept. 27.

Piatra Neamtz (Roumania).—The Municipality invite tenders for the lighting of the town by electricity for 30 years by Nov. 2 concession).

Hoylake and West Kirby.—The Urban District Council invite tenders for wiring premises. Tenders by Oct. 4. Details in our advertisement columns.

Philippopolis (Bulgaria).—The Town Council invite tenders for erection and working of electric lighting and working of tramways. Tenders by Nov. 4 (concession).

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for electricity supply mains. Tenders by Oct. 3. Details in our advertisement columns.

Birkenhead.—The Corporation invite tenders for the supply, delivery, and laying of feeder mains, etc. Tenders by Oct. 2. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of cast-iron bases for tramway poles. Tenders by Oct. 1. Details in our advertisement columns.

Santiago.—Offers are invited for the laying down and working of a telephone system in Santiago de Compostela, in the province of Coruna, Spain. Tenders by Oct. 19.

Azuaga.—Offers are requested by the Municipality of this town, in the province of Badajoz, Spain, for the installation and working of the electric light for 20 years. Tenders by Oct. 11.

Melton (Suffolk).—The Visiting Committee of the Suffolk County Lunatic Asylum invite tenders for wiring and fittings. Tenders by Oct. 5. Details in our advertisement columns.

Fuenteovejuna.—Offers are requested by the Municipality of this town, in the province of Cordoba, Spain, for the installation and working of the electric light for 20 years. Tenders by Oct. 9.

Manchester.—The Directors of the Lancashire and Yorkshire Railway Company invite tenders for the supply of various stores. Tenders by 10 a.m. on Oct. 8. Particulars in our advertisement columns.

Ilford.—The Urban District Council invite tenders for meters (direct-current) and cut-outs. Specification may be obtained from Mr. J. W. Benton, clerk, Council Offices, Cranbrook-road, Ilford. Tenders by Oct. 8.

Horton (Surrey).—The Asylums Committee of the London County Council invite tenders for the installation of boilers, engines, dynamos, etc, at the Horton Estate, Epsom, Surrey. Tenders by Sept. 22.

Whitehaven.—The Water and Lighting Committee of the Corporation invite tenders for the supply and erection of a switchboard at their electric lighting station. Tenders by Oct. 13. Details in our advertisement columns.

Fulham.—The Vestry invite tenders for the supply and erection of plant for unloading and storing coal at their electric lighting works, Townmead road, Fulham. Tenders by Sept. 25. Details in our advertisement columns.

Wigan.—The Corporation invite tenders for steel poles, section pillars, flexible bonds, trolley wire, overhead construction material, bracket arms, and castings. Tenders by 25th inst. Details in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for steam and water pipes, feed pump, water softener, etc., at their Sculcoates-lane generating station. Tenders by Sept. 27. Full details in our advertisement columns.

Aberdeen.—The Tramways Committee invite tenders for the manufacture and supply of 25 electrical tramcars, and equipments for six horse cars, about to be converted. Tenders by Oct. 17. Details in our advertisement columns.

Dublin.—The Corporation invite tenders for electric motors and pumps for Ringsend drainage works. Specifications may be obtained at the office of the consulting engineer, Mr. Chatterton, 6, The Sanctuary, Westminster. Tenders by Oct. 3.

Tunbridge Wells.—The Corporation invite tenders for erection of an octagonal brick chimney shaft, 180ft. in height, at their central electric light station, adjoining S. E. and C. Railway goods station, Tunbridge Wells. Tenders by Sept. 24.

Bradford.—The Corporation invite tenders for the construction and delivery of an engine and dynamo, also switchboard apparatus, etc., for their destructor works, Southfield-lane, Bradford. Tenders by Oct. 9. Particulars in our advertisement columns.

Limerick.—The Town Council invite tenders for erection and completion of an electric generating station building at Frederick-street, Limerick. Drawings and specification may be seen at the office of Mr. J. J. Peacocke, B.E., city surveyor, Town Hall, Limerick. Tenders by Oct. 4.

Walthamstow.—The Council invite tenders for the supply, delivery, and erection of electric lighting plant and apparatus, consisting of gas plant, gas engines, dynamos, switchboard, booster, balancer, and measuring instruments. Tenders by Sept. 25. Details in our advertisement columns.

Bray.—The Urban District Council invite tenders for supplies required at their electric light works for 12 months, including cables, carbons, house wires, switches, lampholders, incandescent lamps, etc. Particulars may be obtained from Mr. P. MacDonnell, clerk of the Council, Town Hall. Tenders by Oct. 4.

Eastbourne.—The Corporation invite tenders for the supply and erection of a water-tube boiler, with fittings, feed pump, etc., a 400-kw. steam alternator, with exciter (vertical enclosed high-speed engine), and main switchboard and connections. Tenders by Oct. 4. Particulars appear in our advertisement columns.

Sheffield.—The Corporation invite tenders for specification No. 3 (a) two two-phase steam alternators and exciters, 600 kw.

Digitized by Google

each; (b) alteration of present single-phase plant to two-phase. Specifications can be obtained from Mr. S. E. Fedden, chief engineer and manager, Commercial-street, Sheffield. Tenders by Oct. 6.

Devonport.—The Corporation invite tenders for supply and erection of (Part 1) two vertical engines; (2) two 300 kw. generators, balancer, battery, booster, and motor; (3) switchboard for electric lighting and traction; storage battery and travelling crane (10 ton). Tenders by Sept. 26. Details in our advertisement columns.

Dundee.—The Dundee Gas Commissioners invite tenders for: (1) overhead travelling crane; (2) economiser; to be supplied and erected at the electric lighting station, Dundee. Specifications, plans, and forms of tender may be had on application to Mr. Walter H. Tittensor, city electrical engineer, Dunhope-crescent-road, Dundee. Tenders by 26th inst.

London, S.W.—The London County Council invite tenders for the supply within 12 weeks of the order being given of the mains required in connection with the electric light installation for the Victoria embankment and Westminster Bridge. Particulars may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 24th inst.

Brighton.—The Council invite tenders for the supply and delivery of 2,000 tons of steel girder tramrails, 78 tons of steel fishplates, 90 tons of steel joists. Specifications and form of tender and all necessary information may be obtained on application at the office of Mr. Thos. B. Holliday, tramways engineer, Town Hall, Brighton. Tenders by Oct. 1.

Aberdeen.—The Electric Lighting Committee invite tenders for supply of (1) two 200-kw. direct-coupled continuous-current generators and one 120-kw. balancing set; (2) one 420-kw. direct-coupled continuous-current generator. Specification and form of tender can be obtained from Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen. Tenders by Sept. 29.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and laying of electricity supply mains and accessories. Specifications and form of tender may be inspected at the office of the city engineer, Mr. Spencer Harty, M.I.C.E., City Hall, Dublin, and at the offices of Mr. R. Hammond, consulting engineer to the Corporation, 64, Victoria-street, S.W. Tenders by Oct. 4.

Medomsley (Durham).—The Parish Council invite tenders for the supply and erection of electric lamps, posts, cables, etc., necessary for the lighting of the road leading from Black Hall Mill to Medomsley Village, via Westwood Colliery. Particulars may be obtained from Mr. M. T. Milburn, Medomsley, R.S.O., clerk to the Council, and the ground may be viewed on making an appointment by letter.

Brighton.—The Corporation invite tenders for the supply and delivery of 25 electric motorcars. The work is divided into three sections, and contractors may tender in respect of all or any one or more of such sections—viz.: (Section 1) 25 electric motorcar bodies; (2) 25 electric motor trucks; (3) 25 electric motor electrical equipments. The specification and form of tender and all necessary information may be obtained on application at the office of the tramways engineer, Mr. Thos. B. Holliday, Town Hall, Brighton. Tenders by Oct. 1.

Long Eaton.—The District Council invite tenders for the construction of a line of poles, also two wires (about 5·10 miles in length), with other accessories, for the purpose of establishing a telephonic and electro-mechanical transmitting and registering and recording apparatus between their waterworks pumping station at Stanton-by-Bridge, near Derby, and the service reservoir at Castle Donington, Leicestershire. Plan may be seen at the offices of the Council, Long Eaton, and specification, with form of tender, obtained on application to Mr. Frank Worrall, surveyor and waterworks manager, Council Offices, Long Eaton. Tenders by Oct. 1.

RESULTS OF TENDERS.

Heywood.—The Corporation have accepted the tender of Messrs. Crompton and Co., Limited, for the supply of plant for the electricity works at £8,389. 15s. 1d.

Aberdeen.—The Tramways Committee have accepted the tender of Macartney, M'Elroy, and Co., Limited, amounting to £6 597. 19s. 10d., for the supply of tramway poles, etc.

Leeds.—The contract for the iron and steel work for the boiler-house has been let to Messrs. Clayton, Son, and Co., Hunslet, and the building trades' contract to Messrs. Irwin and Co., Burley-road. The amount of the contracts is a little over £10,000.

Kensington.—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, have secured the contract for the supply of storage battery required by the Committee of Management of the Kensington and Notting Hill electric lighting for use in the lighting of their Wood-lane works.

Birkenhead.—The Corporation have accepted the tender of Mr. J. Merritt, Adelphi-street, for constructing and erecting a new car-shed in connection with the electric tramways in Laird-street, at £10,183; and the tender of Mr. W. R. Holland, Dacre-street, for alterations and additions to the tramway car-sheds, New Ferry, at £995.

Ilford.—The Urban District Council have accepted the tender and designs of S. Pontifex and Co. for lamp columns—viz., for 20 of No. 5 of the patterns submitted, weighing 2cwt. 3qr., 10ft. high, to be delivered for 30s. each. They have asked Messrs. Pontifex and Co. to quote for lots of 200, 300, 400, and 500 lamp columns.

Aberdeen.—The Town Council have accepted the following tenders: P. and W. McLellan, Glasgow, straight and curved rails, £7. 13s. 9d. per ton; P. and W. McLellan, fishplates, £8. 13s. 9d. per ton; Bayliss, Jones, and Bayliss, Wolverhampton, bolts and nuts, £16. 10s. per ton; A. and J. Main and Co., Possilpark, Glasgow, tiebars, £12. 7s. 6d. per ton.

Bradford.—The Guardians have accepted the following tenders in connection with the electric lighting of the workhouse: C. A. Parsons and Co., Section No. 1, £900; Electrical Power Storage Company, Section No. 3, £1,025; G. A. Steinthal, Section No. 4, £308; G. F. Cook and Co., Section No. 5, £613; C. A Parsons and Co., for steam separator and steam trap, £20.

Newcastle-on-Tyne.—The Corporation have accepted the following tenders: Mather and Platt, Limited, Salford Ironworks, Manchester, for erection of pumping plant for condensing water at the generating station, £1,470; J. J. Robson, Osborne-road, Newcastle, for carrying out the western section of the new electric tramways (Blackett-street, Gallowgate, Barrack-road, Stanhope-street, Westmoreland-road, and Hamsterley-road), £24 505; E. Nuttall, Manchester, for carrying out the eastern section of the new electric tramways (City-road, Walker-road, Raby-street, and Heaton-road), £26,072. 5s.

Tunbridge Wells.—The Town Council have accepted the following tenders for carrying out telephone installation: Henley's Telegraph Works Company, supplying, laying, and jointing of armoured telephone cables, £2,373. 10s.: Reid Bros., erecting and staying poles, wires, arms, insulators, etc., £1,080; General Electric Company, telephone instruments, £843; Wade and Co., creosoted poles, £702. 2s. 3d.; Bolton and Sons, hard copper wire, £518. 2s. 1d.; Telegraph Manufacturing Company, switchboard, £282. 15s. 6d., insulated wires £218. 10s.; General Electric Company, insulators, £216. 19s. 8d.; International Electric Company, lightning arresters and high-tension guards, £102. 1s.; Bullers, Limited, miscellaneous ironwork, £97. 2s. 2d.; Aspden and Co., oak arms, £64. 1s. 2d.; Dennis and Co., iron and steel stay wire, £37. 15s.; India Rubber, Gutta Percha, and Telegraph Works Company, batteries, £35. 5s.; Bolton and Co., soft copper wire, £21. 11s. 8d.; Potter and Co., arm bolts, nuts, and washers, £10.

BUSINESS NOTES.

TRACTION.

Folkestone.—The General Purposes Committee have decided to recommend an electric tramway sceeme, involving an outlay of £95,000.

Lambeth.—The Vestry have declined to contribute towards the cost of widening certain streets by the London County Council in order to construct tramways.

Ince.—The District Council have appointed a deputation to confer with the Hindley and Pemberton Councils upon the question of the purchase of the tramways within their district.

Huddersfield.—At the meeting of the Town Council on Wednesday the Tramways Committee proposed that tramway works be carried out by July 1 next to the amount of £68,953. 6s. 11d.

Sunderland.—The Tramways Committee's former minute relating to the application to the Board of Trade for permission to lay a double line of tramways in Vine-place has been rescinded.

Swinton.—A special meeting of the District Council will be held on Oct. 8 to consider the question of the purchase from the Manchester Carriage Company of the tramways within the district.

Ilford.—The Board of Trade have determined that the tramways authorised by their recent order shall be constructed on a gauge of 4ft. 8½in., and that no engine or carriage is to exceed 6ft. in width.

Ipswich.—Notice will be served upon the Ipswich Tramways Company requiring that company to sell the undertaking authorised by the Ipswich Tramways Order, 1879, to the Corporation of Ipswich.

North London.—A rumour, the source of which we have not been able to trace, is to the effect that an underground electric line from Liverpool-street to Romford is to form the basis of a Bill in the next session.

Torquay.—Mr. J. Taylor's scheme for five miles of electric tramway has been referred to a small sub-committee, who will consider the details and report. The cost of the scheme is roughly estimated at about £50,000.

Reddish.—The Urban District Council's parliamentary expenses incurred in obtaining a provisional order for the construction of a tramway through the district, extending from the Stockport borough boundary to the Gorton boundary, amount to over £560.

Wednesbury.—Notice will be given to the South Staffordshire Tramways Company requiring them to sell to the Council so much of the tramway undertaking as is within the borough of Wednesbury, and as was authorised by the Staffordshire Tramways Order, 1879.

Oberammergau.—According to a recent note in the *Globe*, the Passion Play at Oberammergau has been a great success from various points of view. Since May 24 the electric branch railway line from Murnan to Oberammergau has earned total receipts amounting to £21,222.

Leeds.—The new engines in course of erection at the generating station at Crown Point will be supplied with steam from nine boilers, each 30ft. in length and 8ft. in diameter. The boiler-

Digitized by Google

house will have a second storey which will form a coal store, where 2,000 tons of coal can be stored for an emergency.

Dundee.—Three additional electric bogie cars for the Lochee route have arrived in the city, and are being fitted up to be ready for the Board of Trade inspection of the line on the 27th inst. The Board of Trade have consented to the speed of the cars on the High-street and Nethergate being increased from four to six miles an hour.

Windermere.—The local opposition to the Windermere and district light railway scheme has resulted in the withdrawal of the present application to the Light Railway Commissioners. It is, however, stated that the British Electric Traction Company have made agreements with the local authorities, and will bring forward in November another application.

Hull.—A movement is in progress among the Corporation's electric tramway employés for an eight hours' continuous working day and an alternate Sunday off, or time and a half pay. The Tramways Sub-Committee have the matter in hand, and are endeavouring to obtain information from other large towns as to the working conditions of tramway employés.

Brighton.—The Tramways Committee of the Town Council have decided to take electricity from the Corporation supply for working the tramways at 5d. per unit for the first hour's consumption and 1d. per unit afterwards, and have asked the Lighting Committee to be ready to supply the current by Aug. 1 next. The estimated cost of wood paving the tramway area is £44,067. 16s.

Stourbridge.—Trial trips have been made along the Kingswinford electric tramway during the last few days, and the line will probably soon be opened for public use. Several new cars for this and connected branches have just been delivered at the Stourbridge goods depôt. They are two-deckers, and will carry 65 instead of 28 passengers each, as is the case with the present cars.

Cardiff.—Mr. Ellis, who has within the past week taken up his post, has submitted a report, in which he points out the short time that remains in which to accomplish a good deal of work. As a site for the generating station, Mr. Ellis recommends the committee to secure the Heath Brook site. The committee have come to an agreement to purchase land adjoining the scheduled site, which will enable the work to go on immediately.

Paisley.—The draft tramway order as brought forward by Bailie Bell has been remitted to committee for consideration and report. The cost of the scheme, which is practically the same as that promoted by Mr. Murphy, with the exceptions of the line to Meiklerigge and the extension of the line in Johnstone, is estimated at £200,000. This includes provision for 30 cars and the necessary sheds, £12,000 for the additional electric plant required, with 7 per cent. added to meet contingencies.

Devonport.—The Borough Council have adopted a report of the Tramways Committee recommending that the Corporation construct the lines authorised by the order of 1899 and the Act of 1900 if satisfactory arrangements are come to with the Devonport and District Tramways Company for the working thereof; and, further, that the town clerk be instructed to make an application to the Board of Trade for an extension by 12 months of the time within which the tramway may be commenced and completed.

Hyde.—The Stalybridge, Hyde, Mossley, and Dukinfield Electric Traction and Lighting Joint Committee have agreed to apply for an Act to carry out a proposed joint electric traction and lighting scheme. The capital required for the purposes of the scheme is to be raised by calls in a similar manner to the capital raised under the Ashton-under-Lyne, Stalybridge, and Dukinfield (District) Waterworks Acts, each corporation to contribute £100 towards the general expenses. The Council have ratified the committee's proceedings.

Twickenham.—The London United Tramways Company have written to the Council stating that the attention of the directors had been drawn to the proposed raiding of the district by a scheme of light railways on the part of the Middlesex County Council, and that the directors were prepared to entertain any proposed extensions of the London United system that may be deemed expedient. The Council have agreed to give their careful consideration to any further extensions of the London United system in the district which the company might desire to lay before them.

Holland.—A company has been formed, with the beautiful and simple name of the Zuid-Hollandsche Elektrische Spoorweg Maatschappij, for the purpose of constructing an electric railway to connect Rotterdam with the Hague and Scheveningen. The authorised capital is £300,000 of ordinary shares and £400,000 of obligations, and of the latter £100,000 in 4½ per cents. are now being issued in Amsterdam and Rotterdam. It is reported that the whole of the plant for the railway and all the electrical machinery have been ordered from Messrs. Siemens and Halske, of Berlin.

Sheffield.—A memorial has been presented to the Corporation, asking that in any continuance of the tramway on the Ecclesall-road route hardwood may be placed on either side of the rails. A similar memorial has been presented by the inhabitants of Fulwood-road and district. The matter was brought to the attention of the City Council at its meeting last week, but the chairman of the Tramways Committee said that neither the Highway nor his own committee had considered the matter, and he forebore giving his opinion, as he did not want to pledge the Tramways Committee without their authority.

Esher and the Dittons.—The London United Tramways Company intend to apply for powers to make and work a tramway from their boundary on the Portsmouth-road, Long Ditton, to High-street, Esher, and from Long Ditton, *viâ* St. Leonard's-road and Summer-road to Hampton Court Bridge. The Council will oppose any tramway being made in the district, but they decided last week that it would not be wise to bind themselves with Kingston in their application to the House of Commons, or with Surbiton, who were also anxious to get their help. The successful opposition to the light railway proposed by the British Electric Traction Company gave rise to a vote of thanks to the chairman.

Southend.—Great are the ways of red-tape! At a recent meeting of the Town Council the Electric Lighting Committee reported that an application had been made to the Local Government Board for sanction under the provisions of the light railways order to the use by the Corporation of the land at the rear of London-road, adjoining the Corporation's depôt, as a site for car-sheds and generating station, etc. The Local Government Board having doubts as to their powers in the matter, the Board were interviewed, when the town clerk suggested the difficulty might be overcome by the Corporation selling the land as superfluous land and then repurchasing. No objection to the proposal had been made, and the committee asked for an authorisation to do what was necessary. This was agreed to.

Wandsworth.—The Board of Works have received notice from the London United Tramways, Limited, of intention to apply for powers in the coming session of Parliament to construct the following tramways: Commencing at Hammersmith-broadway and passing along Queen-street, Fulham Palace-road, High-street, over Putney Bridge, High-street, Putney, Putney-hill, Kingston-road, and Kingston-hill, London-road, Clarence-street, over Kingston Bridge to a junction with authorised tramways at Hampton Wick. Also commencing at the junction of High-street, Putney, and Upper Richmond-road, along Upper Richmond-road, and Sheen-road, to Richmond. This communication is now being considered by the General Purposes Committee.

Govan.—The Tramway Committee of the Glasgow Corporation have agreed to recommend that the previous arrangement be amended, so far as applicable to Govan, as follows—viz., that in equipping the tramways in Govan-road from Linthouse to a point east of Whitefield-road, so far as is necessary to give a clear access to the 130-ton crane at Prince's Dock, for electric traction, the overhead construction should be so arranged as to permit, when the necessity arises, for taking any boiler or large piece of machinery along the Govan road, of a clear headway of 23ft. being given in the centre of the street above the level of the tramway rails, instead of at the side of the street, it being understood that the engineers and boilermakers shall use as low a bogie as it is possible to construct when conveying any boiler or other machinery of unusual dimensions along the streets.

Bolton.—At a recent meeting of the Tramways Committee a letter was read from the Turton Urban District Council, asking whether the Corporation would be willing to lease and work as a portion of their system a line between the Royal Oak and Bradshaw, and Dunscar Bridge, and upon what terms. The matter was referred to the borough engineer and electrical engineer to report upon. The borough surveyor was requested to prepare plans for the improvement of the curves of the tramlines at the junction of Knowsley-street and St. George's-road. Lieut.-Colonel Von Donop was to hold an enquiry on the 19th inst. into the application of the Corporation for powers to borrow money for tramways purposes. The borough engineer is preparing plans and estimates of the cost of laying double lines on the whole of the track where practicable, and the Board of Trade have been requested to postpone the enquiry.

Fulham.—The Vestry have received the following letter from the engineer of the London United Tramways Company, Limited: "I beg to inform you that it is the intention of this company to apply in the coming session of Parliament for powers to construct tramways in the parish of Fulham. A tramway commencing at Hammersmith-broadway, and passing along Queen-street, Fulham Palace-road, High-street, over Putney Bridge, High street, Putney, Putney-hill, Kingston-road, and Kingston hill, London-road, Clarence-street, over Kingston Bridge to a junction with authorised tramways at Hampton Wick, making a route mileage in your parish of about 1¾ miles. There will be certain improvements, street widenings, etc., involved in the construction of these tramways, which it will be my pleasure to explain and discuss with your committee at any time which they may make convenient for the purpose between now and the date fixed for making the parliamentary deposits."

New London Electric Railway Scheme.—According to the *Times*, negotiations are practically completed by which the construction of the long-projected railway from Charing Cross to Hampstead will be almost immediately commenced. It is stated that Mr. A. E. Gathorne Hardy, Lord Verulam, Sir D. L. Salomons, Sir E. Leigh-Pemberton, and Mr. J. Browne Martin, who have been acting as directors, have recently retired in connection with the negotiations referred to, and that a new Board will be appointed next week by Mr. Yerkes. The length of the projected line, including the branch to Kentish Town, is about 6½ miles and the total expenditure on the undertaking is estimated by Mr. Housman at between £3 000 000 and £4,000,000. The engineers are Sir Douglas Fox and Mr. W. R. Galbraith, and the solicitor is Mr. Perks, M.P. Mr. Housman will return to New York on the 29th of this month and Mr. Yerkes on Oct 6, but Mr. Davis will remain in London in connection with the scheme.

Thames Ditton.—The Highways and Drainage Committee reported at last week's meeting of the District Council as follows: "A letter was received from Mr. J. Clifton Robinson, stating that attention had been drawn to a proposed scheme of light railways to be promoted by the Middlesex County Council,

Digitized by Google

and stating that his directors were prepared to entertain any further extensions of the scheme in this Council's district which may be deemed expedient. The clerk was instructed to reply that the committee had not received any intimation from the County Council on the subject, and that if the tramways company had any proposals to make the committee would be glad to receive particulars thereof as soon as possible. A letter was received from the surveyor of the Middlesex County Council stating that the London United Tramways Company had submitted plans of the work they proposed to carry out on the portion of main roads within the District Council's district, and that before taking any steps in the matter of approval or disapproval of the plans and the materials proposed to be used, he would be glad to know the views of the District Council with respect to the kind of materials to be used. It was resolved to reply that the Council would require the company to pave, maintain, and repair with hardwood blocks the portion of the roadway which the company are required to maintain and repair under Section 28 of the Tramways Act, 1870, and also the remainder of the roadway in places where the tramway shall be situate within 3ft. of either kerb."

LIGHTING AND GENERAL.

Whitehaven.—The Town Council are taking steps to popularise the use of electric light.

Fallowfield.—The postal authorities are being asked to provide a telegraph office at Fallowfield.

Bangor.—It is reported that the electric light works will be ready by the middle of October at latest.

Trowbridge.—It appears that at present 144 replies have been received from householders willing to take current.

Grantham.—The Town Council are considering the advisability of establishing in the town the municipal telephone system.

Devonport.—Sanction has been obtained to loans of £15,250 for land and £52 700 for works in connection with the electric supply scheme.

Bedford.—The Town Council have decided to increase the price of electric current by 1d. per unit, giving six months' notice to Michaelmas.

Colwyn Bay.—The works by the contractors for both the machinery and buildings for the electric light installation are making progress.

Ince.—A meeting of the District Council is to be held on Oct. 8 to consider the advisability of applying for an electric lighting provisional order.

Walsall.—The Council propose to purchase 542 square yards of freehold land in Pleck-road, for the sum of £130, as a site for a transformer station.

Teddington.—The District Council have decided to engage a parliamentary agent for the purpose of applying for a provisional order for electric lighting.

Millarew.—The North British Electric Supply Company intend to obtain powers to supply with electrical energy the area over which the Council has jurisdiction.

Truro.—The report of Mr. Headley, electrical engineer, St. Austell, on the suggested lighting of the city by electricity, is under consideration by the Council.

Amazonia Rubber and Trading Co.—The directors have declared an interim dividend for the current year on the preference and ordinary shares at the rate of 10s. per share.

New Branch.—The British Thomson-Houston Company, Limited, of 83, Cannon-street, E.C., have recently opened a branch office in Manchester, in the Trevelyan-buildings, Corporation-street.

Barnet.—The North Metropolitan Electrical Power Distribution Company, Limited, started supply on Sept. 1, that being the date specified in their agreement with the Council for lighting the streets.

Barrow.—The Council have adopted a report from Messrs. Kincaid, Waller, and Manville in connection with the further application for sanction to borrow £6,690 for the purposes of electric lighting.

Stock Exchange.—The committee have been asked to allow the Aron Electricity Meter, Limited, 125,000 ordinary shares of £1 each, fully paid, Nos. 1 to 125,000 (special application), to be quoted in the official list.

Heywood.—At the last meeting of the Council it was stated that the tender for the plant at the electricity works amounted to £8,389. 15s. 1d., and it comprised all that was required from an engineering firm.

Swanage.—Letters from the Bournemouth and Poole Electricity Supply Company with regard to their application for a provisional order for the lighting of Swanage have been referred to a committee of the whole Council.

Electric Incandescent Lamp Regenerating Syndicate, Limited. This Company has been registered, Sept. 8, with a capital of £7,500, the object being to carry on the business of electrical engineers, manufacturers, etc.

Ashton.—The sub-committee appointed to visit and inspect electricity stations with a view of ascertaining the best makers and description of generating plant have visited Messrs. Musgraves and the Bolton Corporation electricity works.

Dollar.—The Burgh Commissioners have signed a provisional agreement with the electric company for the electric lighting of the burgh. The minimum number of lamps to be required has been fixed at two arc and 12 incandescent lamps.

Wisbech.—The Town Council are considering the expediency of applying to the Board of Trade in the ensuing session of Parliament for a provisional order to enable them to supply electricity for all public and private purposes throughout the borough.

Direct Spanish Telegraph Co.—The directors announce, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent. on the ordinary shares for the half-year ended June 30.

Paris Exhibition Awards.—The awards given to the firm of Stern Bros., of London and Glasgow, makers of the Fram lubricant, and inadvertedly referred to as having been made in respect to lamps, were awarded for refined lubricating oils and greases and lubricators made by that firm.

Taunton.—The agreement between the Corporation and the National Electric Wiring Company has been terminated, owing to difficulties with regard to the arrangement for payment by the Corporation of a minimum charge. Arrangements are being made whereby the consumers can purchase their installations.

New Agency.—The British Thomson-Houston Company, Limited, of 83, Cannon street, London, E.C., have appointed Mr. J. W. Sheffield as their district manager of the branch depôt recently opened at Trevelyan-buildings, Corporation-street, Manchester, for the sale of electrical apparatus and general supplies.

Scothill Nether.—Representatives from the Northern Counties Electric Supply Company waited upon the District Council last week, and discussed the terms upon which the company would be prepared to apply for necessary powers to enable electricity to be supplied to the Council's district. The matter was left over for further consideration.

Kingswinford.—The deed of transfer of the Kingswinford Electric Lighting Order, 1898, as settled by the Board of Trade, was approved at the last meeting of the Urban District Council. The Clerk reported that the Council had been served with a notice in which the company expressed their desire to press on with the work of laying the mains.

New China Cable.—The Great Northern Telegraph Company and the Eastern Extension Telegraph Company on the 17th inst. completed the laying of the Shanghai-Chi-fu cable, placing Chi-fu, Taku, Port Arthur, and We-hai-wei in direct communication with the central station of the Great Northern Telegraph Company, and thus rendering those places independent of the Chinese land lines.

King's Lynn.—The electrical engineer's last report states that the number of applications for the supply of current is now 213, representing an equivalent of 6,696 lamps of 8 c.p., an increase of 232 lamps during the month. The offer of the committee to the Electrical Chloride Syndicate not having been accepted, Major Cardew has been nominated as arbitrator to deal with the matter.

New Brancepeth Colliery.—A meeting of the Lighting Committee of the Brandon and Byshottles Urban District Council was held at New Brancepeth Colliery last week, when the chairman of the Council, Mr. W. Willis, switched on the electric light for the first time. Twenty-seven electric lamps have been fixed in the public streets. Mr. J. J. Spoor, of Bishop Auckland, was the contractor.

Aberdeen.—The Town Council on Monday resolved that the present salary paid to Mr. J. A. Bell, the electrical engineer, should be increased by annual increments of £50 till it reaches £500 per annum. At the same meeting it was decided to spend £6,600 in constructing a subway for feeder and pilot cables which it will be necessary to lay from the new electric station at Dee village to the different feeding points.

Accident.—A lineman in the employment of the National Telephone Company lost his life at Aberdeen last week owing to the collapse of a standard which several men were engaged in erecting on a block of buildings in Holborn-street. The guy rope at the front of the building broke, and the man was precipitated to the ground with the standard, a distance of 81ft. He died after being admitted to the Royal Infirmary.

Rochdale.—The New Infirmary Committee have agreed that the wiring for lighting the new infirmary be done under the supervision of Mr. Senior, workhouse engineer, the clerk to get prices for the wires and tubing. It is also proposed that the union offices be lighted by electricity by the Rochdale Corporation. The method of installation, etc., has been referred to a sub-committee, which will consult with the workhouse engineer.

Fraud.—William Neal, 38, storekeeper, was convicted on the 13th inst. at Marlborough-street police court for fraudulently obtaining from West-end firms subscriptions towards an outing for the workpeople of the National Telephone Company. Detective West said that Neal had collected £21. 19s. and appropriated it. The "outing" existed only in his imagination. Prisoner pleaded guilty, and said he had done it as he was out of work. Mr. Fenwick sentenced him to a month's hard labour.

Camborne.—As the provisional order for the supply of electricity for public and private purposes in this district obtained in July, 1898, by the Camborne Electricity Company has been purchased by the Camborne and Redruth Tramway Company, negotiations will now be opened by the Council with the company with a view of ascertaining the fullest information as to the conditions, etc., for the supply of electric light for the street lamps, commencing, if possible, on Sept. 1, 1901.

Durham.—We learn that the mains of the Electrical Power Distribution Company, who have taken over the provisional order for the electric lighting of the city, will be completed by about the end of the present month. The work has been somewhat retarded, as the company desire to await the result of the forthcoming

Digitized by Google

enquiry into the Durham, Neville's Cross, and Brandon light railway order, but we understand that the electric light will be available for the city in July or August next.

Knottingley.—Some time ago the Northern Counties Electric Supply Company gave notice that they were going to apply to the Board of Trade for a provisional order to supply the district with electricity for public and private use. The Rural District Council have now resolved to adopt electric lighting if it was found to be cheaper than gas. The clerk has been instructed to ascertain from various companies what the cost would be for public lighting; also the relative value of electricity and gas of 16 c.p.

Sproatley.—An agreement with the Sproatley Parish Council for the establishment of a telegraph office at Sproatley has just been signed. A guarantee of £27 per annum for seven years was required by the postal authorities. Half that amount has been guaranteed by the Parish Council, and the other has been guaranteed by private subscription. From the £27 guaranteed will be deducted all the receipts from telegrams handed in at the Sproatley office, and the guarantors will be called upon to make up only half of the balance remaining.

Enfield.—The Urban District Council have decided to apply for a provisional order for electric lighting in their district. A committee has been appointed to consider the proposals of the Edmonton Electricity Company, the United Electric Light and Traction Company, Limited, and the North Metropolitan Electric Power Distribution Company, and report as to whether it is desirable to enter into an arrangement with either of them, and if so upon what terms, or whether the interests of the district would be better served by proceeding with the promotion of the joint Bill.

Maidenhead.—The Council have adopted the following recommendations of the Electric Lighting Committee with regard to the recent enquiry into their application for £25,000 for purposes of electric lighting: (1) That so soon as the sanction of the Board is obtained the town clerk be authorised to apply to the Public Works Loan Commissioners for the amount sanctioned; (2) that the committee be empowered to instruct the consulting engineers to proceed with all necessary plans, specifications, quantities, and other matters, and to advertise for tenders for executing all the contemplated works.

London Gazette.—The following estates have been released from trusteeship: E. B. Pym, 29, Bramham-gardens, South Kensington, and E. M. Winter, Amberley House, Norfolk-street, Strand. The last day for receiving proofs in the estate of A. G. Inrig (trading as the Globe Electrical Company), 46, Whitepost-lane, Victoria Park, London, is Oct. 2; Mr. E. H. Hawkins, Wholesale Traders' Association, 3, Barbican, London, E.C., is the trustee. A first and final dividend of 2s. 1½d. per pound has been declared *re* H. Sewell, 63, Birklands-road, Shipley, Yorks, payable at Official Receiver's chambers, 31, Manor-row, Bradford, from Sept. 20.

Horsham.—At the last meeting of the Urban District Council the Electric Lighting Committee reported that they had considered the plan and estimate of cost of the proposed building for an electricity supply station, and had taken steps to get the estimate reduced. They now put the approximate cost of the building at £3,100, but stated that the work might possibly be done for £3,000. The committee recommended that the plans should be adopted, that tenders should be invited for carrying out the work, and that they be empowered to engage counsel to represent the Council at the Local Government Board enquiry. This was adopted.

Brechin.—The Angus Electric Lighting Company have submitted to the Police Commissioners a series of proposals to form a basis of an agreement for the lighting of the streets in which cables were to be laid. The company propose to use 16-c.p. incandescent lamps in place of the present lamps and to provide lamps, connections, etc., the present lamp-posts to be allowed to remain. They would also agree to undertake the lighting and extinguishing of the lamps at such hours as should be fixed by the Commissioners, the charge to be at the rate of £1 per 1,000 hours per lamp, which would be at the same rate as paid for gas lighting. The letter is now being considered by the Electric Light and Lighting Committee.

Worthington Pumping Engine Co.—This Company, which rejoices in various titles, one of which is Worthington Szivattygep Reezveny-Tarsasag, has just published a well got-up souvenir of the Paris Exhibition, giving details of 25 of their installations of engines distributed all over the Exhibition. With the exception of three cases, all these engines are to be seen at work. There are 17 pumps comprised in the exhibit at the Eiffel Tower in the American section. In the English section we find an independent compound and one independent triple-expansion condenser. The latter is designed for use with a Willans and Robinson engine of 2,500 h.p. The illustrations of the booklet are well executed, and it is rather interesting to compare thus the various types side by side.

Appointments Vacant.—An engine driver is required at the Corporation electricity works, Bedford.—The Bermondsey Vestry require the services of a resident electrical engineer. Full particulars of these vacancies appear in our advertisement columns. There are also required, for the Cape Government postal service, good Morse sounder clerks, with an average speed of not less than 30 words per minute. Applicants must be single, and not more than 25 years of age, and must bear good characters. The appointments are permanent. Salary £120 to £145 per annum, with an annual increase of £12. 10s. or £15, according to class. Free second-class passage out on signing for two years. There is a pension fund. Letters of application should be addressed to Messrs. Preece and Cardew, 13, Queen Anne's-gate, London, S.W.

Gosport.—The General Purposes Committee are considering a letter from the Corporation of Portsmouth enquiring if the Council had any objection to make to the application to be made to the Postmaster-General by the Portsmouth Corporation for the establishment of a municipal telephone exchange at Portsmouth, the area to be co-extensive with that of the Telephone Company, or if the Council would support the application. It is estimated that with the districts of Cosham, Gosport, and Fareham, and possibly Havant, included in the proposed exchange, 1,000 subscribers could be obtained, and that the price would thus be reduced to £5. 10s. per instrument. The Council are considering a proposal of the Electric Power Distribution Company to take over and work their electric lighting order and to develop the tramways.

Presentation.—An interesting ceremony took place last week at the city electricity works, Bolton-road, Bradford, when a presentation of a case of cutlery, subscribed for by the chief officials and staff, was made to Mr. F. Kershaw, who has recently left the service of the Corporation to take up a post as chief assistant to Mr. A. H. Gibbings, consulting electrical engineer, Bradford and London. Mr. C. B. Holdsworth, chief clerk in the electricity department, who was voted to the chair, spoke of the painstaking and courteous manner in which Mr. Kershaw had always carried out his duties, and of the good feeling that existed between him and the rest of the staff. Mr. S. T. Dalton (chief assistant engineer), Mr. R. A. Chattock (city electrical engineer), Mr. Jones, Mr. Goff, and other officials in kindly terms reiterated the sentiments expressed by the previous speakers.

Swansea.—At the last meeting of the Corporation Electric Lighting Committee it was urged that the Corporation should wire houses free and increase the cost. The Chairman said that an application for such powers would cause considerable delay. The only place where he could find it had been done was Worcester. There the resident engineer received applications and submitted estimates of fittings, which were then supplied by tender by private firms, the consumer either paying for them in a lump sum or by instalments. In the case of the National Free Wiring Company, they supplied the capital—that was the difference. It was eventually decided to recommend the Council not to proceed in the contract with the Free Wiring Company, but to carry out the work itself on similar lines, and the surveyor was instructed to prepare an estimate of the necessary amount to be borrowed.

Hackney.—Considerable discussion took place at the last meeting of the Vestry on the recommendation of the Electric Lighting Committee to receive and open tenders for condensing plant, cooling apparatus, pipework and valves, feed-pump, switchboard and boosters, meters, travelling crane, and workshop equipment. Mr. Richmond moved that the opening of these tenders be deferred six months. He defied the committee to complete the buildings or the chimney stack in less than 12 months, and this plant would not be wanted till then. They had paid a lot of commission already for work put on order, which would not be delivered for 12 months. Therefore any sensible or discreet business man would adjourn the acceptance of these tenders. At the present time the cost of every metal was at the apex; prices could not be higher. Therefore by accepting these tenders now they would be throwing ratepayers' money away. The amendment was rejected, and the committee's report carried, the tenders being initialled by the chairman, and referred to the Electric Lighting Committee and the engineer to consider and report upon.

Blackhill.—Mr. Thomas Trotter, of Blackhill, in the *Consett Guardian* gives details of his proposal for the working of an electric light, refuse destructor, and tramway scheme. He estimates that with fares 60 per cent. below those of the railway companies for the same distance, two cars at 2d. per passenger (only two are counted as working, one being spare in case of a breakdown), and making 51 journeys per diem, would earn on an average 1s. 4d. per journey operating 6·5 days per week. This would total to £2,298. 8s. per annum. To this he adds the assumed gas account saving of £500, and thus £2 798. 8s. would be obtained from the combined tramway and lighting scheme. The waters of the Derwent are to be utilised, and the expenditure he estimates as follows: one waterwheel, £250; dam construction, £350; two 30-kw. dynamos at £110, £220; storage batteries, £120; three cars at £350 each, £1,050; poles and trolley wire erected, £1,250; power-house, £220; car-shed, repair shop, and office, £230; rails and track making, £7,500; cables, etc., £420; lamps and sundries, £390; legal expenses at 5 per cent., £600—total, £12,600. Working expenditure per annum: one commercial manager, salary, £104; one electrical engineer, and one mechanic at 38s. per week, £197. 12s.; four car drivers at 6d. per hour, 8½ hours per day, 6½ days per week, £287 6s.; four conductors, same hours, at 3d. per hour, £143. 13s.; three machine minders at 6d. per hour, eight hours per day, seven days per week, £218. 8s.; one labourer at 6d. per hour, 48 per week, £62; interest on £12,600 at 3 per cent., £378; depreciation, 5 per cent. on capital, £630; sinking fund, £630; sundries, £125—total, £2,776. 7s. Therefore estimated income £2,798. 8s. minus £2 776. 7s. working expenditure leaves a balance of £22. 1s. per annum on the right side.

Lowestoft.—Application is to be made for a loan of £20,000 for electric lighting extensions on the basis of the following figures: A three-wire network to be laid in the following streets—London-road, town hall to park, Victoria arcade, London-road South, Pakefield road, Suffolk-road, Waveney-road, and Marina, £930; 39 arc lamps, posts, and cables (complete), £1,595; spare 3in. stoneware pipes (7,400 yards in all), £617; alterations necessary

Digitized by Google

for strengthening buildings, raft for engine-room, concrete flooring for boilers, deepening trench across harbour to satisfy Great Eastern Railway Company, £1,000; a three-wire distributing network to be laid in the following streets—Tonning-street (part), Bevan-street (part), Clapham-road (part), Gordon-road (part), Alexandra-road, Arnold-street (part), Old Nelson-street (part), Commercial-road (part), Duke's Head-street (part), Kirkley Cliff-road, Carlton-road, Beach-road, Grove-road, and Whapload-road (part), £1,875; two feeder cables and pilot wires from the generating station to Pakefield and Belle Vue Park respectively, £3,608; additional network to be laid as and when desired, £3,000; additional meters, cut outs, and house services, £2 000; one 250-kw. steam dynamo with accessories, together with boiler pipework and switch gear, etc. (complete), £4,175; legal and advertising expenses, printing, engineering fees, etc, £1,200—total, £20,000.

Salford.—The *Salford Reporter* has the following report on the local tenders recently accepted by the Corporation: "Alderman Shaw moved the acceptance of the tender of Messrs. W. T. Glover and Co., Limited, for supplying delivering, and laying the lighting cables, tramway feeders, and street-lighting accessories for the sum of £159,648. 12s. 8d. This was the lowest tender which conformed to the specification, and the cable would be subjected to the test mentioned in the specification before it was taken over. The consulting engineers would see the cables tested. Councillor Higson said there was one tender lower than Messrs. Glover's, but the reason it was not accepted was because they proposed to substitute tar in place of a bituminous compound. The British Insulated Wire Company, of Prescot were £650 below, but they did not conform to the specification. He congratulated the Council and Messrs. Glover that they had a firm within the boundaries of the borough capable of undertaking the work. Councillor Hailwood asked what the time limit was for the completion of the contract. Alderman Shaw: Before we are ready. The Mayor said he was pleased to find that there were local firms capable of doing the work they required. He had heard it said that directly they had some money to spend, they spent it a considerable distance from their own town. The local firms, such as Mather and Platt's, Galloways, and one or two others, could do their work, and it was pleasant to think that they were practically employing their own people. The resolution was carried."

Wrexham.—The Corporation of Wrexham will shortly be in a position to supply electricity for lighting and other purposes, and they have circulated a pamphlet for the use of intending consumers, from which we take that distributing cables are being laid in the following streets and roads, but the Corporation will consider requests for cables to be laid in other streets: High-street, Town-hill, Hope-street, York street, Chester-street, Regent-street, Bridge-street, Charles-street, Queen-street, and Henblas-street. Egerton-street is proposed to be included. The anonymous author of the pamphlet remarks, justly, that in the case of churches, chapels, or other buildings where large numbers of people congregate, it is well known that, with other artificial forms of lighting, unless ample ventilation is obtained, the building soon becomes unbearably hot and stuffy, and the atmosphere impure. With electric lighting the advantages are very apparent, and instead of a hot stifling atmosphere it is pleasant and cool. We give the concluding remark, entitled "Municipal Control," in full: "The Corporation incur a large expenditure in order to supply electricity in the borough for lighting, power, and other purposes, and if the ratepayers largely support this scheme, by taking a supply of electricity, the cost of generating can be so reduced that the consumers may expect to reap a substantial benefit therefrom. The profits made by the Corporation on the undertaking will not, as in the case of a company, be distributed in dividends, but will go towards cheapening the cost of supply, and indirectly diminish the rates. If those ratepayers of the borough who are in a position to avail themselves of a supply of electricity will give the scheme their liberal support, its success, from a commercial and financial point of view, will doubtless be assured."

Telephony in Mid-Wales.—Colonel Pryce Jones, M.P., who takes a keen interest in the proposal to extend the facilities for telephonic communication to the principal towns of Montgomeryshire and to Aberystwyth, has been in communication with the Postmaster-General on the subject, but from the letter given below it will be seen that he considers the demand for such facilities is not likely to be sufficient to justify the Post Office in making any move in that direction. Colonel Pryce-Jones does not propose to let the project drop, and he proposes to ascertain the minimum number of subscribers requisite to justify the extension of the system at any rate to Newtown. The following is the letter of the Postmaster-General: "General Post Office, London, Sept. 10, 1900 Dear Colonel Pryce-Jones,—I have had local enquiry made regarding your proposal that the Post Office telephone system should be extended to Newtown, Welshpool, Aberystwyth, and other towns in Mid-Wales, and, judging from the reports which have been received, I fear that there is little probability that sufficient support would be forthcoming from any of the towns or districts named in your letters to justify the expenditure that would be involved. At Newtown there appear to be only seven firms besides your own who are at all likely to avail themselves of telephonic communication, and even they, it is feared, would not take advantage of the facilities to any great extent, as they do not at present make much use of the public telegraphs. As regards the other parts of the district the prospects seem even less hopeful, as the great majority of the people, being engaged in agricultural pursuits, would have little occasion to use the system. I am sorry not to be able to send a more favourable reply, and I shall be happy to consider any local representations showing that adequate public support would be given to any extension of the trunk telephone system, such as you say in your last letter are likely to be forthcoming.—Truly yours, Londonderry.—Colonel Pryce-Jones, M.P."

Batley.—The plans for the electricity works to be erected off Field-lane, according to the *Batley News*, comprise a boiler-house, 61ft. by 64ft.; engine-house, 64ft. by 31ft.; condenser-house, 18ft. by 17½ft; and accumulator-house, 24ft. by 33½ft., with offices, stores, lavatories, etc. The chimney will be 6ft. in diameter and 150ft. high. The generating plant for the supply of power to the tramways, and for public street and private lighting, will consist of three Lancashire boilers, each 30ft. long by 7ft. 6in. in diameter, equipped with mechanical stokers, electrically driven, and three triple-expansion engines, each rated at 250 h.p., but capable of running for short periods at 300 h.p. These engines will be of the high-speed enclosed type, running at 400 revolutions per minute. The dynamos will be directly coupled to the engines, and will each have an output of 150 kw., and an emergency output of 180 kw. each. The machines will be so arranged that they may be used for either lighting or traction purposes. In the former case they will generate current at a pressure of 440 volts, and in the latter at 525 volts. The exhaust steam from the engines will be condensed by a large jet condenser, the pump for which will be steam driven. An economiser will be provided for heating the feed water for the boilers. The feed pumps for the boilers will be electrically driven, and an injector will be installed as a stand-by. The lighting of the town will be done on the three-wire system, the supply to consumers being at 220 volts. For purposes of balancing the load on each side of the system, a "balancing" machine, consisting of two 10-kw. dynamos, coupled together, and mounted on one bed-plate, will be used. A set of 252 accumulators of 400 ampere-hours capacity is being provided, the cells being charged by means of a special motor generator. A separate switchboard will be provided for both the lighting and traction systems. A travelling crane of 15 tons capacity will be arranged to run the whole length of the engine-room to afford facility for handling the plant. The feeder cables will be laid in cast-iron pipes, and the distributing cables in stoneware casings. The principal streets will be lighted by 20 arc lamps of 2,000 c.p. each. The trams will be run on the overhead (trolley wire) system. Messrs. Lacey Clirehugh, and Sillar are the consulting engineers

HAMPSTEAD ELECTRICITY ACCOUNTS.

The following is the report of Mr. A. P. Johnson, clerk to the Vestry of St. John, Hampstead, to the Lighting Committee on the working of the electricity department of the Vestry for the 12 months ended March 25, 1900:

It is again my pleasant duty to congratulate the Vestry and the ratepayers of the borough upon the result of a commercial enterprise of such unqualified success. For during the past year the undertaking has continued to steadily expand, with the result that larger profits have been secured and the price of the current supplied to consumers substantially reduced. This statement of loans requires little comment. It will be noted that only one loan—viz, £2,560 to meet the expenditure on the West End-lane arc lighting scheme—has been negotiated during the year. Still, this by no means represents the capital expended during that period, as by reference being made to the capital account it will appear that there is a balance of over £30,000 due to the treasurer. To in part meet this adverse balance, the Vestry have applied to the London County Council for the necessary sanction to raise a loan of £97,178. Negotiations for this loan are still pending. It will be remembered that this sum of £97,178 is principally to meet the capital outlay on the building and equipment of the large additions now being made to the present station, a small part of this amount being allocated to meet the annual increase of expenditure on mains, transformers, meters, etc. As foreshadowed in my last report, the total amount of loans repaid during the year has considerably increased, in fact, more than doubled that of the previous year—viz., £2,896 against £1 197. Of necessity, the net profits of the year have suffered thereby, yet the fact that the capital is being so steadily repaid is one of the distinctly favourable features of the year's trading. The question, however, which is now exercising the minds of many members of your committee is: "Is the capital being repaid fast enough, having regard to the rapid deterioration of the plant of an electric lighting station?" It would appear that the only safe course to pursue is to undertake the formation of a depreciation fund. Attention is directed to the fact that the last loan negotiated (referred to above) carries interest at 3¼ per cent., whereas the interest on the three previous loans was 3 per cent. The present condition of the money market points to a still higher rate of interest having to be paid on loans raised in the near future. It will be seen that the total capital outlay has reached the sum of £162,212—an increase during the year of £36,802. Building and machinery account for a large portion of this increase—viz., £11,436 and £10,952 respectively, or a total of £22,388. It is only fair to point out that of this latter sum £11,820 has been so far unremunerative, as this sum represents the amount expended, to the date of closing the accounts, upon the enlargement of the station. Mains, transformers, meters, etc., account for the remaining increase of £14,414. Of this sum the West End light

Digitized by Google

ing scheme made up £2,185, and the remainder is the usual yearly outlay incurred to meet the continued growth of the undertaking. It will be noticed that the sum of £1,160 again appears in this account as the value of the lands belonging to the Vestry appropriated for the purposes of the station. This sum is a purely nominal one, and by no means represents the true state of affairs. Your committee decided that the only proper course to pursue was to purchase the stoneyard outright, and to debit the undertaking with the fair market value of the site thus appropriated. By agreement between yourselves and the Works Committee this value has been fixed at £12,500. The consent of the Local Government Board is now being sought to carry out this equitable transfer. In the event of this arrangement being ratified, the capital account next year will be swelled by that amount. Two transfers from the revenue account to this account have been made during the year. The Vestry adopted the suggestion which I ventured to put forward in my last report—viz., of transferring the sum of £873, that being the amount disallowed by the London County Council on the loan transactions up to date, from the revenue account. In addition, the Vestry resolved to defray out of revenue the sum of £218 for arc lighting expenditure, for which sum a loan had been sanctioned. The increase in the capital expenditure for each period since the commencement is shown by the following figures:

		Increase.
15 months to Christmas, 1895	£56,522	—
15 months to Lady Day, 1897	83,331	£26,809
12 months to Lady Day, 1898	100,177	16,846
12 months to Lady Day, 1899	125,410	25 233
12 months to Lady Day, 1900	162 212	36 802

The working expenses, revenue, and gross profits are disclosed by the revenue account. Taking the expenditure first into consideration, the total working costs amount to £14,336, as against £11,363 last year—an increase of 26 per cent. It will be noted at once that the item "coal," amounting to £7,357, is more than half the total expenditure. This item shows an increase of £2 226, or nearly 50 per cent. over that of the previous year. Unfortunately, the increased output of the station cannot be made accountable for the whole of this heavy expenditure. It will be found that the increased price of coal is the main factor, and one that must still more seriously affect the economical working of the station in the future. The amount expended on repairs and maintenance is £678, as compared with £1,446 the previous year. It will be within the recollection of your committee that during 1898-9 exceptionally heavy outlays had to be made on these items, as fully detailed in my report for that year; fortunately, during the past year it has to a great extent been found unnecessary to incur any such heavy outlay. As a set-off to this, however, the distribution expenses have reached £674, as against £187 last year. The chief cause of this large increase is attributable to mains. This is an expenditure which must of necessity increase the older and larger the undertaking becomes. The increase in expenditure on repairs and renewals of public lamps is accounted for by the larger number of lamps erected and in lighting in the borough. Only one other item calls for comment—viz., discounts. Last year this amounted to £611, and this year to £8. 7s. 10d. This decrease is due to the introduction of the demand indicator, which directly extinguishes this item, although indirectly a much larger discount is, as a matter of fact, allowed to "paying" consumers under that system. Turning to the revenue side, the total receipts amount to £30,661, an increase of £6,283, or 26 per cent. as compared with the previous year. This can fairly be considered satisfactory, considering the new system of charge, coupled with the decrease in the revenue derived from public lighting. The average revenue per 8 c.p. lamp connected works out to 6s. 2d., as against 6s. 4d. the previous year. The comparison between the last two years as to the revenue derived from private and public lighting, taking into account discounts, is as follows: for 1899-1900 private lighting, £27,767; 1898-1899, £21,010—increase, £6,757. For 1899-1900 public lighting, £1,734; 1899-1899, £1,923—decrease, £189. The decrease thus shown in the public lighting is entirely due to the altered system of charge for the current supplied to the arc lamps. Formerly the charge was 6d. per unit with discounts, now the charge is fixed at £28 per annum per arc lamp, this charge representing the actual cost of supplying the current, together with renewals, etc. The result of this change has brought about a decrease in the revenue, notwithstanding the increase in the number of lamps in lighting. It is obvious, therefore, that formerly a considerable profit was secured under this head—this profit has, however, now ceased to exist. It may be remarked, *en passant*, that during the year the price to private consumers has again been largely reduced—the largest reduction so far made—namely, 6d. per unit for the first hour, and 2½d. afterwards, against the previous charge of 6d. for the first two hours and 2½d. afterwards. I here append the usual table showing the expenditure and income under their various heads (see Table A).

I cull the following figures from a report of the engineer presented to your committee, as being of interest: Lamps (8 c.p.)—1899, 82 672; 1900, 104,579; increase, 21,907. Consumers—1899, 1,268; 1900, 1,671; increase, 403. Weekly outputs in units: Highest winter load—1899, 43,027; 1900, 63,441; increase, 20,414. Lowest summer load—1899, 11,181; 1900, 14,633; increase, 3,452. A severe check was given to the number of consumers connected during the year owing to the Vestry having to refrain from taking new customers. This was unavoidable through lack of power at the station. Sir William Preece, the expert called in by the Vestry at the outset, reported in 1891 as follows: "If the experience of other localities is any guide, we may reasonably hope

TABLE A.

Item of income and expenditure.	15 months to Christmas, 1895.	15 months to Lady Day, 1897.*	12 months to Lady Day, 1898.	12 months to Lady Day, 1899.	12 months to Lady Day, 1900.	Total.
INCOME.	£	£	£	£	£	£
Sale of current	3,432	11,583	14,238	21,190	27,776	78,219
Public lighting	1,039	1,470	1,145	2,354	1,734	7,733
Rental of meters	142	365	531	802	1,108	2,948
Sundry receipts	3	8	16	32	43	102
Dividends on stock	—	—	—	—	79	79
	4,607	13,426	15,930	24,378	30,740	89,081
EXPENDITURE.						
Generation—	£	£	£	£	£	£
Coal	2,036	3,101	3,330	5,131	7,357	20,955
Oil and stores	351	353	403	574	856	2,537
Wages at station	948	1,101	998	1,313	1,898	6,258
Repairs to:						
Buildings	81	13	9	63	33	199
Engines and boilers	214	777	254	1,091	633	2,969
Dynamos, etc.	4	8	3	2	—	17
Machinery, tools, etc.	25	21	11	291	15	363
Distribution—						
Wages to fitters, etc	8	—	—	—	—	8
Repairs to mains	10	115	100	44	403	672
Consumers' apparatus	13	15	10	67	76	181
Distributing apparatus	67	104	17	75	195	458
Public Lamps—						
Repairs and renewals	164	259	271	255	365	1,314
Rates, taxes, etc.	394	442	362	353	381	1,932
Management—						
Salaries of engineers	670	875	868	991	1,308	4,712
Stationery and printing	154	159	166	113	220	812
General charges	290	282	280	276	393	1,521
Special Charges—						
Insurances	81	117	95	92	94	479
Discount	98	356	550	611	8	1,623
Testing meters, etc.	—	2	11	20	62	95
Sundries	—	69	109	—	38	216
Repayments, Interest, etc.						
Repayments	464	595	1,188	1,197	2 896	6.340
Interest on loans	1,034	1,692	1,730	2,971	3,723	11,150
Interest on overdrafts	416	1,066	1,251	493	348	3,574
Bad debts and allowances	—	4	8	14	81	107
Transfers to loan deficits, etc.	—	—	—	—	1,091	1,091
Totals	7,522	11,526	12,024	16,037	22,474	69,583

* In this year an additional amount of £68. 13s. 6d. was written off for preliminary capital expenses.

that in Hampstead we shall ultimately supply and fix about 24,000 16-c.p. lamps." This statement was, at the time, thought by many to be extremely optimistic. It will be gathered from the above figures that at Lady Day, 1900, the number of 16-c.p. lamps fixed was equivalent to 52,290! From the net revenue account it will be gathered that repayment of principal of loans, with interest, absorbed no less than £6,619 out of the gross profits of £16,325, while interest on bank overdraft (£348), and bad debts and allowances (£81) still further reduce the figures to £9,277, which, however, are increased again by the interest on stock investment (£80) to £9 357. As formerly, I would point out that, assuming the Vestry to be a private company, and the principal repaid to be equivalent to a contribution to a depreciation fund, the shareholders' dividend (assuming again that the whole of the remaining profits were appropriated for this purpose) would be 8·23 per cent. I give the "dividends" of previous years by way of comparison, it being necessary, however, to again point out that the decrease last year is brought about by the reduction in the price of the current: 1896-7, 5·59 per cent.; 1897-8, 7·0 per cent.; 1898-9, 9·5 per cent.; 1899-1900, 8·23 per cent. The following table gives the gross and net profits since the commencement of supply:

Gross profit.		Interest and principal of loans.	Interest on overdrafts, less credits.	Bad debts.	Net profit.
	£	£	£	£	£
To Christmas, 1895 (loss)	1,002	1,498	416	—	2,916 (loss)
Lady Day, 1897	5,258	2,288	1,066	4	1,900
" 1898	8,081	2 917	1251	8	3,905
" 1899	13,015	4,168	493	14	8,340
" 1900	16,325	6,619	268	81	9,357
	41 677	17,490	3,494	107	20,586

The total net profit, therefore, since the commencement of the supply is £20,586. Of this sum, £69 was allocated to write off th

Digitized by Google

preliminary expenses in 1896-7, while during the past year the deficit of £873, disallowed by the Council from the Vestry's applications for sanctions for loans, and the item of £218 in respect of arc lighting capital expenditure, for which a loan had been sanctioned, have both been defrayed out of revenue account, thereby still further reducing the surplus to £19,426. Of this surplus, it will be remembered that the Vestry have already invested £6,000 in London County 2½ per cent. consolidated stock as the first instalment of the reserve fund. Acting on the resolution of the Vestry—viz., that so far as the profits will allow, the reserve fund shall be kept up to 10 per cent. of the total capital outlay, in accordance with the terms of the provisional order—your committee have, on the presentation of these accounts, invested a further sum of £10,221 in the same stock. Thus there is at present standing to the credit of the reserve fund £16,221, an amount equal to 10 per cent. of the total capital outlay to Lady Day last. With regard to the balance—viz., £3,205—this has by the advice of your committee been placed to the formation of a depreciation fund, an amount equivalent to nearly 2 per cent. of the total capital. To show the allocation of the profits at a glance I append the following:

Total net profits as per above statement	£20,586	Written off for preliminary expenses, 1896-7	£69
		Loan deficit	873
		Transferred to cover capital expenditure, arc lighting	218
		Reserve fund.....	16,221
		Depreciation fund	3,205
	£20,586		£20,586

As regards the reserve and depreciation funds, I believe I am correct in stating that no other municipal undertaking in London of a like nature stands in so favourable a position as does that of the Hampstead Vestry. The wisdom of the Vestry in so dealing with the profits is unquestionable, for it must be understood (1) that the whole of the loans are borrowed for a period of 42 years; (2) that renewals during that period cannot be met by further loans; (3) that taking into account the high and continuous pressure at which the station is run, very heavy renewals of plant, etc., will have to be made from time to time; (4) that constant changes and improvements take place in the electrical world necessitating the replacement from time to time of antiquated plant by new and improved machinery, etc.; and (5) that in case of sudden and unforeseen accident or calamity happening at the station or elsewhere there is no fund to fall back upon save that of the rates. It is the primary wish of your committee to first place the undertaking in such a sound financial position that when in the future contributions can be made to the rates, such contributions shall be both uniform and sustained. The balance-sheet calls for no comment. The assets, as far as the consumers' accounts are concerned, are now almost wholly realised, and the liabilities entirely discharged. The engineer's statement as to the number of units generated, etc., is attached to the accounts as usual.

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		1,711,782
Quantity sold { Public lamps.....	122,232	1,418,442
Quantity sold { Private consumers	1,296,210	
Quantity used on works		13,720
Total quantity accounted for		1,432,162
Quantity not accounted for		279,620
Number of public lamps		89
Total maximum supply demanded (kilowatts)		1 198

PROVISIONAL PATENTS, 1900.

SEPTEMBER 10.

16049. Improvements in electric commutator bars. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William Le R. Emmet, United States.) (Complete specification.)

16050. Improvements in controlling high-potential electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward W. Rice, junior, United States). (Complete specification.)

16051. Improvements in systems of electrical distribution The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

16052. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

16064. A new or improved apparatus for automatically charging accumulators. Béla Klein, 55, Chancery-lane, London.

16081. A device for putting into and cutting out of circuit liquid rheostats operated by means of compressed air. Coleman de Kandó, 18, Buckingham street, Strand, London. (Complete specification.)

16082. Combined reversing switch and automatic maximum current interrupter for multiphase reversed current motors. Coleman de Kandó, 18, Buckingham-street, Strand, London. (Complete specification.)

SEPTEMBER 11.

16094. Walsh's connection rope to table attachment for use in the drawing in of electrical cables through iron, earthenware, or other conduits. Edward Walsh, 28, Newhall-street, Dudley.

16127. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

16128. Improvements in compounding electric alternators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, junior, United States.) (Complete specification.)

16129. Improvements in dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

16130. Improvements in high-potential electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett and William Le R. Emmet, United States.) (Complete specification).

16144. Improvements in apparatus or means for varying the speed of electromotors. George Jackson Churchward and Francis Loder Waite, "Fairholm," Swindon.

16146. Process of making metallic duplicate phonograph records. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16147. Improvements in electrically-propelled motor vehicles. Thomas Jefferson Ryan, 18, Buckingham-street, Strand, London. (Complete specification.)

16148. Improvements in electrically-propelled motor vehicles. Thomas Jefferson Ryan, 18, Buckingham-street, Strand, London. (Complete specification.)

16159. Improvements in and relating to lifting magnets. Eugene Bradley Clark, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16164. Improvements in electrical measuring instruments. Arthur Cecil Heap, 28, New Bridge-street, London.

SEPTEMBER 12.

16225. Improvements in measuring electrical energy and in apparatus therefor. Rankin Kennedy, 89, Gathorne-terrace, Leeds.

16226. Improvements in or relating to machinery or apparatus for covering electric cables, wires, and other cores. Isaac Lovell Berridge and Benjamin Kerr, 111, Hatton-garden, London.

SEPTEMBER 13.

16289. Improvements in induction coils or transformers. Herbert Watson Sullivan, 19, Great Winchester-street, London.

16290. Improvements in and connected with electric circuits for the transmission of energy by variable currents. George Ashley Campbell, 55, Chancery-lane, London. (Complete specification.)

16291. An electromagnetic regulator of the admission valves of gas or oil motors. Charles Denton Abel, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London. (La Société Anonyme des Anciens Etablissements Panhard et Levassor, France.)

16293. Improvements in electric furnaces. John Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery lane, London. (La Société Electro-Metallurgique Française, France.)

16299. Improved construction of electric switch. Eduard Schulz, 166, Fleet-street, London.

16308. Improvements in switchboards applicable for electric call apparatus. Charles Shore and Charles Heap, 6, Bank street, Manchester.

SEPTEMBER 14.

16329. Improvements in or connected with electrical switches. Samuel Simpson Berry, Market-street, Huddersfield.

16357. Improvements in underground electric railway systems. John Denis O'Brien, 23, Coleman-street, London. (Charles Alexander Balph, United States.)

16375. Improvements in accumulator boxes. Henry Herbert Hill and William Frederick Hill, 4, South-street, Finsbury, London.

16389. Improved apparatus for trimming commutators. John Phillips, 37, Chancery-lane, London.

16395. Improvements in electric locomotives. John Smith Raworth, 46, Lincoln's-inn-fields, London.

16408. Improvements in the electrodes of electrochemical accumulators. Johannes von der Poppenburg, 160, Friedrichstrasse, Berlin, Germany. (Complete specification.)

SEPTEMBER 15.

16424. Improved automatic electrical cut-in and cut-out switches. Joseph Edmundson, Penny Bank-chambers, Halifax.

16466. Improvements in electro-hydraulic brakes. André Goldschmidt, 6, Lord-street, Liverpool.

Digitized by Google

16458. Improvements relating to the terminals of fuses, switches, and other electrical appliances. Archie George William Baxter, 18, Southampton-buildings, Chancery-lane, London.

16483. Improvements in portable electric batteries. Manes Ephraim Fuld, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Oct. 6.

1899.

14304. Application of electric motors for automobile vehicles. Thompson. (Cantono.)

18550. Armoured insulating conduits and the method of treating same. Brookes. (Lougee.)

18759. Disconnecting boxes for electric cables. Fowler and Reason Manufacturing Company, Limited.

19710. Wireless telegraphy. Brown.

20110. Electrical accumulators. Loppé, Morin, Martin, and Griner. (Date applied for under International Convention, April 1, 1899.)

20387. Manufacture of cement applicable for uniting porcelain, glass, metal, and other substances for the manufacture of electric glow lamps and for dental and other purposes. Sehr.

20438. Means for holding shades or globes for electric and other lights. Barker.

20793. Apparatus for regulating the speed of gas and like engines driving dynamo-electric machines. Richardson and Highton.

21082. Electric circuit breakers. Wright. (Date applied for under International Convention, March 23, 1899.)

21083. Controllers for electric motors. Davis and Wright. (Date applied for under International Convention, March 24, 1899.)

21670. Alternating electric current transformers. British Thomson-Houston Company, Limited. (Everest.)

21810. Electrical measuring instruments. Davis and Conrad. (Date applied for under International Convention, April 1, 1899.)

22164. Electromagnetic ignition device with revolving armatures for gas, petroleum, and similar motor engines. Thompson. (Sturm.)

22754. Alternating arc lamps. Davy.

23293. Trolley stands for electric railways. British Thomson-Houston Company, Limited, and Samuelson.

24437. Coin-controlled mechanisms for use in connection with prepayment electric meters or the like. British Thomson-Houston Company, Limited. (Cox.)

24740. Electric switches. Ely.

25701. Controlling apparatus for electric motors. Steven and Haigh.

1900.

7133. Incandescence electric lamps. Lake. (Washburn and Tinkham.)

12152. Method of increasing the capacity of lead secondary batteries in practical use. Heim.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Sept. 15	743	806	- 63	11,694	10,397
Birmingham Trams.	,, 17	4 579	4,439	+ 140	160,457	152,797
Blackburn Corp'rat'n	—	—	—	—	—	— *c*
Blackpool Corporatn.	,, 13	1 492	966	+ 526	22,080	16,843
Blackpool-Fleetwood	,, 17	1,329	1,136	+ 193	15,850	15,934
Bradford City Trams	,, 16	605	395	+ 210	12,327	9,930
Bristol Tramways Co.	,, 14	3,683	3,360	+ 323	—	—
Carlisle Tr'mw'ys Co	,, 15	214	—	—	2,291*f*	—
Central London Ry.	,, 15	4,833	—	—	32,308*e*	—
City & South London	,, 16	1,506	868	+ 638	16,528	10,307*c*
Cork E. T. and L. Co.	,, 13	503	495	+ 8	15,245	14,015
Dover Tramways ...	,, 15	275	308	- 33	7,692	7,383
Dublin & Lucan E.R	,, 15	117	88	+ 29	1,298	1,048
Dublin U.T., elec. cars	,, 14	3,840	2,011	+1,829	—	—
Dublin S.D. Electric	,, 14	1,079	891	+ 188	—	—
Glasgow Corporation	,, 15	9,932	9,590	+ 342	—	—
Halifax Corporation	,, 16	949	684	+ 265	19,416	15,216
Hull Corporat'n E.S.	—	—	—	—	— *a*	— *a*
Liverpool Corporat'n	,, 8*b*	9,129	7,888	+1,241	277,210	245,768
Liverpool Overhead	,, 16	1,719	1,484	+ 235	19,206*c*	18,753
St. Helens Tramwys.	,, 12	—	—	+ 147	—	—
Sheffield Corporation	,, 16	2,645	—	—	—	—
Swansea Tramways..	,, 14	497	288	+ 209	5,192	3,351

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *d* Since July 5. *e* From July 30. *f* From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	—	—	10⅞-11
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5⅝-6⅛
—— 5 per cent. Mortgage Debentures	100	..	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	⅜-½
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅜-½
—— 4½ per cent. First Mortgage Debentures	108		97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4⅞-5⅛
Brush Electrical Engineering, Ordinary	2	—	1⅞ 2
—— Non. Cum., 6 per cent. Pref.	2	—	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	101-103 xd
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-13⅛
—— 5 per cent. Pref.	5	—	5-5⅛
Crompton and Co.	3	—	3⅞ 4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	1⅞-2⅛
—— 5 per cent. Debentures	5	—	3¾-4⅛
—— 4 per cent. Deb. Stock, Red.	100	—	90 92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	..	68 72
Electric Construction	2	—	1⅞ 2⅛
—— 7 per cent. Cumulative Pref.	2	..	2⅛ 3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-13½
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	108 112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½ 21½
—— 4 per cent. Debentures	100	—	101-104
Telegraph Construction and Maintenance	12	—	35-39
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5⅛-5⅜
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6⅛-7
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	9½-10½
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6⅛-6⅞
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½ 5⅝
Chelsea Electricity Supply	5	—	6½-7½
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref.	10	—	12½-13½
—— 5 per cent. Debenture Stock	100	..	124-129
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	99-102
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	—	1⅞ 2⅛
—— 6 per cent. Pref.	5	—	4⅞-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	99-101
Metropolitan, Ordinary	10	—	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	14½-15½
Oriental, 1879	1	..	1⅛-1⅜
—— £5 Shares	5	..	7⅛-7⅜
—— £4½ Shares, New	4½	..	6-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5⅛-6⅛
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$100	..	165-185 xd
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8-9
Westminster, Ordinary	5	..	12 13
—— 80,001-109,437	2½	..	8½-9½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	5-5⅛
—— ,, ,, deferred	5	..	5 5⅛
City and South London, Consolidated Ordinary	100	..	57-60
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	—	138 143
—— ,, ,, ,, '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	92 95
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	14-16
Brisbane Tramway	100	—	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary	10	..	14½-15½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	..	123-126
—— ,, ,, ,, 1900	100	—	122-125
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅞-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	3⅞ 4⅛
—— 5 per cent. Deb. Stock, Red.	100	—	103-106
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9½-10½
New General Traction, Ordinary	5	—	3⅜-3⅝
—— 6 per cent. Cum. Pref.	5	—	4⅛-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-19
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
—— 4½ per cent. Debenture Stock	100	—	104 107
Telephones.—			
National Telephone, Ordinary	5	..	4⅝-4⅞
—— 6 per cent. Cum. First Pref.	10	..	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	98-101
Oriental Telephone and Electric Company	1	—	¾-1

Digitized by Google

NOTES.

"Science Abstracts."—We have received the September volume of *Science Abstracts*. The volume contains, as it usually does, a large number of abstracts of a very useful and interesting nature dealing with general physics, light, heat, sound, electricity, steam plant, telegraphy and telephony, etc.

National Telephone Company.—We note that the head offices of the National Telephone Company have been removed to Telephone House on the Victoria-embankment. The erection of these fine offices has occupied a considerable time, and it must be admitted that this building helps considerably to improve the appearance of the Blackfriars end of the Embankment.

Central Technical College.—The third annual dinner of the Association of Old Students of the Central Technical College is to be held on Tuesday, Oct. 2, at the Restaurant Frascati, Oxford-street. We are asked to state that old students can obtain further particulars from the hon. secretary, Mr. M. Solomon, 12, Edith-road, West Kensington, W., to whom applications for tickets should be made.

Poona College of Science.—We note that Mr. H. M. Page has been appointed to be professor of chemistry and geology, and to act as professor of physics and electrical engineering at the Poona College of Science. It would seem to us that Mr. H. M. Page's duties in his new positions will be too many to allow of the proper fulfilment of his duties in either of the departments, and we think that the post is one which should have the attention of two professors.

The Metallurgical Congress.—This is a year of congresses, and one is not surprised to find that a metallurgical congress has just been held at Paris. At this congress on Saturday the Swiss representative read a report on the situation of unionist metal workers. It was subsequently decided to hold a congress every five years. The congress also approved a proposal made by the British representatives in favour of a certain number of workmen belonging to the federation being sent from one country to another.

The Central London Railway.—After a very considerable period of waiting, the passenger by the twopenny tube who wishes to alight at Bond-street Station may now do so. The station was opened to the public on Monday last, and appears to be quite as popular as the other stations in Oxford-street. The station has during the past month or two had a rather ghostly appearance, owing to the use only of the incandescent electric lamps, which, with the white walls of the station, had a rather depressing effect. This is, however, now all changed, and the bright arc lamp sheds its rays in London's last new station.

"The Masonic Illustrated."—We have received a copy of the first number of the *Masonic Illustrated*, which, as its name implies, deals entirely with news concerning the fraternity of Freemasons. The paper is to be issued in monthly parts, and will, we presume, chronicle all the events, meetings, etc., which take place in the community which it chooses to represent. The journal is plentifully illustrated with portraits of various Masonic officials, as well as some views of the interior of the Freemasons' Hall in Great Queen-street, to which has recently been added a new wing. The usual first-number presentation plate is issued, the subject naturally being the Grand Master of the Order, the Prince of Wales. The editor in his leader speaks in a very optimistic way as to the future of his magazine, and we think, judging by the present issue, that to some extent this is justified.

Motor Mail-Vans.—Postal motors of various kinds have been tried from time to time in several large towns in different countries. The last one to take up the question is Paris, in which city the Paris correspondent of the *Daily Telegraph* states that there will be running a motor postal service. Mr. Mougeot, who is well known in connection with the French Post Office, is said to be studying a plan for the utilisation of electrically-worked cars or voiturettes for the speedy distribution of letters and telegrams. The cars will have somewhat the appearance of the tradesman's distributing cycle, and will have four wheels. We hope that these new aids to the quick delivery of letters and telegrams may be a great success.

The New York "Electrical Review."—We note with interest that our contemporary, the New York *Electrical Review*, by reason of its great success and the consequent expansion of its business, has found itself compelled to remove its offices from the Times Building to more commodious premises at 13, Park-row. The office building to which our contemporary has removed has a certain distinction of its own, it being the highest building in the world used for office purposes. It has no less than 31 floors, and requires 900 h.p. for its 7,500 electric lights and 10 electric lifts. We must heartily congratulate the editor of the *Electrical Review* on the success to which the paper has been brought, and hope that this success may be even greater in the journal's new home.

Electromobiles.—In a recent article the New York *Sun* thinks that at present the automobile which is most in favour is the electrically-propelled vehicle. It, of course, enumerates the objections to the accumulator-propelled car—that it cannot go very far with one charge, that the batteries are heavy, etc.—but yet thinks that electricity where it can be used is the favourite. Gasolene motorcars are stated to be very objectionable, owing to the odour which they emit, and which for some minutes after they have passed makes the air smell like burnt oil. Steam is said to be popular for long-distance travelling, this being naturally so, as it is fairly cheap and does not smell badly. It is to be hoped, however, that in a few years' time improvements will be effected which will give the electromobile a much wider range, and stations at which the accumulators can be recharged will also be probably more common.

Penny-in-the-Slot Telephones.—We notice that it is reported in the daily Press that Mr. C. J. Bayard and Mr. Arthur Lamkin, two London electricians, have invented an ingenious arrangement for supplying telephone calls for a penny-in-the-slot. In this instrument, by dropping a penny into the slot, it is put into working order, and the central exchange can be called up. The whole thing is automatic, and if a user does not want to bother with pennies every time he calls anyone up he can have each call notched against him by a ratchet-wheel arrangement. The great feature of this machine is, however, that if one puts a penny in the slot, or has a call notched against one, and the person called up cannot be put in communication with the caller, the telephone operator can cancel the notch or make the instrument return the penny by switching in another current. The instrument would seem to threaten the existence of telephone rentals.

London United Tramways.—The London United Tramways Company, having obtained concessions as to electric tramways in Middlesex, is now apparently turning its attention to Surrey. Thus a letter was read from Mr.

Digitized by Google

Clifton Robinson at the meeting of the Richmond Town Council last week, stating that although the time was yet somewhat distant for lodging formal proposals, he thought it only an act of courtesy to give them early intimation of his company's intention to apply in the next session of Parliament for powers to construct additional extensions to the existing tramways in the Richmond district, and to connect and work the same as part of their comprehensive system of electric tramways in Middlesex. If the tramway company obtains the powers for which it is apparently going to ask, there will soon be existing from the West of London to the nearer towns and villages an electrical tramway service which cannot fail to be of immense value both to Londoners and those in the towns through which the tramways run.

Rapid Transit.—Mr. H. C. du Val, of the New York Central Street Railway, recently returned from Europe to America, and consequently has given his views on how the traffic is managed in Paris and in London. The Parisian electric railroad, which has only been in operation a few months, he does not seem to think much of, and says the way of managing in Paris would not suit America. His first objection is that the cars seat only 36 persons, and there is standing room for eight; so that 44 passengers are taken up, and the crowd waits for the next car, which is besieged until another 44 are on board, when the crowd has still another wait. This does seem rather a bad plan, and Mr. du Val thinks that if the French officials had to handle a six o'clock crowd at Brooklyn Bridge, they would resign within 24 hours or end up in a madhouse. He does not say very much as to London, but remarks that there is the same wait as in Paris. We would, however, point out that there is generally room on the electric railways in London to take the waiting passengers, and the waits are not very long.

Damaging Electric Lamps.—We noted some time ago the case of a boy who was fined for throwing stones at telephone wires and insulators. A variation of this amusement is reported from Bootle, where the boys turn their attention to damaging the arc lamps in the town. The amusement consisted in the interference with the switch gear inside the lamp columns. The boys got a piece of wire and inserted it in the keyhole in the lamp column, and this in some way caused a short-circuit, which burnt the mechanism and damaged the enclosing box. The actual damage done to a particular lamp was about fifty shillings' worth, but the total damage during the week was estimated at £10. Mr. Wright, the electrical engineer, said he thought the boys did it to get a little shock, but very serious damage might result. In reply to the Bench, Mr. Wright said the lamps were similar to those in other towns, but the Corporation were about to take measures to prevent any recurrence of the mischief. The magistrates inflicted a fine of 1s. and costs upon each of the defendants, and ordered them to pay £1 damages. The parents were also warned to look after the boys, as if the latter came to the court again they would have to go to gaol.

Derailment Prevention.—Mr. W. T. Van Dorn has invented a device by which he claims high speeds can be obtained without derailing the cars. There is in the device no material variation from the ordinary standard road bed and rolling-stock. The only difference is that for about every fourth tie one somewhat longer is substituted on which to fasten the brackets for the support of the safety rails. These consist of ordinary T-rails turned upside down and bolted securely to the brackets, in this way somewhat increasing the stiffness of the road bed. The car axles, instead of terminating in a grease-box, are extended until they project out under the inverted safety rails, and are provided with a small anti-friction roller at their extremities, which travels along those rails. By having this roller insulated from the axle, and using a contact shoe on each side of the car, the safety rails may, it is stated, be insulated and used as the two sides of a trolley circuit and the cars run electrically, this being the most likely form of power for a high-speed service. The invention is no doubt one which is well worth considering, but it would appear to us that the inventor places too much confidence in anti-friction rollers, and we think that he would have great difficulty in overcoming the friction of which he speaks so lightly.

The Lakeside Tramways.—The inhabitants of the Lake District have recently been much disturbed, owing to the British Electric Traction Company having expressed its determination to seek powers to run an electric tramway in the district. The tramways are intended to compete with the coaches which run in the district, and which carry passengers to and from particular portions of the neighbourhood round the lakes. It is argued by the local people that electric tramways would entirely spoil the beauty of the place, and would prevent a large number of people who go there for quietness and solitude from patronising the district. To this the traction company reply that they quite appreciate that some people dislike, not only electrical tramways, but railways as well, and the few living in this secluded district may wish to maintain their seclusion. This, however, it is argued is not fair to visitors who go there, and who cannot afford to pay the excessively high coach fares which are charged. The company further state that there are numerous places of great natural beauty in America and in Europe in which electric tramways are used for communication, and the view in these districts is almost invariably that the greater the number of persons within whose reach the beauties of the district can be brought the better, and also that the introduction of electrical tramways appreciates the value of the property and the attractions of the district.

The Determination of Magnetic Force.—The committee of Section A of the British Association appointed to ascertain the most suitable method of determining the magnetic force on board ship, presented an interesting report to the section at the recent meeting at Bradford. The report was not read, but was briefly referred to by Dr. Lees. He pointed out that the great difficulty in determining the magnetic force on board ship was due to variations in strength of the magnets used. In fact, a number of the observations so obtained were rendered almost valueless by the assumption that the magnetic moment of the needle used in the experiments was constant. Up to the present the committee favoured the method of experimenting devised last year by Captain Creak, which was devised with the special object of getting over this defect. By this method two magnetic needles were used, and the experiments consisted in finding out the alteration in readings given by adding weights to the needles. In this way two determinations were obtained, and the third equation required to eliminate the magnetic strength of the two needles was made by observing the deflection caused by one needle on the other. In this way, with three observations one could be absolutely independent of the variations of the magnetic moment of either of the needles, and the true values of the magnetic force of the earth can then be accurately made on board ship.

Electric Heating.—Electric heating and cooking apparatus would seem to be more of a success in America than in England. It is true that Messrs. Crompton and Co. have a department which deals with this subject, but since the removal of the heating and cooking utensil works from Fulham to Chelmsford the matter would seem to have

Digitized by Google

taken somewhat of a back place in the firm's manufactures. At the last meeting of the company the shareholders were informed that the department was still carried on, and that it just paid its way, but that no very special efforts were being made to develop the industry. From America, however, we have received a catalogue of the Simplex Electrical Company, of Cambridge Port, Massachusetts, which deals entirely with electric heating. The process of manufacture, that of burying the resistance in enamel, which has been burned on to the article, would appear to be very similar to the Crompton method. The articles can be used both on alternating and direct currents, and they can be had for any standard voltage up to 220 volts. The articles include almost all domestic utensils which are used for boiling, grilling, frying, etc., and irons, sealing-wax pots, soldering irons, kettles, coffee-pots, foot-warmers, stoves, radiators, etc., are amongst a few of the numerous articles to which electricity is applied as a source of heat. With the development of electricity in Great Britain we may, however, look forward to the time when, instead of the ordinary coal fire or gas stove, our kettles will be boiled by simply turning a switch on or off as required.

An Overhead Line to France.—An idea, which does not strike one as being very practicable, was explained in a recent issue of the *Daily Mail*. An Italian with the high-sounding title of Comte Pompio Pieri claims to have invented a scheme by which the Channel Tunnel will be rendered needless, if ever it was otherwise. The inventor proposes to take passengers from Dover to Calais and *vice versâ* in a quarter of an hour without sea sickness, danger, and with a sea breeze thrown in. The electro-aerial railway which is to do all this is said by French engineers to be simplicity itself. Two strong cables, the upper one being charged with electricity and the lower one for steadying purposes, are to be upheld by some 50 captive balloons, and are to go from the highest points on the English and French coasts. Along these two cables cars capable of containing 10 persons, and supplied with electric motors, are to travel at lightning speed, this speed being accelerated by the sag in the wire. The car is to be built of aluminium and cork, and will float right side up if it happens to be precipitated into the sea. The wire will be supported at either end by large captive balloons, and small captive balloons will serve the purpose of lifts and land the people in the cars. The count thinks his scheme is daring but quite practicable, and states that we should have nothing to fear from France owing to its connection to us with this line, as the cables could be cut in five minutes, which, as our above-mentioned contemporary remarks, would be bad for those enjoying the sea breeze on it at the time.

Automobile Racing.—The automobile races which have taken place recently in America do not seem to have been so generally appreciated in that country as such races are in France. For instance, our contemporary, the *Electrical World* of New York, points them out as "a fine example of fruitless competition," and there is no doubt that this was the right way of looking at the particular races spoken of. They were open to all, like some horse-races, there being no limit to weight, size, etc. There was consequently a general scramble, out of which the machines with the biggest motors came first. The electrical machines, we notice, did well even under these absurd circumstances. Our contemporary protests against such foolish and reckless races, which, it thinks, will bring the automobile into disrepute, and will probably end in such restrictions being placed on motor driving as to prevent any enjoyment or use being derived from it. "Developing a speed of a mile per minute huddled up behind green goggles on a gasoline tank may be sport after the Gallic canons," thinks our contemporary, "but it will not go far or fast towards encouraging the general use of automobiles for practical purposes." The road races of the early summer were more to the point, as they brought out machines capable of fairly hard service and ample speed for ordinary uses. The faults of automobiles at present are not in the speed, but in weight, noise, smell, short radius of action, and general complication. For pleasure riding, a machine that can make 15 miles an hour if necessary, or run 40 or 50 miles without attention and with the reasonable certainty of getting home, is much more useful than a racer which may make 40 miles in an hour, and have to be left on the road to be sent home by rail.

A Submarine Arc Lamp.—It may be remembered that some time ago an arc lamp for submarine purposes was invented, but which failed for various reasons. We now learn from the *Electrical Review* of New York that the inventors did not despair of accomplishing their object, and after a considerable amount of investigation claim to have at last obtained an arc lamp suitable to submarine use. In this lamp no air-tubes are used, oxygen being fed to the lamp by a secret process. The diving outfit includes the lamp, portable waterproof cable, and switch for turning the light on and off. The lamp consists of an upper mechanism chamber, containing a solenoid and other mechanism. The lower chamber is enclosed in a glass globe, which is hermetically sealed by means of rubber gaskets to the upper chamber. Inside this lower chamber is placed an inner globe and carbons. The length of the lamp is 22in., and the metal parts are of gunmetal. The glass globes are constructed to withstand a pressure of 500lb., allowing a depth of 1,000ft. to be reached with safety. This is, of course, more than sufficient for all ordinary diving cases. The lamp is equipped with Holophane globes, these having a high diffusive quality, and avoiding the casting of sharp shadows by the framework of the lamp. The lamp is very compactly built, and can be used in very confined spaces. In the light of the enclosed arc lamp practice, we are not quite sure that it is the inclusion of oxygen which it is said is required in order to make this lamp a success, but think it might possibly be that some means should be provided to enable the gases to expand, and also those gases formed by combustion to escape. It is interesting, however, to note that the inventors, the Naval Electric Company, have succeeded in getting an arc lamp which will be of real use in submarine work.

Commutators.—The bursting of a commutator on a booster at the Plymouth electricity works reminds one that in designing commutators the mechanical details require careful construction. In the early days we remember two or three similar accidents in which a commutator burst, throwing sections of copper in all directions. More recently we have heard of large machines in which the mechanical details for securing the commutator sections in place have been defective. With these large commutators and high-speed engines the circumferential speed is very considerable, and the centrifugal force reaches a high value. One is not surprised, therefore, that steel of a high quality is entering into the construction of practically all commutator supports for large multipolar machines. Referring to the accident at Plymouth, we notice that a most circumstantial account has been published in the local papers, in which the engineer in charge of the station at the time covers himself with glory in giving exceedingly full details of what he did after the accident happened. The gentleman in question is lucky not to have been in the line of fire when the fragments were flying round,

Digitized by Google

but we do not think it does any good whatever to the undertaking to put accounts of such detail in the untechnical Press. Although serious damage might have been done, no personal injury was caused, and as soon as Mr. Rider arrived on the spot the tramway service was restarted. We therefore hold that the local papers should have been satisfied with the statement that there had been a slight mishap to one of the running machines, which would in no wise interfere with the running of the tramways, nor would it cost any considerable amount to repair. We do not quite go so far, however, as one borough engineer of our acquaintance, who, when the arc lighting of the public streets went out, assured his committeemen that he had cut them out in order to test the circuits. He did not state that the testing was a necessity owing to a bad breakdown in the insulation.

The Question of Brakes.—When commenting a few weeks ago on the report of the commission of the New York State, in which it was advised that more powerful brakes were required on most of the tramcars in that State, we alluded to the fact that the committee of enquiry, although appointed by the State, had not means to enforce any decision on the tramway companies. It will be remembered that a large number of trials were undertaken with electric brakes, from which good, useful conclusions were derived as to which of the various electric, compressed-air, and hand-power brakes were most effective. We now notice in our contemporary *Electricity*, of New York, that they interviewed the presidents of the Metropolitan Street Railway Company, and also of the Brooklyn Rapid Transit Company. Both of these gentlemen are apparently experts in avoiding a direct reply to a question, and the first, Mr. Vreeland, even questions the advantage of having powerful brakes. He asks who would care to ride in a car, the brakes of which would stop it within 30ft. or 40ft., and he appears to infer that once in a way the car not so equipped should be stopped by running into a brick wall or into other traffic. He, of course, has a word to say as to the advantage of using a couple of chains instead of one on a hand-power brake, which his company has done. President Rossiter, of the Brooklyn Rapid Transit Company, gave his views on the same general lines. His company were extremely interested in the trials made on behalf of the State, in order that they might be compared with similar trials which they themselves had undertaken. Of course his company were exceedingly anxious to adopt the best brake, and having hedged to that extent, one gathers from the remaining statements that he would neither accept the verdict of the committee as to which was the best brake, nor would he advise any extra expenditure on the brakes for his tramcars at the present time. In fact, neither of the gentlemen will take any advice from the committee, nor will they expend anything on improving their systems of braking in consequence of the report. We here therefore reiterate our point, that in such matters Government control, as exercised by the Board of Trade, is the best.

Water Power from the Rhone.—We notice in the August issue of the *Bulletin* of the Société des Ingénieurs Civils de France a description by Mr. M. F. Bonnefond of the water power available and of the schemes for utilising the same on the higher waters of the Rhone. The author states that from Pyrimont to Fort de l'Ecluse the Rhone falls rapidly through a series of gorges and waterfalls. Thus in a length of 12½ miles the total fall is no less than 210ft. Again, the Lake of Geneva acts as a reservoir to keep the flow in the river within limits, and the minimum amount of water passing down the river is said to be at least 5,250 cubic feet per second. From this the author works out that the minimum effective horse-power which can be obtained from the water in the driest months is 100,000 h.p., while for nine or ten months in the year one could depend on getting at least 200,000 h.p. Up to the present the only quantity used amounts to 10,000 h.p., which is obtained by an Anglo-Swiss company, but there are three schemes on foot organised by French companies, which only wait for the formal sanction of the authorities before commencing work. It is said that this consent is now exceedingly difficult to obtain quickly, and that whereas 30 years ago all the formalities could be completed within three months, it is now actually two years since the present French companies first applied for permission. The author then proceeds to describe these three schemes and the civil engineering works which will be necessary in carrying them out, but for these details our readers will do well to seek the volume above mentioned. The names of the schemes and their engineers will, however, be of interest. The first, which would have its works about 2½ miles from Bellegarde, would when completed be able to provide 25,000 h.p. even in the winter months, when the river is lowest. The engineer who is responsible for this scheme is Mr. Supéry, of Lyons, and it is being financed by Messrs. Planche et Cie. The next scheme takes its name from the Boucle du Rhone, and would develop 30,000 h.p. from a fall of about 90ft. The engineers for this scheme are Messrs. Gotteland and Garcia. The third scheme, called after the Pont de Grésin, is due to Messrs. Buffaud and Tavian, of Lyons. In this case the fall utilised is above Bellegarde, and here again 30,000 h.p. is expected to be obtained. The horse-power which will be developed at these three stations would be largely used for electro-chemical and electro-metallurgical purposes, but, of course, the electricity could also be transmitted to the various industrial centres within a range of from 75 to 100 miles. The author states that the various promoters think that £2 per horse-power hour per annum will repay for the cost of the works, and this will be about one-tenth of the cost of the horse-power per annum in the district when obtained from coal.

The Viagraph.—At the recent meeting in Bradford of the British Association, Mr. J. Brown read a communication on an instrument, called by him the viagraph, for testing and recording automatically the unevenness of the road surface. The subject is one which is of great interest to manufacturers of automobiles, and hence to those electrical engineers who are working on the problem of accumulator traction on ordinary road surfaces. Since the meeting we have had the opportunity of inspecting the instrument in London, and one cannot but be struck by the simplicity of the mechanism and by the ingenuity displayed by the designer in its construction. The viagraph consists of a sledge, the runners of which are straight edges about 16ft. long. In the middle, between the two runners, is a toothed wheel of from 3in. to 4in. in diameter, which always rests on the road surface. The revolution of this wheel is reduced by suitable gearing until it moves the drum carrying the recording paper. The reduction is such that ⅛in. of the motion of the paper represents 1ft. along the roadway. The vertical movement of the wheel which is carried on the lever is reproduced to scale by a pencil resting against the recording strip of paper. In this way a jagged diagram is produced, which gives one a good idea of the local unevennesses which occur on the road surface. In order, however, to give some indication of some of the vertical movements through which the wheel resting on the road surface is moved, an ingenious arrangement is added of the following nature: A cord from a point on the lever near the wheel axle is carried over guide pulleys to the driving wheel of a counting train. This driving wheel is provided

Digitized by Google

with a ratchet, so that it only drives in one direction, and moves back without altering the train in the other. In this way a record is obtained of the total vertical displacement in one direction only. The author gave as an example the record obtained in this way when on the Guildford road, on which the sum of the depth of the ruts is from 12ft. to 14ft. per mile. On the Prescot road, from Liverpool, the average of several readings gave 42ft. per mile, while on the Lisburn road, near Belfast, no less than 134ft. of rut per mile was recorded. The above figures suggest an interesting experiment as to the additional energy required to drive a vehicle over an uneven road. The actual energy wasted in the vertical vibration in the framework of an automobile, and also of its contents, is a subject which requires careful investigation. That this vertical vibration would waste a considerable amount of energy, is obvious from the great advantage given by pneumatic tyres over solid rubber tyres, as experienced by the cyclist. It was suggested in the discussion which followed Mr. Brown's paper that such experiments should be actually made. In this case, trials made with an automobile supported free from the ground, with brakes applied to the driving wheels, would be used as the datum line.

Radio-Telephony.—We notice in the *Revue Générale des Sciences* a description by Prof. A. Popoff, of Kronstadt, of some experiments in radio-telephony. He states that in May, 1899, he was experimenting with wireless telephony on two islands near Kronstadt, when suddenly the signals ceased to be received although transmitted. He then tried the effect of placing a telephone in the circuit of a radio-conductor and dry battery. He then found that the signals transmitted were perfectly audible in the telephone. On other trials he found that only weak currents would produce this effect. For experiments at long distances he used a glass tube in which were pasted small bands of platinum upon which rested steel filings mixed with crushed pearl. The tube was well dried and hermetically sealed. This radio-conductor, he found, was preferable to any other. The electric waves were found to successively increase and decrease the resistance of the radio-conductor. After reading an article by Hughes, the inventor of the microphone, which stated that a combination of the microphone and telephone might show the existence of electric radiations, the author tried several forms of microphones, but found the combination only good for more powerful currents. Last winter, Prof. Popoff states, an accident occurred to a war vessel in the Gulf of Finland, and to facilitate the work of saving the vessel, which was ice-bound, it was necessary to establish a system of wireless telegraphy between the island against which the injured vessel lay, the continent, and the ice-breaking vessel, "Ermack.' The professor was intrusted with this work. Sets of apparatus were placed on the island and at the village of Kotka. The first trials were made with a kite in order to determine the best position for the masts. When the masts were fixed, dispatches were easily sent and received. An ice-floe had broken adrift with 27 fishermen upon it, and a dispatch was sent to the ice-breaking ship in a few minutes. The dispatch was received perfectly, and the ship saved the fishermen, who were floating out at sea on the ice-floe. This immediate application of wireless telegraphy, he states, caused some sensation. The posts which were established included two telegraphists and an assistant electrician. The two stations were supplied with Ruhmkorff coils giving long sparks. The masts at Kotka and Hohland were about 50 yards high. Messages were regularly transmitted between the posts, and during the 84 days in which work was going on, 440 officia telegrams were exchanged. The longest dispatch contained 108 words, this being the Press message to the effect that the vessel was saved. The weather was very bad, heavy snow falling, but the messages were not interrupted. The author believes this to be the first regular service of wireless telegraphy. During the time the telegraphy was employed the temperature did not rise above 12deg. F., and went down as low as 20deg. The author thinks that, in view of the work done in this instance, the use of radio-telephony, being very simple, will become of great service in the future.

An Electric Automobile with Trolley.—Mr. J. W. G. Aldridge's paper on "An Automobile for Electric Street Traction," read before Section G of the British Association at Bradford, was remarkable for the inconsistency of certain of the opinions expressed. Mr. Aldridge is, however, to be congratulated on the use of the cinematograph for illustrating the flexibility of the system he advocates, although the instrument at the same time illustrated defects in certain respects. The system of electric traction in question is that developed in Paris, on the road to Vincennes, by Mr. Lombard Gerin. While up to the present we do not think the system is commercially feasible, every credit is due to the inventor for the ingenuity displayed by him. We have previously referred to this system, which consists of a motorcar running on the ordinary roads and fed from two trolley wires by the side of the road. Instead of the usual trolley for collecting the current, a flexible cord containing six conductors is used. This cord connects to a small carriage which runs on the two trolley wires, and which is driven by means of a synchronous three-phase motor, which is supplied with current from three slip rings on the motor on the car. The speed of the small motor on the trolley wires is made slightly more than is required to keep pace with the vehicle, so that the dragging on the wire is avoided. By means of a brake the advance can be restricted by the driver. The author explained that the jolting of omnibuses on the common roads was so terrible that they would have to be replaced, but he failed entirely to explain how he expected the electrically-driven 'bus to avoid the jolts which are due rather to the road surface than to the means of propulsion. The great objection to the system up to the present seems to us to be that the small motors running on the trolley wires will not be able to pass each other. Thus we were shown on the cinematograph the operation which had to be conducted when two of these electric automobiles met. It involved the change over of the conductor from one car to the other, and although the work was smartly done, the interval was much too long to be allowable on any important roads. We were told, however, that the inventor had succeeded in solving the question which has so long troubled the mind of the erratic engine driver of how two trains running on the same line towards each other can pass without destruction. The other alternative, of providing two trolley wires on both sides of the street, considerably nullifies the author's claim that the system is cheaper than the ordinary trolley. In the discussion which followed the paper, one or two of the speakers mistook the action of the motor on the trolley, thinking that it was a converter from direct current to three-phase current. Another suggestion was that the underside of the trolley motor, which with its wheels weighs about 40lb., should be provided with rubber springs, so as to reduce the damage done when the said motor falls on the heads of pedestrians passing underneath. The weight of the vehicles was stated by the author to be about three tons empty and five tons loaded, and at ordinary speeds on ordinary roads they required from 130lb. to 160lb. per ton-mile,

Digitized by Google

THE ELECTRIC LIGHTING OF THE CITY OF GLASGOW.

(Concluded from page 413.)

The engine-room presents some novel features; indeed, one's first impression on entering this portion of the station is that it is the electrical section of an international exhibition. There are dynamos from England, America, and Germany; engines of four different types from as many different makers in Scotland, England, and America. The plant first installed was set to work in a wooden shed built inside the main engine-house, it being imperative to get a supply of current for the winter of 1898-99, and all quarters of the civilised earth was searched with a view to obtaining the necessary plant. The smallest unit consists of a 200-h.p. set, comprising a Crompton bipolar dynamo of 125 kw. output coupled to a Mirrlees-Watson engine of 200 h.p. The combination runs at 380 revolutions per minute. Next in point of size comes another Mirrlees-Watson-Crompton set. The dynamo is of the usual bipolar type, having an output of 255 kw., and driven by two engines, duplicates of the one already mentioned. The two engines are coupled in line, and give a brake horse-power of 400 at 380 revolutions. They can easily be seen in Fig. 6, the set almost immediately below the crane hook. Recognition will be easy, as they have the doors of the crank chambers removed. The large unit beyond is an ordinary marine type three-crank triple-expansion engine, made by Messrs. Matthew Paul and Co., of Dumbarton. The indicated horse-power is 900, and it has its own condensing plant driven from the engine cross head in the orthodox marine fashion. It is the only unit in the station which drives its own condenser; the others have independent motor-driven condensing apparatus. This marine engine drives a 12-pole dynamo by the Schuckert Company at a speed of 120 revolutions per minute. One distinctive feature of the machine is its armature, which is smooth core—the only smooth-core machine in the station. Its output is 650 kw. The set at the extreme end of the engine-room consists of a Ball and Wood engine of 100 h.p., with two Walker dynamos, one on each end of the crankshaft; their output is 350 kw. each, and as the E.M.F. is 250 to 270 volts they are used as balancers on the three-wire system (500-550 volts between outers). It has an independent motor-driven condensing set, which will afterwards be described.

The more recent additions to the station plant consists of three units. Two are Belliss-Thomson-Houston sets, and one a Willans-Crompton set, and they can easily be recognised in the foreground of Fig. 6.

The Belliss engines consist of six-cylinder three-crank triple-expansion engines. The cylinders are one high pressure, two intermediate, and three low-pressure, the three latter being placed below the single high and the two intermediate cylinders. The slide valves are of the piston type, the high or intermediate and low pressure valves being on the same valve rod and operated by a single eccentric. Each engine is capable of giving 1,100 b.h.p. continuously when running at 230 revolutions per minute with steam at 180lb. (stop-valve pressure), or 1,500 h.p. for short periods. Coupled to each engine is a 12-pole British Thomson-Houston dynamo, having a rated output of 655 kw. at 500 to 550 volts, and over-compounded for a rise of pressure of 10 per cent. at full load (they are generally run as simple shunt machines). They are of standard B. T.-H. design, having all the usual features. There are as many sets of brushes as there are poles; each set consists of seven carbon brushes.

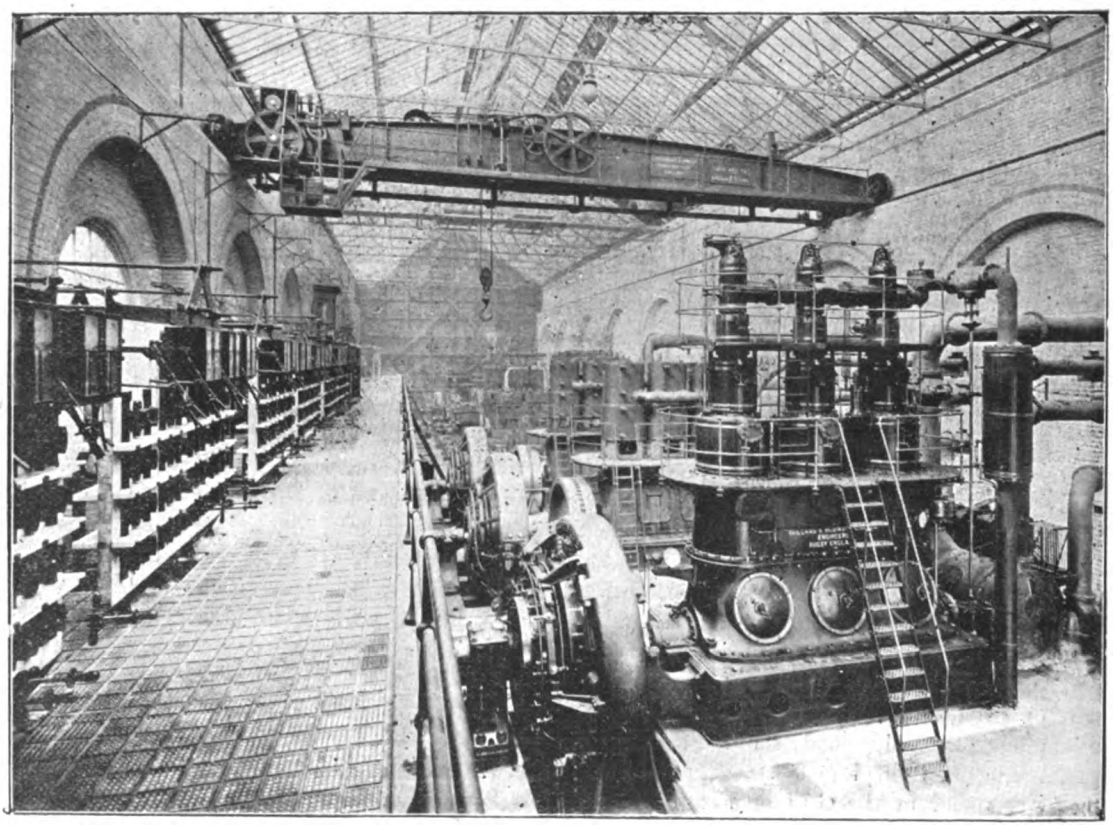


FIG. 6.—General View of Engine-Room, taken from Switchboard Gallery.

The Willans-Crompton set consists of a 1,200 i.h.p. to 1,500 i.h.p. Willans engine running at 230 revolutions per minute, coupled to a Crompton 12-pole dynamo. The generator has several features of interest. The field magnets are of the usual construction—laminated pole-pieces cast into a cast-iron yoke. The series winding is, however, outside the shunt and held clear of it by means of three insulated brackets. This permits a free circulation of air between the series and the shunt winding, with the result that the range of temperature, and consequent variation of the shunt resistance, is not so great as it would otherwise be. Each turn of the series winding is divided into four parallel strips to facilitate removal—an advantage when dealing with copper of such large cross-section. Another notable feature is that the combination has no flywheel. The only other unit in the station lacking the flywheel is the Ball and Wood-Walker combination. All the necessary flywheel effect is obtained from the armature, which is carried on a steel hub and bolted direct to the barring wheel of the engine. The armature spindle is, therefore, not subjected to the torsional strain which it would otherwise have to bear. The brushes are carbon, held in aluminium brush-holders. The station is yet only one-

Digitized by Google

third its ultimate size, and at the time of our visit foundations were being prepared to receive some important additions — viz., two Willans-Westinghouse sets — the engines being of 2,500 h.p., and duplicates of the Willans engine at the Paris Exhibition.

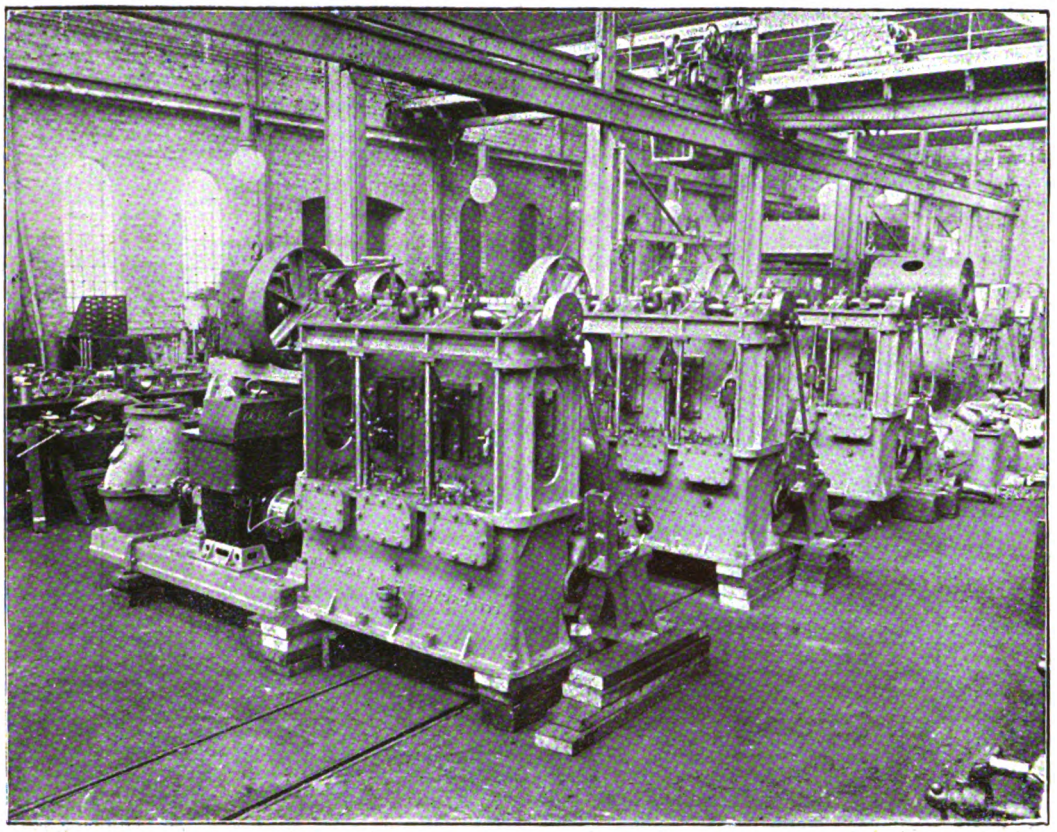


FIG. 7.—Electric Air Pumps of the Edwards type, driven by Allen Motors.

The elements of each consist of a surface condenser, which can be seen in Fig. 6 immediately below the separator of the Willans engine (the exhaust pipe from the engines is fitted so that the engine may exhaust either into the condenser or to the atmosphere), a three-throw Edwards air-pump, and a centrifugal circulating pump, each pump being driven by a separate electric motor. The shells of

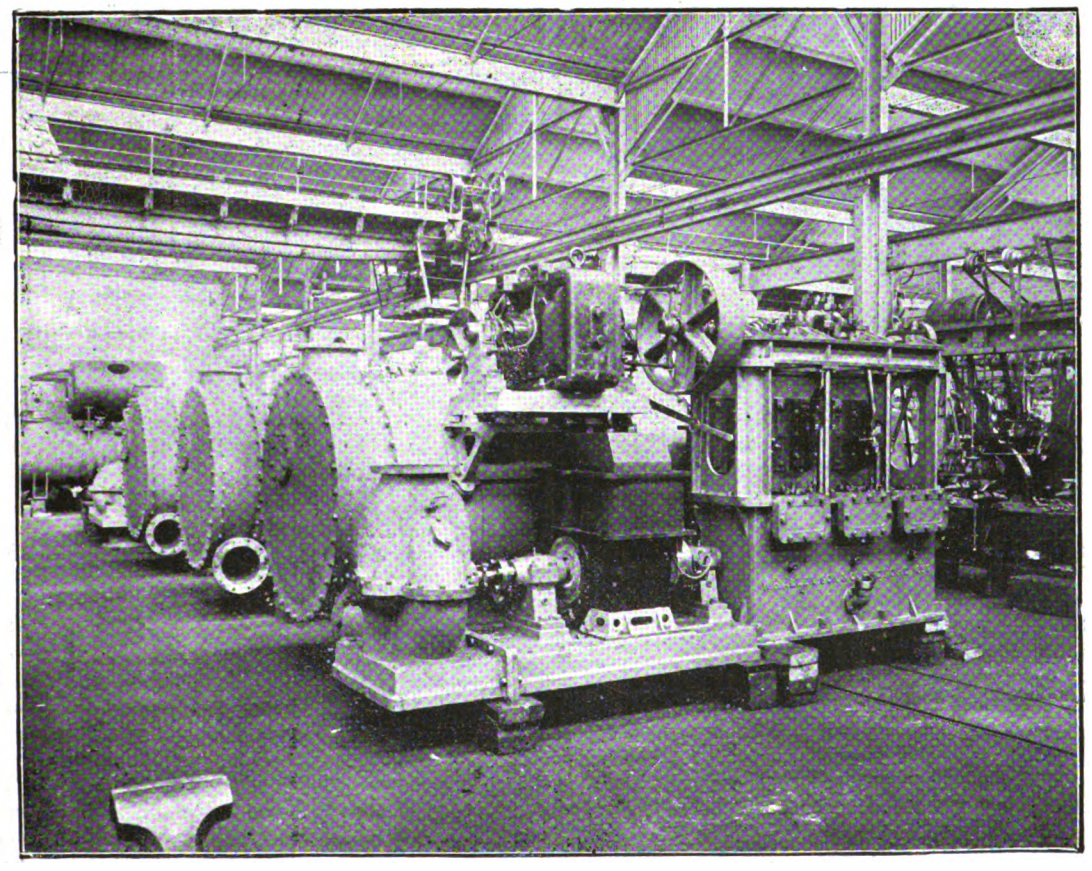


FIG. 7A.—Another View of the same Pump, with a Circulating Pump in Foreground.

Condensing Apparatus.—With the exception of the marine engine already described, which drives its own condenser, all the other units have separate motor-driven condensers, made by Messrs. W. H. Allen, Son, and Co., Limited, of Bedford. They are of the surface-condensing type, capable of dealing with 27,000lb. of steam per hour.

Digitized by Google

the condensers are of cast iron, cylindrical in form, fitted with branches for the exhaust and circulating water inlets and outlets, and air-pump suction. Each condenser has a cooling surface of 2,550 square feet, the tubes being of solid-drawn brass, fixed into rolled naval brass tube plates, by means of screwed ferrules and tape packing. These ferrules are provided with lips to prevent the tubes from slipping out of place, while allowing sufficient play for free

they can deal with 225 amperes, raising the pressure by 160 volts. There are two sets of balancers—one a bipolar set by the India Rubber, Gutta Percha, and Telegraph Works Company, capable of dealing with 250 amperes on either side of the system, and a four-pole set by Bruce Peebles capable of dealing with 500 amperes. The fields are excited differentially so as to reduce the amount of manipulation by hand.

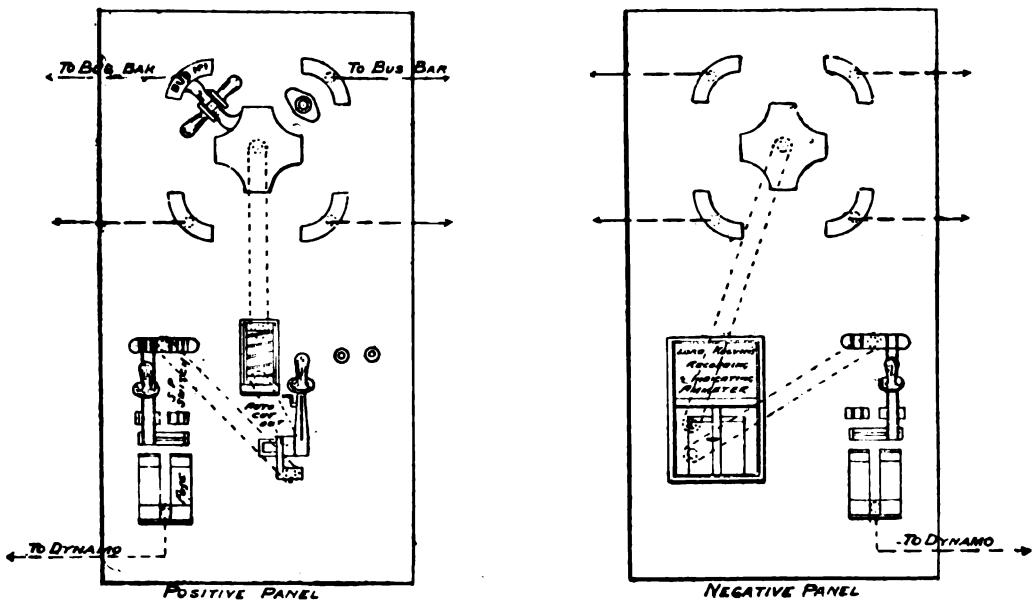


FIG. 8.—Generator Panels—Port Dundas Station.

expansion. The air-pumps are designed to run at 160 revolutions per minute, and are driven by an Allen motor. Each pump has three barrels 12in. diameter by 12in. stroke, of Edwards's well-known pattern. They are driven from an overhead crankshaft, as seen from the photograph, Fig. 7 (taken in Messrs. Allen's shops). The pump seen on the overhung crank on the right-hand side is a small water-pump for dealing with the hot-well water. The circulating pumps are of the "Conqueror" type, the suction

Accumulators.—These consist of 334 cells, made by the Tudor Company. They are divided into two batteries of 167 cells on either side of the three-wire system. One battery is located on each side of the tower, as seen in Fig. 4 (last week's issue). They are of the Tudor Company's type L B. 19, and have a capacity of 1,100 ampere-hours. Their normal rate of charge is 180 amperes, and normal discharge 150 amperes for 7⅓ hours. They may, however, be discharged at 330 amperes without damage.

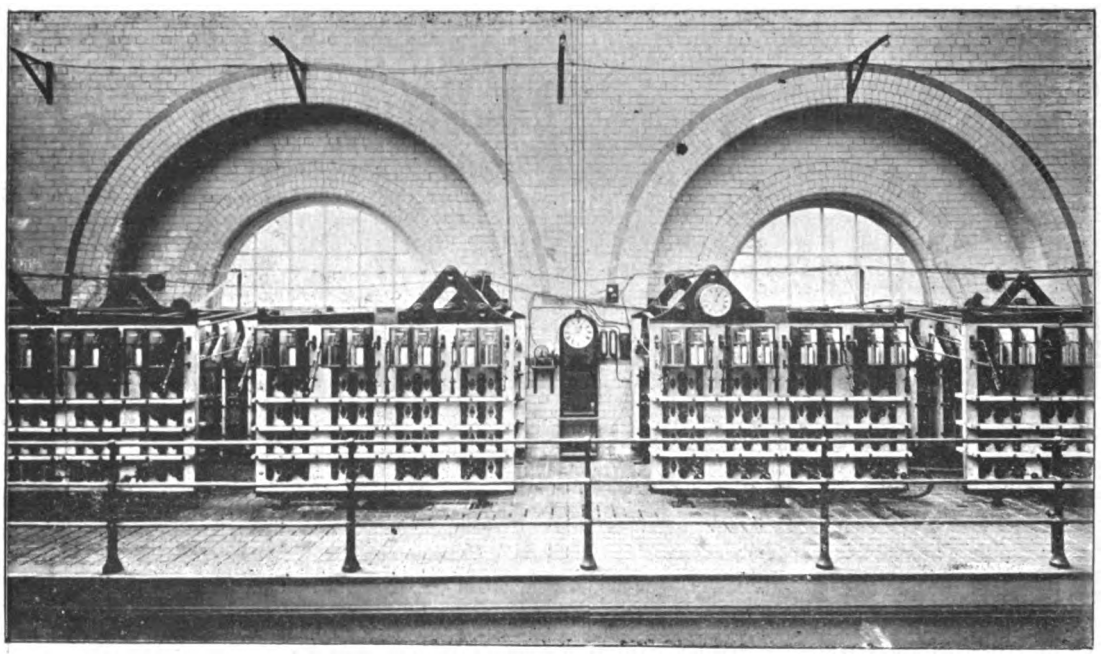


FIG. 9.—Front View of Feeder Panels on Gallery.

and discharge being 11in. in diameter. The pump spindle is directly coupled to the motor shaft, and when running at full speed takes about 75 amperes at 520 volts.

Balancing and Boosting-Sets.—Located in the middle of the station, between the old and new units, are the balancing and boosting machines. For charging the accumulators there are two sets of motor-driven boosters, by Messrs. Mavor and Coulson, Limited, Glasgow. They have field magnets of the Manchester type and drum armatures;

The regulating switches are arranged along the wall of the battery-room, and are worked by a sprocket wheel and chain from the dynamo floor of the engine-room, close to where the attendant manipulates the balancing sets.

Switch Gear.—This presents some features quite unique in central-station practice. Owing to the great output (there will be some 44,000 amperes to be dealt with at no very distant date), not a few departures from the recognised practice in central-station designs are noticeable. For

Digitized by Google

instance, the dynamos are not controlled from the main switchboard, their output being dealt with at smaller boards on the dynamo floor, the feeders only being controlled from the switchboard gallery above. The generator panels consist of a + and a − panel, one on either lead from the dynamo. Each generator has its own pair of panels immediately opposite it. The + board consists of a four-way combined plugging and switching device. This enables the dynamo to be plugged on to any of the four + 'bus bars, which run along the underside of the switchboard gallery for its entire length. Current as it comes from the dynamo passes through a switch to a duplex fuse, and then through an Andrews cut-out to the four-way switch already described. Some of these panels were made by Messrs. Jas. White, Glasgow, and some by Messrs. Cowans, Limited, Manchester. A diagram of those made by Messrs. White is shown in Fig. 8, from which the connections can easily be traced. Messrs. Cowans's panels were similar, though the relative position of the fuses are different, being in the centre of the board. The minimum cut-outs are set to take a back current of 350 amperes before dropping out; the reason being that should a short pull the engine up, and the battery try to motor the dynamo, the unit may have an opportunity to recover its load before cut out of the circuit. The current returning to the dynamo through the negative panel passes first through the four-way combined switching and plugging switch, seen on the right-hand panel of Fig. 8, then through a Kelvin combined recording and indicating ammeter reading to 2,000 amperes, thence through a duplex fuse and a switch to negative pole of dynamo. The equaliser switch of the machine—it will be remembered they are compound wound—is placed on the yoke of the dynamo field magnets. From the + dynamo panel connection is made to any one of four positive 'bus bars which run under the gallery. These consist of 22ft. lengths of copper strip coupled together at the ends by thin U-shaped strips, 4in. broad by ¼in. thick, these serving as expansion joints for the total length of 216ft. The 22ft. lengths consist of four bars, the bottom one being 4in. broad by 1in. thick, and three others 4in. wide by ¼in. thick, giving, when assembled, a total section of seven square inches. The strips are separated from each other by copper washers, and bound together by means of steel bolts, enabling more copper to be added. Should necessity arise for increased section, it may be increased to 14 square inches with ease. The construction of these bars in strips, separated by copper washers enables a very large section of copper to present an unusually large radiating surface to the atmosphere, hence the current density may be increased to a much greater extent than usual without undue rise of temperature. The bars, of which there are eight (four + and four −), are carried on porcelain insulators along the underside of the switchboard gallery, and connections are taken from them to the feeder panels above. Here Mr. Chamen's ingenuity has enabled him to solve many of the knotty problems which arise in the design of boards dealing with such large currents. Connections from the 'bus bars under the floor are taken to the short bars on the back of the feeder panels. These feeder panels are divided into sets, each set supplying eight feeders. Fig. 9 gives a front view of the feeder panels on the switchboard gallery. On each panel are grouped eight feeders, and the panels are arranged starting from the extreme right of Fig. 9: +, −, clock, +, −; two complete panels, one + and one − being seen on either side of the clock, and portions only of the other two. They are all in duplicate, positives and negatives being alike in

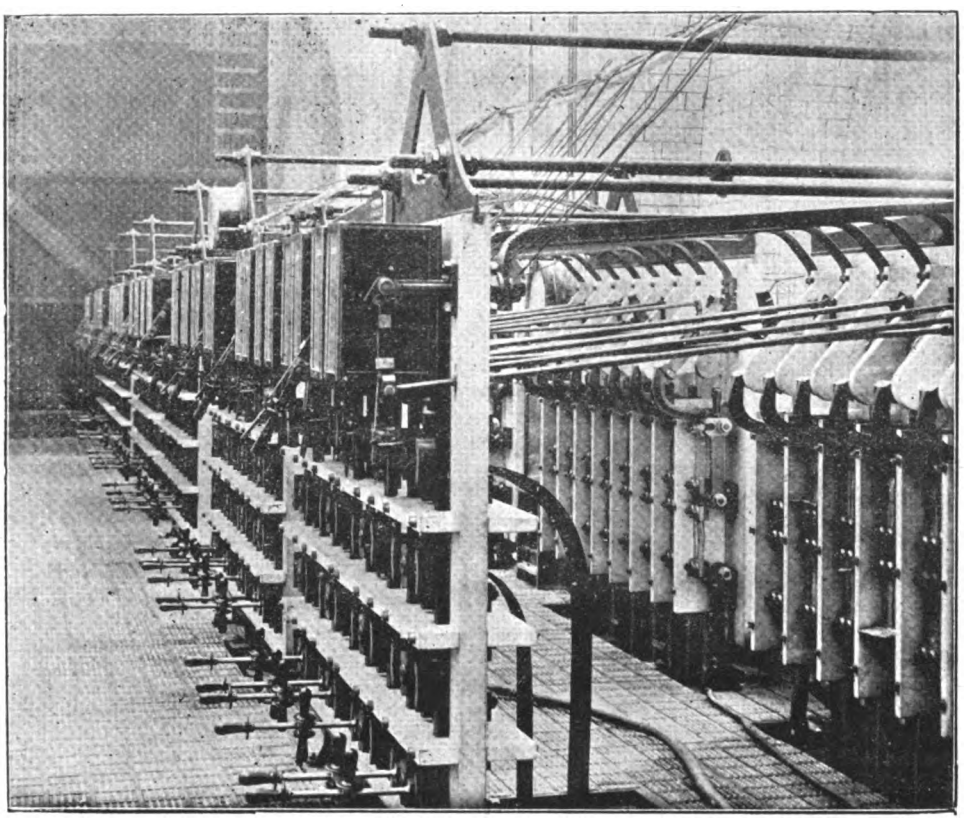


FIG. 10.—Side View of Switchboard.

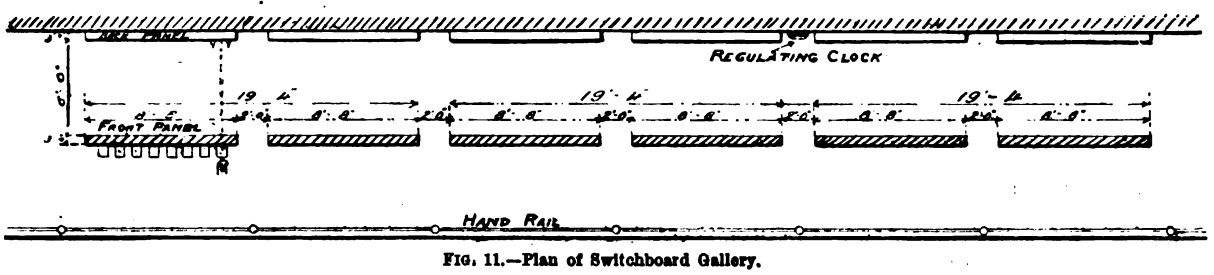


FIG. 11.—Plan of Switchboard Gallery.

Digitized by Google

all respects. They are constructed of marble slabs carried on an iron framework. The four horizontal bars seen across the lower portion of the board are marble slabs separating the four short bars, which are connected to the main 'bus bars below the floor. It is possible by means of the combined plugging and switching arrangement to plug any feeder on any one of the four main 'bus bars, and, therefore, run any dynamo on any pair of feeders should this become necessary. At the top of the board will be seen the measuring instruments, which consist of a Kelvin combined volt and ampere meter, indicating and at the

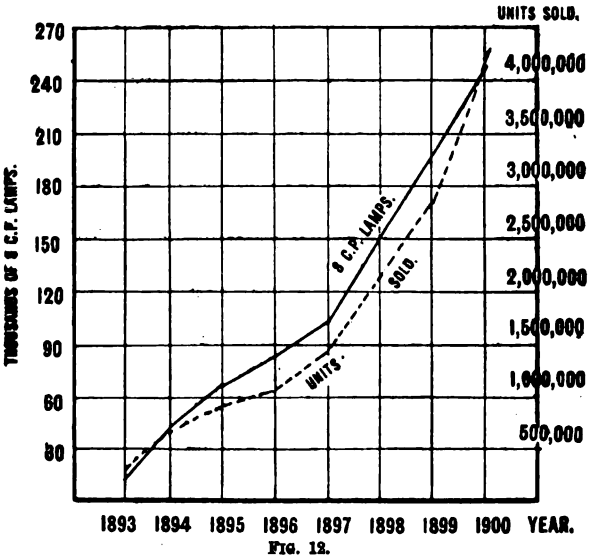


FIG. 12.

same time recording both the pressure and current on a sheet of paper. The attendant can thus see at a glance the pressure at the ends of the feeders (the voltmeters are calibrated for drop of pressure in the feeders), and the current, while a continuous record is kept. The clockwork mechanism operating the drum which carries the paper on which the record is made, is impelled by a central clock seen on back wall (Fig. 9) and also on the plan (Fig. 11). Thus all the records are made simultaneously, all the record instruments—there are 48 of them—being absolutely in synchronism.

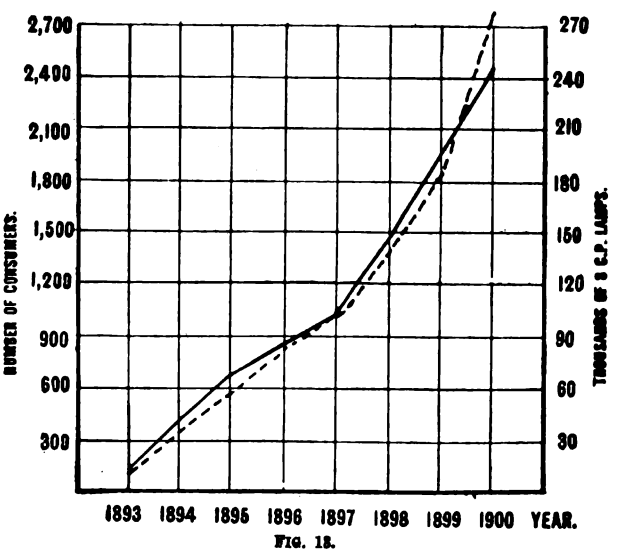


FIG. 13.

A side view of the board is given in Fig. 10, from which additional information will be gathered. The combined plug and switch gear, which can be moved into any one of the four bars, are seen near the floor; while the instruments, whose functions are too numerous to rehearse, are seen at the top. The signal levers, seen at the side of the measuring instruments, operate the switches seen on the back panel—this latter panel carries the double-break feeder switches, which, of course, are single-pole—and the duplex fuses easily seen in Fig. 10. From the latter the current passes to the feeders, which can be seen passing through the floor. Thus the circuits are not broken on the front panel although the switches are operated therefrom. A plan showing the general arrangement of the switchboard gallery and panels is given in Fig. 11. From the measurements it will be seen that this design has resulted in an unusually compact board.

The feeders pass down through the floor (as seen in Fig. 10) to the cable tunnel, which runs along the front of the buildings, and from thence they pass to the streets. The feeders are chiefly triple-concentric; nearly all have paper insulation, and are lead-sheathed. They are laid in wooden troughing on the solid system. The larger feeders have a section of one square inch, and at the time of ordering were the largest of their kind in the world, having an external diameter of $3\frac{1}{8}$in. The longest feeder is a little over two miles in length. The distributing system originally laid, copper strip laid on porcelain insulators in iron culverts, has been largely superseded by the solid system.

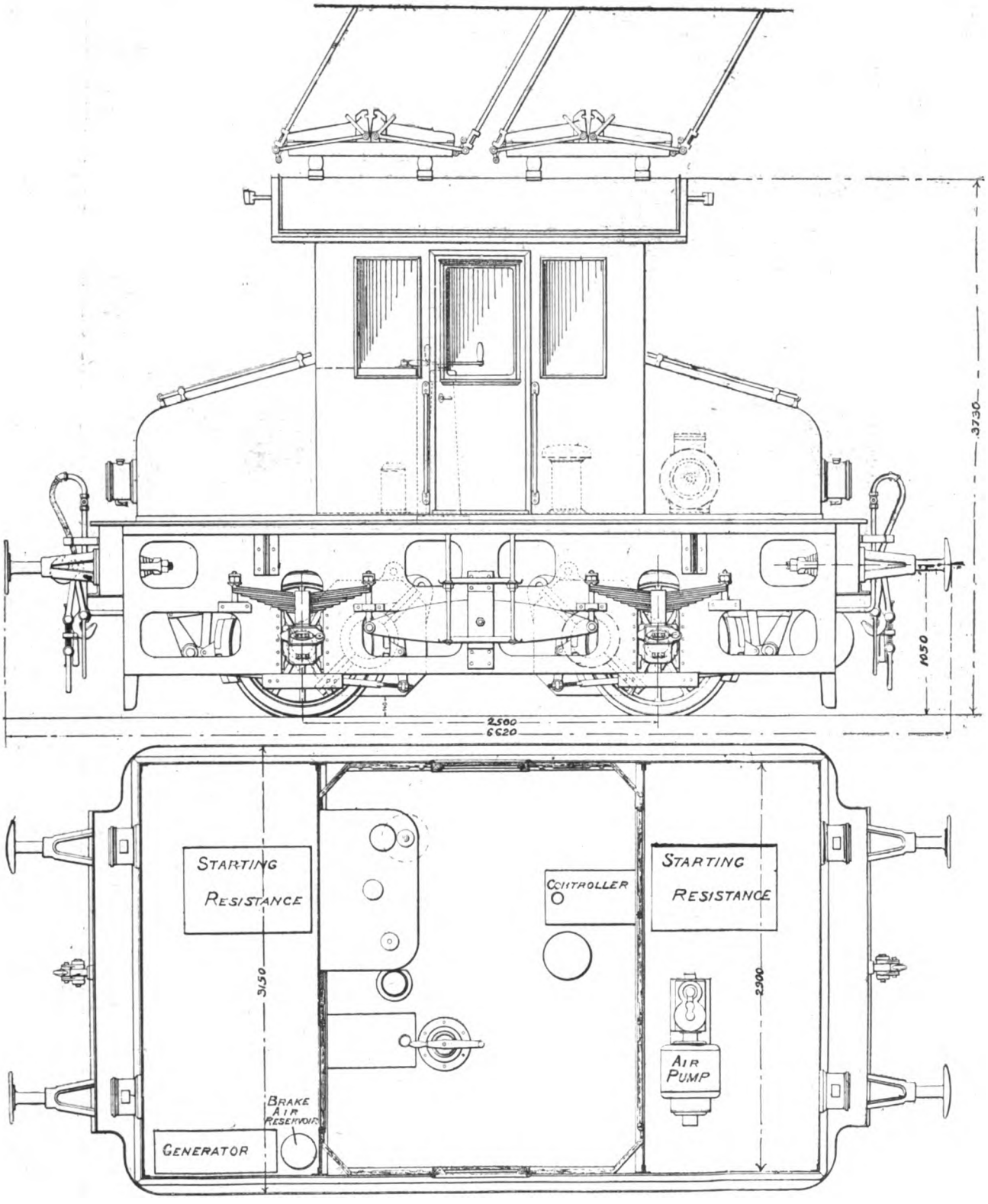
In order to show the development of the Glasgow system since its inauguration, two curves are given (Fig. 12) showing the progress of the undertaking in units sold and number of lamps connected: the broken line shows the former and the solid line the latter. Fig. 13 gives the number of consumers and their equivalent number of 8-c.p. lamps connected. It will be seen from Fig. 12 that the demand per lamp does not show any serious variation, but that each consumer has within the last two years shown a distinct tendency to use his supply for a longer period.

THE STANDARD-GAUGE ELECTRIC LOCOMOTIVE EXHIBITED BY THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT AT THE PARIS EXHIBITION.

The electric locomotive exhibited by the Allgemeine Elektricität-Gesellschaft at Paris, and herewith described, is designed for the haulage of goods and passenger trains on branch lines and for shunting purposes upon standard-gauge tracks. It is symmetrical in appearance, and constructed for the normal gauge of 3ft. 11in. The locomotive has two axles, each of which is driven by a separate motor. The general design of the locomotive is based upon the conditions prevailing upon the German State Railways. The locomotive is capable of hauling a train having a total weight of 300 tons at a speed of 28ft. per second, or 19 miles per hour on the level. The adhesive weight of the locomotive, included in the aggregate weight given above, amounts to 24 tons, its maximum tractive effort measured at the circumference of the driving wheel upon starting up being 8,000lb. With the exception of the roof of the driving cab, the footboard, and the inner lining of the driving cab, the locomotive is constructed entirely of iron and steel. The truck consists principally of two $\frac{5}{16}$in. frame plates, which constitute the longitudinal bearing girders, these latter being stiffened by means of channel-iron ends riveted with welded L-irons. Two buffers and a cow-catcher are attached to each end of this truck, the cow-catcher reaching to within $2\frac{1}{2}$in. of the bearing surface of the rails. There is nothing special to add with regard to the coupling arrangements, which conform to the standard practice in Germany. For constructive reasons the usual draw-bar is dispensed with; each coupling hook is therefore provided with a special spring attached to the buffer beam. The main frame plates carry iron brackets, with angle-iron strengthening pieces, which serve to support the upper construction of the locomotive. The whole truck is plated over with iron, whereby it receives considerable additional stiffening. The axle boxes are attached to the longitudinal bearers, as shown in the accompanying elevation. The distance between the axle centres is 8ft. 2in., which enables the locomotive to negotiate curves of the smallest permissible radius with ease. The wheels have a diameter on the tread of $39\frac{1}{2}$in., and are provided with wrought-iron spokes and cast-steel tyres forced on hot. The weight of the locomotive is transferred to the axle bearings by leaf springs, built up of separate ribbed laminations of steel $3\frac{1}{2}$in. broad by $\frac{1}{2}$in. thick, and held together in the middle by means of a wrought-iron truss. In order to distribute the weight as evenly as

Digitized by Google

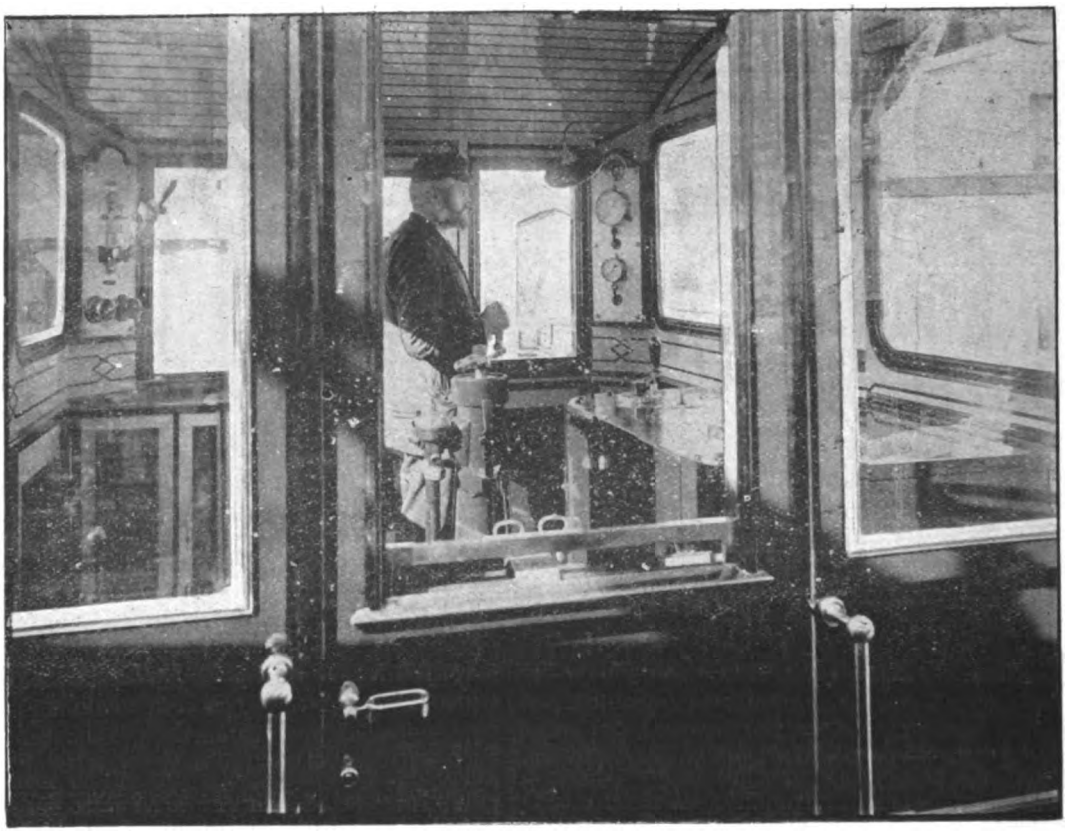
possible between the axles, each side of the frame is provided with a balancer which transfers a possible excess load upon one of the springs to the other spring. The spring suspensions are provided with adjustable nuts, whereby the trim of the buffers may be adjusted at any time. A screw spindle brake is further provided, which actuates two brake blocks upon each of the four wheels. There is also a Westinghouse air-brake, the piston of which actuates a lever attached to the main brake shaft. The necessary supply of compressed air is furnished by an air-pump driven by a special electromotor. The upper construction of the locomotive consists of the driving cab proper, and the sheathed compartment sloping off from either end of the same. The driving cab is protected, as shown in the accompanying illustrations. It may be entered from either side through a swinging door opening inwards, and fitted with windows which may be opened and closed as required. Each of the end walls of this cab is provided with three windows, while the side walls have two large windows each, of which the middle window in each end wall may be opened. Since the driving cab has an extreme breadth of 9ft. 6in., the whole train may be, therefore, kept under observation from the same. The sloping construction of the end compartments admits of an unobscured view of the track being obtained. The roof of the driving cab, as also the inner lining and floor of the same, consists of wood. In order to render the roof more durable, it is covered with waterproofed canvas. The apparatus for actuating the brakes is attached to a cast-iron pillar situated in the driving cab, and enables the eight brakes to be simultaneously put on. In the immediate proximity of this brake pillar are situated the levers in connection with the sanding pipes. Running parallel with each side wall of the cab below the windows is situated a



Plan and Side Elevation—A.E.G. Locomotive.

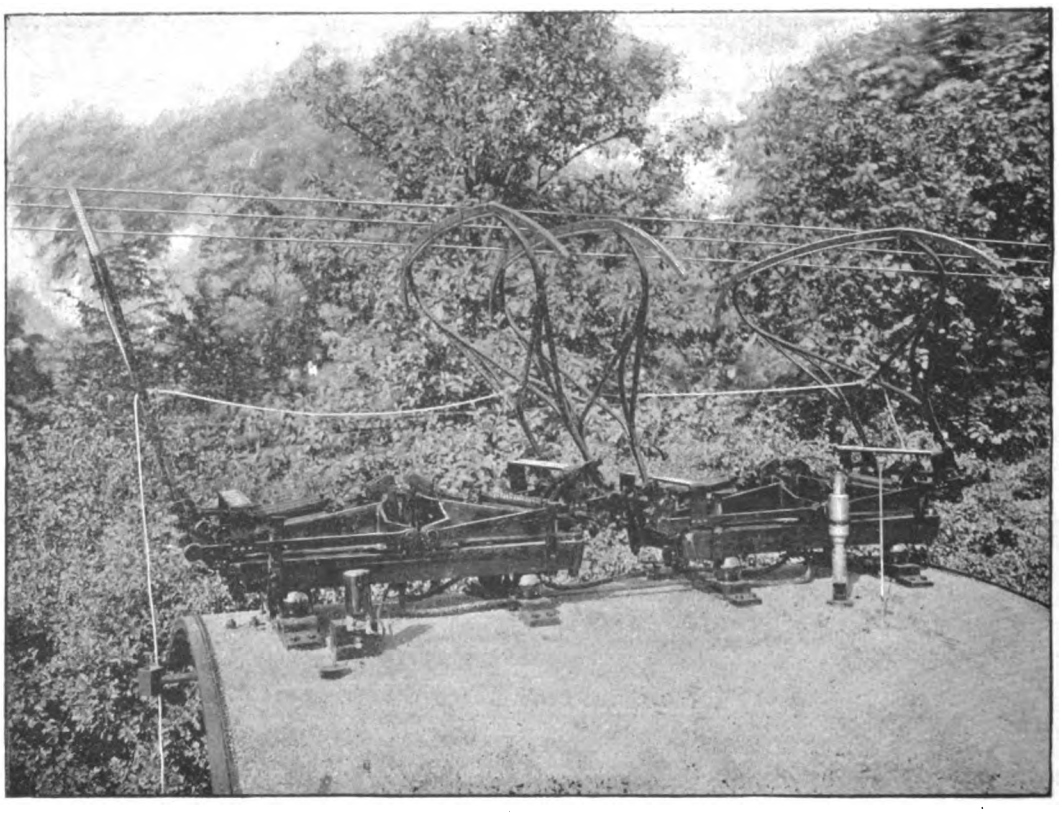
Digitized by Google

locker for the reception of tools and materials. For signalling purposes the locomotive is provided with a whistle actuated by means of compressed air supplied from a compressed-air chamber fed by the pump already mentioned. The floor of the cab is provided with trap-doors, through which the bearings of the motors, etc., are readily accessible.



View through Driving Cab—A.E.G. Locomotive.

An overhead trolley wire, suspended parallel with the track, serves to convey the necessary propelling energy to the locomotive. The current is collected from this wire by means of four contact bows attached to the roof of the locomotive, as shown. These contact bows are of special construction, whereby they adjust themselves automatically to either direction of travel. Having regard to the frequent change in the direction of travel, etc., the employment of a trolley wheel collector was out of the question here. The arrangement adopted for elevated and underground railways, consisting in the collection of current by means of a contact shoe from a conductor placed at the same level and running parallel with the rails, was also impracticable, since, on the one hand, insulation difficulties would have presented themselves, and, on the other, possible contact between the



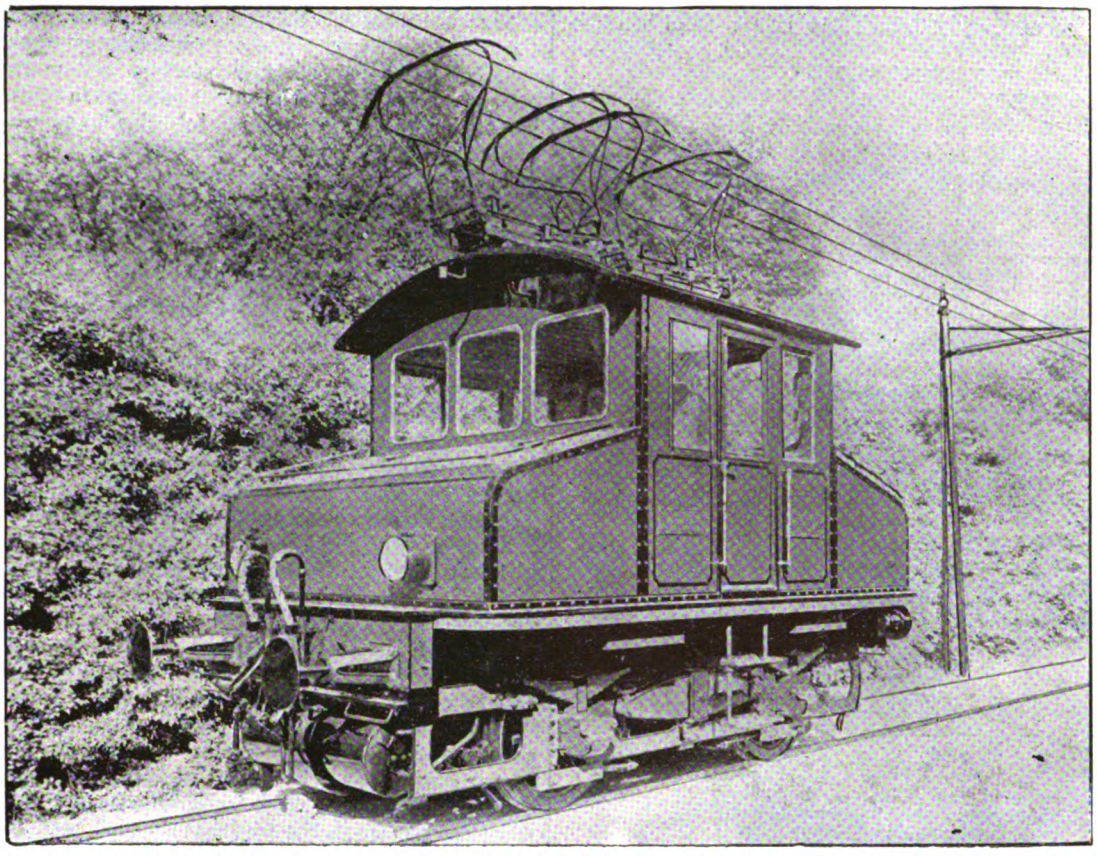
Bow Collectors—A.E.G. Locomotive.

Digitized by Google

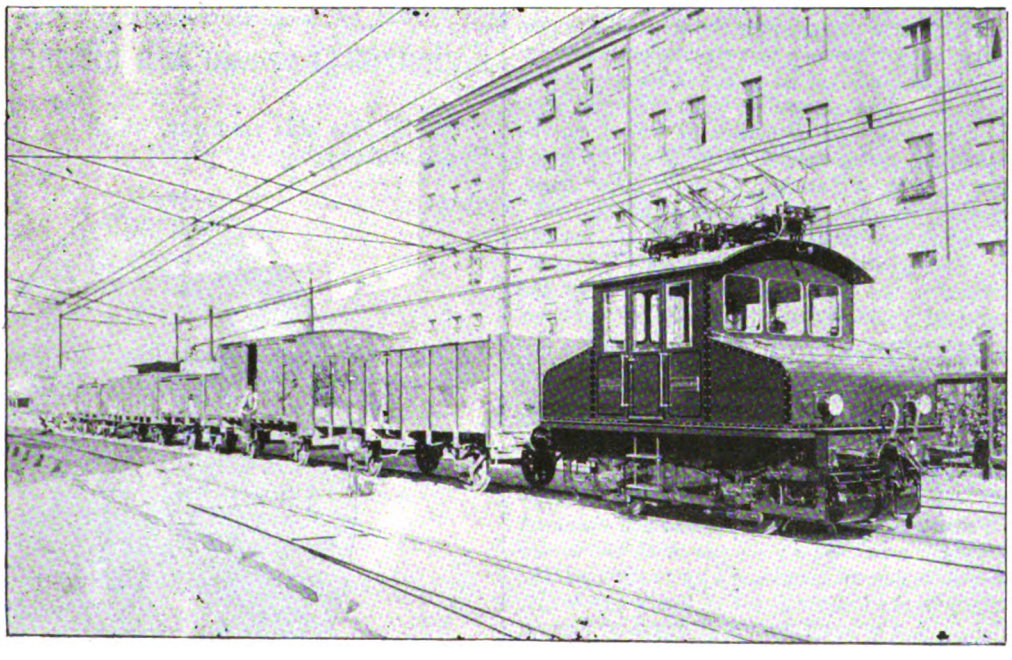
bearing rails and conductor could not be ignored. Further, at all points, crossings, etc., breaks in the conductor would be necessary.

In order to ensure good contact between the collector bows and trolley wire, the latter is divided into several parts consisting each of a single wire 8mm. in diameter. These wires are suspended parallel to each other as shown in the illustrations herewith, and are not insulated from each other. The wires are so suspended by means of special insulators that the sag in no case brings the wire down to less than 16ft. above the bearing surface of the rails. Wood or iron masts placed at intervals of from 100ft. to 130ft. along the railway serve to carry the trolley wire. The rails themselves serve for the return conductor, being bonded, and also connected to a special return cable where thought necessary. The locomotive is equipped with two motors of the A.E.G. V.B.-800 standard railway type. These motors are coupled by gearing to the driving axles, being suspended from the truck by means of springs in such manner that about one-eighth only of the motor's weight is directly borne by the axles. The driving power is transmitted from the motors to the driving axles by means of toothed wheel gearing having a ratio of 1 : 3. The driving pinion keyed to the armature shaft is composed of phosphor-bronze, whereas the large gear wheel keyed to the axle is of cast steel. The teeth of these wheels were were cut by special machinery. The gearing runs in a dust-proof oil bath formed by an iron case.

The motors are of the shunt-wound type, the steel magnet frame of each being so cast as to serve both as a protecting shield and to carry the bearings for the armature shaft, besides those for the driving axle. The motor cover is



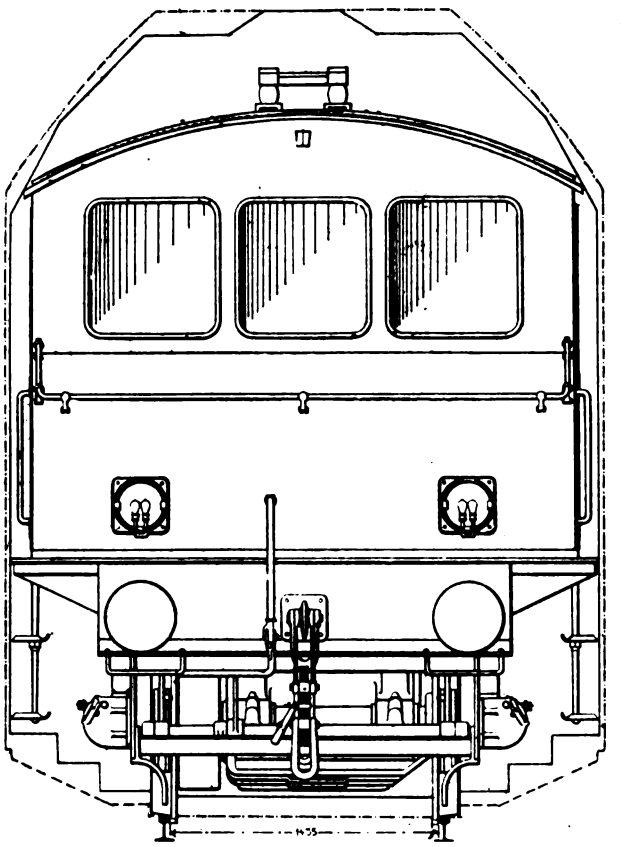
A.E.G. Locomotive.



A.E.G. Locomotive, with Train.

Digitized by Google

constructed in two parts, so as to protect the motor from damp and dust, and at the same time render the inner parts readily accessible. Both the commutator and the brushes are accessible through special openings. The armature is slot-wound, the coils being carefully secured. It is possible, without removing the upper portion or raising the locomotive, to detach the motor from beneath.



End Elevation—A.E.G. Locomotive.

The normal speed of the A.E.G. V.B.-800 type electromotor amounts to about 800 revolutions per minute, with a terminal pressure of 500 volts. Adjoining one of the end walls of the driving cab is situated the controller, which is arranged so as to enable the locomotive to travel either backwards or forwards. For this purpose the controller is provided with two cranks, one of which serves principally to regulate the speed of the locomotive, while the other serves as a cut-out and reverser. The controller is so arranged that the crank for determining the direction of travel can be reversed only when the crank serving to regulate the speed of the locomotive stands at "stop." On the other hand, the speed-regulating crank can be turned in the "on" direction only when the reversing crank stands exactly opposite either the "forward" or "backward" contact. The different speeds of the locomotive are obtained by the different grouping of the motors (series-parallel system), and by varying the strength of the magnetic field. For the low speeds the motors are switched in series, and for the high speeds in parallel. Compared with the system of regulating the speed by means of switching resistances in circuit with the motors, the system described above shows considerable economy. With the system in question the motors consume only that amount of electrical energy which suffices to overcome the work required from them A resistance, however, is switched in circuit with the motor upon starting up, in order to avoid a jerky motion of the train. But as soon as the locomotive has fairly got under way this resistance is switched out, and further loss of energy thus obviated. The starting resistance is situated in the sheathed compartments at either end of the locomotive, half in each.

The regulation of the strength of the magnetic field takes place automatically with the turning of the regulating crank, the necessary shunt regulator for this purpose being situated in one of the above-mentioned sheathed compartments. The aggregate output of the two motors amounts to 300 effective horse-power, the consumption of current corresponding to this output being about 550 amperes at 500 volts. The air-pump for supplying compressed air to the Westinghouse brakes, etc., together with its special driving motor, is placed in one of the sheathed end compartments. The air-pump is provided with a high and a low pressure cylinder, and supplies air at a pressure equal to six atmospheres. So soon as this pressure is attained in the main air reservoir, the pump motor is automatically switched out of circuit, coming automatically into action again when the air pressure in this reservoir has sunk to 5½ atmospheres. In order to enable the locomotive to work over stretches of line which for some reason or other may not have been equipped with overhead trolley wires, contact boxes are fitted to each buffer beam close to the coupling hooks, by means of which the locomotive may be coupled up to a special tender equipped with a battery of accumulators. The making of the electrical contact with the battery tender is accomplished in precisely similar manner to the coupling of brake tubes.

In the four corners of the driving cab are situated the necessary measuring instruments, etc., such as voltmeters, ampere-meters, switch levers, and cut-outs. In addition to the above-mentioned apparatus, the electrical equipment of the locomotive includes fuses for the protection of the motors and cable connections against overloading, and a lightning arrester with automatic spark extinguisher.

The lighting of the locomotive is provided for by means of 10 electric incandescent lamps arranged upon two circuits of five in series each. The head and signal lights, etc., are duplicated and placed on alternate circuits, so as to avoid complete failure of the lights at any one part of the locomotive. The principal dimensions of the locomotive may be gathered from the plan and elevation given herewith.

Experience has shown that shunting operations, etc., upon standard-gauge lines may be conducted at stations 40 per cent. cheaper by means of electric locomotives than with steam-engines. This favourable result owes its attainment principally to the fact that the cost both of the necessary energy and upkeep is much less in regard to electric working than with steam. Further, when electrical energy is employed, one man suffices to attend the locomotive, whereas two are necessary when steam power is used.

We understand that besides standard-gauge electric locomotives the Allgemeine Elektricitäts Gesellschaft have already constructed a large number of locomotives for factory sidings, light railways, and pit railways.

HOUGHTON-LE-SPRING AND DISTRICT TRAMWAY.

The Bill for this tramway, which has its centre about Houghton-le-Spring, was passed without opposition during

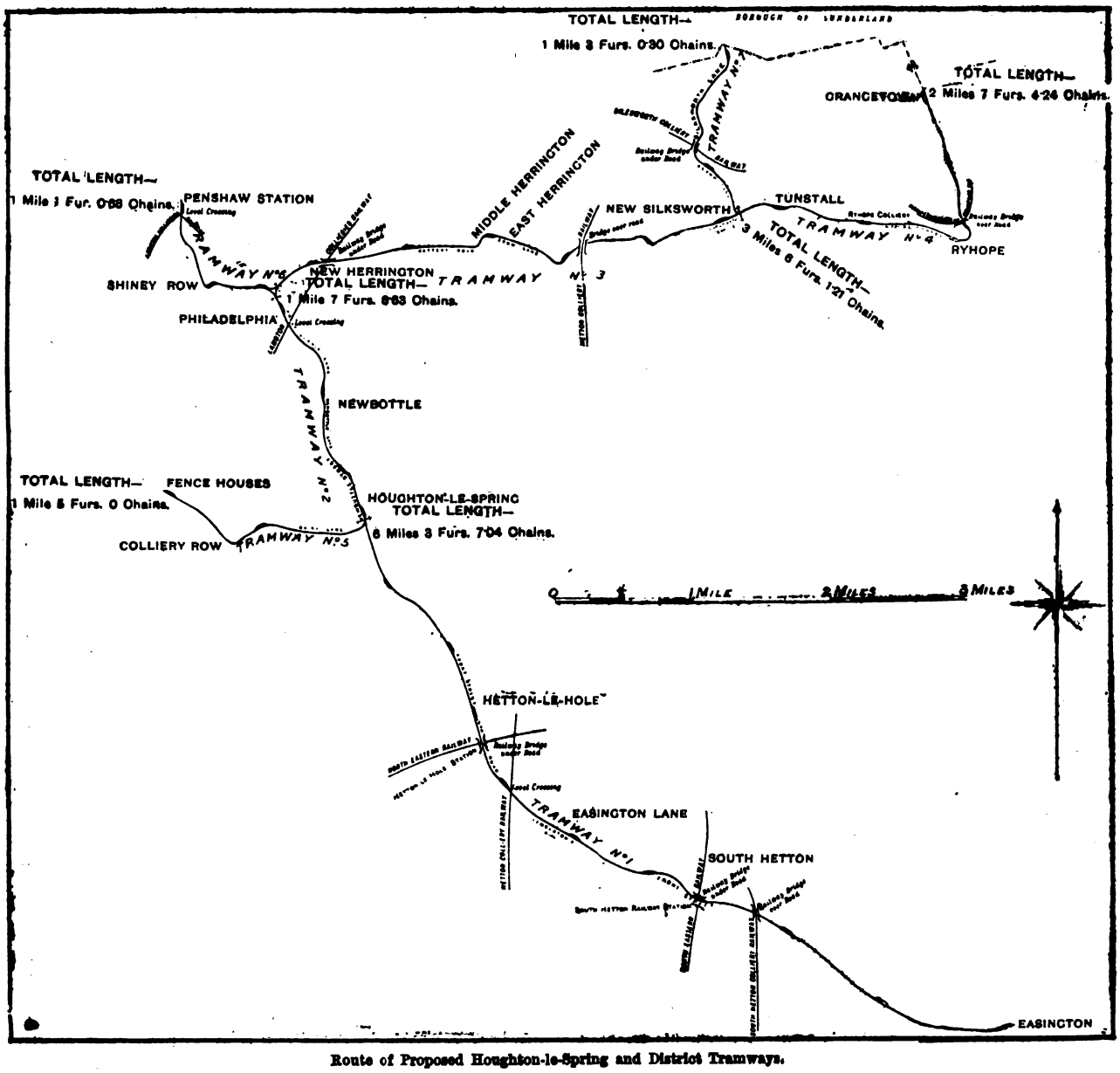
MR. D. BALFOUR, M.INST.C.E.

the last session. It has been promoted by the United Kingdom Tramway, Light Railway, and Electrical Syndicate,

Digitized by Google

and the engineer is Mr. D. Balfour, the well-known consulting engineer of Newcastle. The accompanying map will show the places which the tramway is intended to serve. It is expected that not only will there be a fair passenger traffic, but that there will be a fairly large goods traffic. The rate for this class of traffic, which accompanies the Bill, has evidently been carefully considered in order to develop as far as possible a large goods traffic.

In connection with this matter, we understand that the necessary ironwork will probably have to be obtained abroad, in that delivery cannot be guaranteed by any of the merchants in this country. If this statement is correct, it shows our manufacturers must be filled with orders, and that many of the alarmists' statements so often heard as to



Route of Proposed Houghton-le-Spring and District Tramways.

the decadence of British productions are the outcome of ignorance. We rather hope, however, that by the time active work is commenced that the materials required may be obtainable without bringing them across the sea.

CARDIFF PROPOSED ELECTRICAL TRAMWAYS.

The newly-appointed Corporation tramways electrical engineer, Mr. Arthur Ellis, in his preliminary report to the Tramways Committee on the equipment of the Cardiff tramways for electrical traction, briefly referred to in our columns of last week, remarks upon the Corporation's intentions to take over the present tramways on Jan. 1, 1902, when, in addition to the present lines, several miles of new routes will have to be laid and electrically equipped, whence the necessity of proceeding with the work without delay, there being only 15 months in which to do everything. In this respect Mr. Ellis points out that the plant must be completed and ready for testing at least a month or six weeks before the system is opened for regular service. The principal object of this preliminary report is, therefore, to enable the Tramways Committee to definitely settle the question of site for the power station and type of plant to be installed, which evidences wise forethought on the part of the advising engineer, having regard to the great difficulty in obtaining early deliveries of plant, etc. Hence the report is mainly confined to the question of site, the power station itself, and the plant to be installed therein. As regards the first question, what is known as the Roath Brook site is recommended for the power station. This site, it appears, has in its favour two most essential points—viz., close proximity to a railway, by means of which fuel may be delivered direct from the colliery, and also to a brook, from which water could be obtained for condensing purposes. Moreover, the site affords ample room for future extensions. Its position relative to the tramway system to be supplied with power involves no difficulties in the distribution of the power, the greatest distance from the site to the end of any of the proposed routes being under four miles, and even Penarth, which, as pointed out, may at some future date require a tramway service in connection with the Cardiff system, could be supplied with power from the same station.

With regard to plant, engines of the compound vertical condensing type, running at a speed not exceeding 100 revolutions per minute, and fitted with Corliss valve gear, are recommended for instalment, each engine to be equipped with its own condensing apparatus. Gene-

Digitized by Google

rators of the compound-wound type, mounted direct on the shaft of the engines between the high and low pressure cylinders, are further recommended. The generators would be constructed in such a manner that they could run as ordinary shunt-wound generators, if at some future time it might be desirable to use them for other purposes than tramways. The Roath Brook being of inconsiderable size, and not yielding a constant volume of water throughout the year, although there is a good flow for nearly nine months in the year, it is further recommended that a cooling tower should be provided for working in conjunction with the condensers, whereby the same water, minus any loss from evaporation, would be used over and over again. Besides making up any deficiency of water caused by evaporation, the brook water would be available for boiler feed purposes during the greater part of the year, when the boilers could be fed direct from the hot-well of the condensers, the loss being made up from the brook, whereby cooling apparatus would be saved through the condensing water being constantly mixed with fresh water.

As regards boiler-house equipment, the Lancashire type of boiler is recommended as being the most suitable for a tramway load. Economisers would be used in connection with the same. Superheaters and mechanical stokers, driven electrically, in combination with coal-conveying plant, are also mentioned in the report, the several advantages attending the use of the same being briefly referred to. The overhead equipment of the lines and system of distribution will be dealt with in the complete scheme which Mr. Ellis promises to lay before the Tramways Committee for their consideration at a later date; also the question of car depôts will be dealt with at the same time. The question of cars, having regard to the difficulty of obtaining the same in any number at short notice, will be taken in hand at once, and Mr. Ellis hopes to submit his suggestion both as to the type of car most adapted to local conditions and the number of cars necessary to the next meeting of the Tramways Committee. Mr. Harpur, the borough engineer, has the track in hand. As reported in our last week's issue, the Tramways Committee have agreed to purchase land adjoining the proposed site.

REVIEWS.

The Path of the Sun, its Orbit and Period of Revolution Demonstrated, with an Exposure of the Fallacy of the Precession of the Equinoxes. By WILLIAM SANDEMAN, F.C.A. Simpkin, Marshall, and Co. Pp. 132.

Mr. Sandeman is an iconoclast, and the little book before us shows that an idol may expect small mercy at his hands, unless, indeed, it happens to be of his own creation. For though we are told on the title page, "I do not frame hypotheses; I make no suppositions; I concern myself solely with facts;" yet Mr. Sandeman has an idol of his own, in the shape of a model of the solar system, and this he has frankly set on high, "in the confident hope of a friendly impartial reception" from "the great, tolerant, truth-loving British public." As an introduction, we are told that "there is no doubt that the discovery [which he has made] is a solution of the great astronomical problem of the day," even though it has been repudiated by the leading astronomical authorities.

Just a word as to iconoclasts in general. Scientific experts are not always right, and long-accepted hypotheses may be wrong, in detail or as a whole; but a justifiable conservatism leads us to defend our accepted idols until such time as they may be proved to be of clay. On the other hand, iconoclasts and innovators are not always right. Some, indeed, of our greatest scientists (notably Joule) have in their time had to struggle against adverse opinion for years, and have ultimately triumphed in the general acceptance of their cherished doctrines. But how many inventors of perpetual motion machines, squarers of the circle, and advocates of a flat earth, has the world not seen? *Peace to their hashes!*

Mr. Sandeman tells us that his study commenced in 1831, in which year "Ferguson's 'Astronomy' was perused, and a serious attempt made to understand it." However, "about the year 1886 doubts arose as to the accepted theory of precession being a true exponent of the cause of polar movements. . . . It thus became a settled point that, whatever the truth might be, it was not precession." This belief has grown with years, till it is now believed that precession "is the incubus on the solar path, a nightmare on the minds of astronomers, and an effectual bar to progressive discovery" (p. 77).

It may here be remarked that the mere term, "precession of the equinoxes," unduly excites Mr. Sandeman's censure. Yet this is merely a name given to an observed phenomenon which neither Mr. Sandeman nor anyone else is bold enough to question. The facts are these: The earth travels round the sun in an approximately fixed plane, termed the plane of the ecliptic. The plane of the earth's equator is inclined at a constant angle to the plane of the ecliptic. At the vernal equinox the centre of the sun lies in the intersection of these two planes, and is therefore vertically above a point on the earth's equator. The point in the heavens which the centre of the sun then occupies is termed the "first point of Aries." Now, it has been incontestably proved that the first point of Aries alters its position from year to year; by a very small amount, it is true—so small that only the cumulative effect of many years produces any observable difference—but still by an appreciable amount. The result is that at any particular equinox the sun has not yet quite reached the point in the heavens which it occupied at the previous equinox of the same name. Hence the equinox *precedes* the completion of the sidereal year.

The above is admitted by Mr. Sandeman; it is really the physical explanation given by Sir Isaac Newton to which exception is taken. Mr. Sandeman, unfortunately, has failed to realise that in this explanation Sir Isaac only applied an indisputable corollary of the second law of motion, together with the equally indisputable law of gravitative action, to a problem in celestial mechanics. That the causes mentioned by Newton are capable *in some degree* of producing the observed effect of precession, there can be no doubt, unless we are ready to abandon the whole superstructure of theoretical mechanics. Had Mr. Sandeman shown by calculation that the magnitude of the observed precession is too great to be accounted for by the cause invoked, then there would be just grounds for complaint if his alternative scheme were neglected. This, however, he has failed, or, rather, has never even attempted, to do.

Newton's explanation of the precession of the equinoxes, and the explanation of the conical motion of the axis of a top that is spinning in an inclined position, stand on exactly the same footing. If the top were not spinning, the action of gravity would pull it to the earth; as it is spinning, it possesses angular momentum about its geometrical axis, and the action of gravity further imparts to it an angular momentum about an horizontal axis. These two momenta must be compounded in order to find the resultant momentum, and the result shows that if the spin of the top be sufficiently high, its geometrical axis will remain inclined at a constant angle to the horizon, but will describe a conical surface, just as every schoolboy has observed his top to do. The result of the action of the gravitative attraction of the sun on the earth is essentially similar. The axis of the earth is inclined to the ecliptic, and since the earth has the form of an oblate spheroid, the differential attraction of the sun on the equatorial belt would pull the axis into a position perpendicular to the ecliptic if the earth were not rotating. As it is, however, the resultant angular momentum of the earth is due, not only to its momentum about its polar axis, but also to the angular momentum produced by the gravitative action mentioned above. Hence the polar axis of the earth describes a conical surface, just as a top does when spinning with an inclined axis. As a result, the equatorial plane, which is perpendicular to the polar axis of the earth, remains inclined at a constant angle to the ecliptic, but moves in such a manner that the line of its intersection with the ecliptic plane rotates in a sense opposed to that of the earth's revolution. Hence the precession of the equinoxes.

The above explanation is based on Newton's second law

Digitized by Google

of motion, and there is no logical ground for rejecting one unless we can disprove the other. When Mr. Sandeman writes (p. 35) that in postulating the conical rotation of the earth's axis "it becomes evident that the earth has somehow broken loose from the control of the sun, and turns itself independently of the influence of that orb," we can hardly avoid the conclusion that he has failed to master the fundamental principle of compounding angular momenta. "The extraordinary manifestation of the earth dancing a reel in face of the sun, turning round at the rate of once in 25,800 years," is matched almost every time a schoolboy spins a top. If Mr. Sandeman will take the wheel of a bicycle, set it spinning as fast as possible, and, while holding it with the axle horizontal, try to twist it into some new direction, he will be met by the "extraordinary manifestation," that, like a live thing, it apparently attempts to twist itself out of his hands in a direction at right angles to that of the desired motion.

As previously mentioned, Mr. Sandeman wishes, not only to demolish the accepted theory of the conical rotation of the earth's axis, but to replace this by a theory of his own. On the principle that "it's well to be off with the old love before you are on with the new," we need give no detailed account of Mr. Sandeman's theory; an examination of the foundations on which this is erected must suffice at present. In brief, his theory is that the sun is travelling in an approximately circular orbit of about three billions of miles in diameter, one revolution requiring 25,800 years. It is known, from observations of the apparent drift of stars, that the sun at present really is moving, with a velocity of from six to eight miles per second, in the general direction of Alpha Lyræ. The true curvature of the sun's path is not known, as it could only be determined with certainty from observations extending over several thousand years. We will now let Mr. Sandeman speak for himself, premising that the extract given follows on a vigorous onslaught against the accepted theory of precession. The "forces" mentioned are the centrifugal force due to the earth's rotation (which really has nothing whatever to do with the question) and the gravitative pull of the sun on the equatorial belt of the earth:

"The theory presented in opposition to this—*i.e.*, to Newton's theory—is that the two forces acting together hold the earth in a fixed position in relation to the sun, and if the similitude can be used in reference to loose bodies moving in space, they act as if these bodies were joined by an iron bar. As the sun revolves in his orbit, therefore, the earth and its axis must turn with it; but as the revolution of the sun also involves its revolution round the earth, the equinoctial points on the earth's surface—that is, the places where the sun crosses the equator—must advance with the sun" (p. 36).

We are afraid that the reader will attain no very clear ideas from the above, but no passage of similar extent which we have been able to find appears preferable. From a comparison of a number of passages (see pp. 33, 53, 95, etc.) we believe that the meaning of the author is as follows: The sun is supposed to revolve in an orbit, as previously mentioned, in a plane slightly inclined to the ecliptic, or plane of the earth's orbit. Let us suppose, for instance, that the earth's axis at any time cuts a straight line drawn perpendicularly through the centre of the sun's orbit. Then, as the sun revolves, the earth will move so that its axis always cuts the line mentioned (neglecting the parallel displacement of the earth's axis during its yearly revolution). Hence the earth's axis will, as in Newton's theory, describe a conical surface in 25,800 years, the period required for the sun's revolution; "an extraordinary manifestation," of which the author attempts no mechanical explanation.

It is, perhaps, only fair to give Mr. Sandeman's "proof" of the mechanical principle on which his theory is founded. The plane of the moon's orbit is inclined to the plane of the ecliptic, and the line of intersection of these planes is termed the "line of nodes." Now, it has been observed that the line of nodes rotates once in every $18\frac{2}{3}$ years. This rotation of the moon's line of nodes is accompanied by a small conical motion of the earth's axis, also occupying $18\frac{2}{3}$ years. In the following extract the "nodes of the sun" must be understood to refer to the points in the ecliptic through which Mr. Sandeman supposes the sun to pass in its (conjectured) orbital motions. Now (p. 34), "if the sun revolves round an orbit and round the earth, both of which are admitted in theory by astronomers, the effect of the revolution of the nodes of the sun upon the pole must be the same as those of the moon, in which case the pole must be carried round with the sun in the same time as it revolves itself."

For a short statement the above abounds in fallacies. First of all, the revolution of the nodes of the moon produces a small conical movement of about 18 seconds of arc in the earth's axis, *about what would be its position if undisturbed*; hence it is concluded that the revolution of the nodes of the sun produces a conical motion of 47deg. *about an axis perpendicular to the ecliptic.* But another fallacy lies behind. We are first told that the revolution of the *nodes of the sun* carry the earth's axis round once in every revolution, and then that the revolution *of the sun itself* does the same thing. Now, whilst the moon's nodes make one revolution, the moon makes about $12 \times 18\frac{2}{3} = 224$ revolutions; why the nodes of the sun are tacitly supposed to revolve in the same time as the sun itself we are not told.

Perhaps the above will be enough to indicate the scope of the book and the nature of the arguments used. We are not without sympathy for Mr. Sandeman's aims, but we think that he was badly equipped for the task undertaken. His honest and sincere enthusiasm for the acquisition of truth is sufficiently apparent, even though this is often clouded by a want of appreciation for the work of eminent astronomers. Many of his errors may be traced to a defective knowledge of mechanics and astronomy, due to the use of popular treatises on these subjects. The sort of knowledge which it is possible to impart in a popular lecture or treatise is apt to prove insufficient to enable anyone to criticise or construct a theory. A short but satisfactory account of the motion of the earth, treated mathematically, may be found in Routh's "Rigid Dynamics," paragraphs 610-634. It is there shown that the sun produces a precessional motion of 15·42 seconds of arc per annum, that due to the moon being a little more than double this amount. As in some other cases, the actual figures obtained by Newton were not correct, although the method which he introduced has, in the hands of his successors, led to accurate results. This is not to be wondered at. The work of a pioneer is to make a road, and not to build cities. Mr. Sandeman is mistaken in thinking that a theory would gain immunity from criticism on account of its having been proposed or accepted by Newton. To go no farther, Newton made a serious error in calculating the velocity of sound in a gas, and rejected the wave theory of light in favour of the corpuscular theory; these facts may be found stated in any advanced text-book. A theory which cannot bear criticism is not likely to stand, no matter who the founder may have been. But in the present case Mr. Sandeman has failed to disprove the accepted theory, and has failed also to substantiate his own. There we may leave the matter at rest.

EDWIN EDSER.

FORTHCOMING EVENTS.

FRIDAY, SEPT. 28.

Royal Photographic Society.—Press view of forty-fifth annual exhibition, from 11 a.m. to 4 p.m.

SATURDAY, SEPT. 29.

Royal Photographic Society.—At 8 p.m., at the New Gallery, Regent-street, soirée in connection with the annual exhibition.

MONDAY, OCT. 1.

Society of Engineers.—At 7 30 p.m., meeting at the Royal United Service Institution, Whitehall. A paper will be read, entitled "Paper-Making Machinery," by Mr. Robert Henderson.

WEDNESDAY, OCT. 3.

Society of Model Engineers (Liverpool Branch).—At 7.45 p.m., monthly meeting.

THURSDAY, OCT. 4.

Civil and Mechanical Engineers' Society.—At 8 p.m., first monthly meeting. Presidential address on "Training to keep ahead in the World's Competition," by Prof. R. H. Smith.

SATURDAY, OCT. 6.

Association of Municipal and County Engineers.—District meeting at East Molesey and Hampton.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	433	A Lecture-Room Volt and Ammeter	453
The Electric Lighting of the City of Glasgow	438	Electricity Supply for Lighting and Tramways, with Special Reference to Small Towns	453
The Standard-Gauge Electric Locomotive Exhibited by the Allgemeine Elektricitäts-Gesellschaft at the Paris Exhibition	442	Questions and Answers	457
Houghton-le-Spring and District Tramway	446	Oldham Electricity Accounts	460
Cardiff Proposed Electrical Tramways	447	Truro Electric Lighting	461
Reviews	448	Contracts for Electrical Supplies	462
Forthcoming Events	449	Traction Notes	463
Postal Telegraph Finance	450	Lighting Notes	464
Correspondence	451	Companies' Meetings and Reports	46
Electricity in the Industries	451	Provisional Patents	467
Discussion on Ions	452	Traffic Returns	468
Light Railways	452	Companies' Stock and Share List	468

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

POSTAL TELEGRAPH FINANCE.

The annual report of our Postmaster-General was issued rather more than a month ago, so that it now has had time to reach most of the foreign countries. The comments on this report are hence to be expected in the technical Press of these countries, and we see in our contemporary, the *Western Electrician*, the following verdict on the same: "The British telegraph service is admittedly very good—better, on the whole, no doubt than that of our private companies. But why should that portion of the British public that does not use the telegraph be taxed to meet the deficit of those that do?" Assuming that the verdict of our contemporary on the financial position of the postal telegraph system of the United Kingdom to be a correct one, we should still object to the query at the end of it on the following grounds. Any telegraph system, and particularly a cheap and efficient one, is of such advantage to the commercial world that the benefits conferred are not by any means confined to the actual users. For instance, in a large manufacturing business the telegraph system has now become an absolute necessity, and while the artisans and labourers employed by the firm may not use the telegraph themselves to any large extent, they indirectly receive a great benefit. It is, however, with the general criticism of the *Western Electrician* which we have to deal, and we were surprised to find that this was based on an editorial comment on the report which appeared in the columns of our neighbouring contemporary. As this contemporary is run by a business man, one would naturally expect a reasonable comprehension of the Post Office balance-sheet. The system adopted by the Government in extending its telegraph business is quite unlike that in vogue amongst commercial enterprises, who have to make a return to shareholders each year. In this, we presume, may be found the explanation of our contemporary's most misleading remarks, which are as follows: "Summed up briefly, although the telegraph revenue increased by £200,347, the expenditure also increased by no less than £266,916, resulting in a net deficit of £288,438, or £66,569 more than last year's deficit. If allowance be made for interest on the capital created for the purchase of the telegraph, the deficit for the year is raised to £587,326." Our contemporary goes on to comment that "every year this painful fact is rubbed in with unsparing reiteration, but without the least attempt of explanation or expectation of amendment." One would have thought that the explanation would have been given by the editor of a journal specially devoted to telegraphic undertakings. The facts of the case are as follows: When the Government took over from the various companies the telegraph works which are now united to form the telegraphic system of the kingdom, Government stock was issued in order to obtain the purchase money. The amount of the stock is now practically the same as in the year when it was issued, and the interest on it each year amounts to £298,888. When extensions were required, as has been the case each year, the policy of increasing the capital account was not adopted,

Digitized by Google

so that in the figures quoted above, items appear which can by no means be considered as working expenses. For instance, the telegraph extensions for the past year alone cost £277,133, a large portion of which went in the provision of telephone trunk wires, on which £176,968 were spent. Buildings and new sites were also provided at a cost of £76,097. It is, in fact, clearly pointed out in the tabular account in the report that a profit of £65,592 was made on the working of the telegraph system. This is, of course, insufficient to meet the interest charges on the stock above mentioned. A more equitable way of considering the case is to take the average for the last ten years, which shows that out of interest charges amounting to almost £3,000,000, about £885,000 has been met by the net revenue of the Department. This leaves a deficit of, say, £210,000 per annum, which is the real average deficit, and which does not compare at all with the apparent deficit of £587,000 quoted by our contemporary, and which exists on paper only. The difference between the two is capital expenditure, which the Government, rightly, in our opinion, considers should be borne by the present generation, which has almost immediately the benefit of it. For this capital expenditure the country holds a tangible asset, which is worth considerably more than its cost price to the commercial men of the kingdom. If further comparison were needed as to the wisdom of the policy of extending the system out of the national revenue, it could be obtained by comparison between the cost of a telegraph message here and in the United States. We pay for twelve words sixpence. In the States, while the telegraph companies are not earning extraordinarily large dividends, the cost of a message of the same length would be elevenpence halfpenny. On this comparison of cost, the Government saved the English nation £3,000,000 last year in cost of telegrams by a system which involves an actual expenditure for working expenses and capital charges of something like £200,000 per annum.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—I am sorry, for Mr. Johnston's own sake, that he has not the decency to apologise for having misrepresented me, but merely says that the misrepresentation, which he does not deny, "in no way affects the main points at issue." It affects the matter in this way: By representing me as saying "current" where I said "E.M.F.," he was able to destroy my case completely, and to prove that I had "found a veritable mare's nest." He now complains that I misrepresent him when I say, "He then goes on to show that the statement to which I object does not imply that there will be a current under such conditions." But this is not a misrepresentation at all; indeed, it is obvious that if he did not show that the statement does not imply a current, he would not be in a position to ridicule my alleged idea that it does imply a current. If his argument is not as I represent it to be, it has no force whatever; but a reference to the second paragraph of his first letter will show that he does exactly what I say he does.

I pointed out an extraordinary *non sequitur* in his first letter, and he now replies: "I would point out that the statement of two propositions does not necessarily imply that the one is a deduction of the other." But when you connect the two propositions in this way, "*Remembering that* A is B, *it is evident that* C is D," you do imply that the second is a deduction of the first, and it is Mr. Johnston's use of the words italicised which justifies my criticism. I will now come to the main point at issue, for on the remaining point Mr. Johnston clearly answers himself when he says "the *strength* of the field at any point is represented *not* by the lines, but by the *number* of these lines passing through unit area at that point."

The main point is this: I have said, on the authority of Faraday, that the mere cutting of magnetic lines does not tend to induce a current, but that there must be a change in the number of magnetic lines passing through the electric circuit. Mr. Johnston, like the editor of *Lightning*, suggests that I have misunderstood Faraday. In reply to this, I can only say that some of the best-known writers on electricity are of the same opinion as myself regarding Faraday's theory. This is what Prof. S. P. Thompson says in giving an account of that theory in the fifth edition of his book on "Dynamo-Electric Machinery," p. 27: "It is, however, necessary that the moving conductor should, in its motion, so cut the magnetic field as to alter the number of magnetic lines that pass through the circuit of which the moving conductor forms a part. Without a variation in the magnetic flux that penetrates the circuit, there will be no induction."

Prof. Fleming, in the introduction to his book on "The Alternate-Current Transformer," shows that he too understands Faraday's theory in this way. It will thus be seen that I am by no means alone in condemning the inaccurate manner in which the theory is usually presented to students.—Yours, etc.,

W. F. DUNTON.

ELECTRICITY IN THE INDUSTRIES.

BY PROF. S. P. THOMPSON.

Prof. S. P. Thompson, who was selected to deliver the "lecture to artisans" in connection with the British Association, took as his subject "Electricity in the Industries." In his address he opened by speaking of the growth of Bradford during the 30 years since the last British Association meeting was held there. He stated that the population of Bradford had doubled since then, and that its prosperity was in a great measure due to the invention of the steam-engine and its application to the textile industry. He then went on to speak of the rise during recent years of the electrical industry, and of its application to heavy work. He then showed the leading inventions which had combined to give the electrical applications of the present day. Thus Sir Humphrey Davy put the first two sticks of carbon together and produced the electric arc light; William Sturgeon, a native of Kirkby Lonsdale, invented the electromagnet; Michael Faraday discovered the commercial and mechanical way of generating electrical currents in a magnetic way. The experiments by which these inventors arrived at their great conclusions were reproduced by Prof. Thompson, who showed their relation to the other inventions in the production of the great electric power stations and appliances of to-day. Faraday's ring, for instance, was the prototype of all transformers since made, and which were solving the problem of the economical transmission of power over long distances. Prof. Thompson then had thrown upon the screen photographs of dynamos and motors, of railway engines and tramcars, representing electrical science so far as it has gone. Some small experimental dynamos and motors were also exhibited on the platform. The lecturer then went on to describe great modern generating stations, such as those at Niagara and on the Rhine, where the current is sent at a very high pressure over comparatively long distances, and then transformed down into currents suitable for domestic lighting and similar purposes. Prof. Thompson referred to the Bradford tramway system, and said he was wondering when all the Bradford trams would be electrical. He spoke then of the enormous value which coal in the future would have for the purpose of raising steam to transmit power over long distances, and thought that in the coming age of electricity the workers would have a much better time than at present,

Digitized by Google

DISCUSSION ON IONS.

On Tuesday, Sept. 11, a joint discussion was held at Bradford between Section A and the Chemical Section of the British Association on the subject of "Ions."

This was opened by Prof. G. F. FITZGERALD, who treated the subject in a very broadminded way, and suggested various experiments which should be made in order to elucidate the various uncertain problems connected with electrolysis and the migration of ions. In the first place, he held that the term conductivity was preferable to ionisation. Thus the conductivity in a liquid solution was distinctly different from the conductivity in a gas. In gas, for instance, there seemed to be evidence, as shown by Prof. J. J. Thompson, of masses smaller than atoms, whereas there was no such evidence of smaller masses than atoms in liquids. Besides this, there was a fixed relation between the conductivity of liquids and their other properties, such as their solution, their chemical affinity, and their freezing and boiling points. Prof. Fitzgerald proceeded to point out that they really had not, at the present time, a satisfactory theory to account for the phenomena in ionisation. Amongst the difficulties which were met with in the usual theories, and of which these theories could not give a sufficient explanation, were the stability of ions, the source of energy of ions for dissociation, and the migration of ions with different velocities. German physicists were quite content with the term ionisation, and were rather strict in their orthodox acceptance of the same. He proceeded to point out that hydrogen and chlorine ions seemed to wander about in a solution without any tendency to recombine, which is quite inexplicable by the usually accepted theories. Coming now to the gases, little was known until recently of the conductivity of gases until it was studied by means of X-rays, etc. He hoped that the information obtained would be extended. He suggested that the term ionisation should only be used to denote that charged atoms existed, and he proposed that the word electronisation should be employed to denote the state of a gas acting as a conductor in which there were free electrons. He pointed out that it was probable that both ionisation and electronisation occurred in a gas, and referred to the wonderful work done by Prof. J. J. Thompson in determining experimentally and mathematically the behaviour of an electron, which seemed to consist of small corpuscles connected in some way with the molecules. He then referred to the light which the Zeeman effect threw on the subject. He mentioned that there was not sufficient evidence to justify the assumption that atoms consist of the combination of a number of electrons. The best evidence towards this end was the change in size of objects when moving through ether. According to Michaelson's calculation, this change of size was of the order of 4cm. in the diameter of the earth in consequence of its motion through ether. Amongst the questions which further experiments would decide was that of the influence of gravity on ions. In the old days it was recognised that the internal work in a primary battery ought to be varied by the position of the plates in the same. For instance, if the zinc plate in a Daniell cell was placed horizontally on the top of the salt and the copper plate also placed horizontally on the bottom, the work done should be less than if the reverse were the case. An interesting experiment would be to enclose a copper sulphate solution in a receptacle with the two opposite sides of copper, and then to whirl the same round at a very high speed to see if the centrifugal action caused the ions to be deposited on the outer plate and set free from the inner plate. This would, of course, be evidenced by an electric current. He suggested the following points as ones to which the meeting might give its attention in the discussion which was to follow: (1) The cause and end of ionisation, and why the ions did not exist in pairs. (2) Where the energy comes from which keeps the ions apart, as, for instance, gas ions do not recombine readily. (3) Why ionisation does not obey the law of dissociation. (4) The question of the rate of migration of ions, and why it is different with different elements. (5) What is the end of the double layer of ions which occurs in electrolytic salts, and why the action of gas and liquids in this respect is not the same. (6) Do electrons gravitate? (7) The theory of magnetism and paramagnetism. He thought the last would throw much light on the subject.

Dr. J. LARMOR, the president of the section, suggested that the specific inductive capacity of water might be high in consequence of the electric moment of the molecule being high. This might be the cause if the positive and negative ions were studied at the end of an axis of considerable length in comparison to its breadth. He pointed out that, in spite of the different velocities of the migration of ions, the combining proportions were maintained by the conductivity of circuits.

Prof. H. E. ARMSTRONG alluded to the value of a joint discussion on this important subject, and considered it absolutely sinful that it should be held without provision being made for a verbatim report, so that the remarks of the various speakers should be considered at leisure. It was the first time that they had had a rational discussion between chemists and physicists on the question. The German schools were so fixed in their ideas that a discussion with them was absolutely impossible. The question of the structure of the atom was one which the chemist did not like to consider as being easily effected, and the evidence obtained in chemistry pointed the other way, but in spite of that very little was known of the inner structure of the atom. He believed that the conductivity in gases was due to much the same process as in liquids, and that it was almost impossible to get conductivity in a gas without a vapour being present. He thought that an explanation was required of the association of ions quite as much as of the dissociation.

A manuscript was then read from Mr. WHETHAM on the possibility of ions, which are considered as free, being actually handed from molecule to molecule as suggested by one of the older theories.

Dr. O. J. LODGE agreed with Prof. Fitzgerald in his suggestion that in the conductivity of gases, both electrons and ions were involved. He remarked on the ascertained fact that, although the velocity of ions varied considerably with different elements, the velocity of electricity was constant. He expressed the hope that the electric theory of matter would eventually be confirmed by further experiment.

LIGHT RAILWAYS.

At the last meeting of the Canterbury General Purposes Committee, the Town Clerk mentioned that two parties were applying for powers to establish light railways—one was for a line from Canterbury to Whitstable and Herne Bay, and the other from Herne Bay to Canterbury. Plans will be laid before the Council. The announcement was received favourably.

At the last meeting of the Broadstairs and St. Peter's Urban District Council, the engineers to the Isle of Thanet Light Railway submitted plans of line No. 8, authorised by the order of 1898. They also sent plan of posts for carrying overhead wires. With reference to the Council's suggestion for interlacing lines to be substituted for the double line in Victoria-parade, plans were sent in showing line as proposed by the company and also the position that would be occupied by interlacing lines, which they considered for such a short length would not be any advantage. The letter was referred to the General Purposes Committee.

The Commissioners held an enquiry on the 25th inst. at the Blackburn Town Hall into the application for an order to authorise the Blackburn, Whalley, and Burnley light railways.

After holding a public enquiry at Rhyl on Saturday last the Commissioners decided to sanction the construction of an electric tramway from Prestatyn to the Marine Lake, Rhyl, a length of about seven miles. The capital of the company is £7,500, and the Rhyl Council will supply the electricity. There was no opposition to the scheme, which is to be completed by next season.

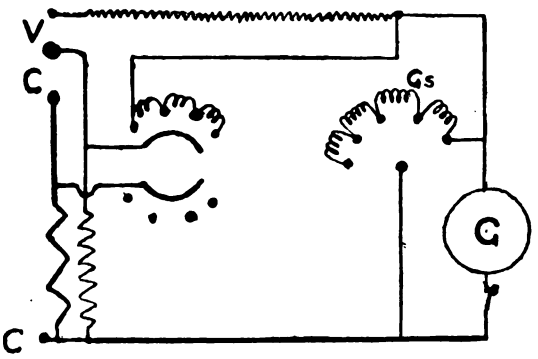
The General Election.—We notice that in the forthcoming election Mr. F. H. Medhurst, whose name will be well known to many of our readers, is standing for West Islington. Apart from any party question, we wish him success in his candidature, as it is very desirable that the important electrical industry should have a representative in Parliament, more especially in view of the large number of electric lighting and traction schemes now being started all over the country.

Digitized by Google

A LECTURE-ROOM VOLT AND AMMETER.*

BY PROF. BAILY.

The author exhibited a compact arrangement of resistances and connections which he has devised for employing the D'Arsonval galvanometer as a laboratory-room volt and ampere-meter. These resistances and connections are contained in a box which is small and portable. The connections are illustrated in the diagram, from which it will be seen that the galvanometer is used in series with a large resistance when measuring volts, in which case the galvanometer is shunted to enable variations in scale to be obtained. The exceedingly wide range obtained will be gathered from the following figures: When the galvanometer is practically in series with the resistance across the voltage to be measured the full scale corresponds to one-twentieth of a volt, while with the shunt switch moved over to the right the range of the scale corresponds to 300 volts. For measuring current the connections are those used for potentiometer work, and two resistances, which are carefully calibrated, are provided, through one of which the current to be measured is passed.



The connections of this end are shown in the illustration. The range, as far as current is concerned, varies from ·15 ampere for the full scale deflection up to 30 amperes. It will be seen that this allows accurate readings to be taken down as far as one-half of a milliampere. In the same way, the voltmeter arrangements are sufficiently sensitive to allow of thermo-electric force being measured. For the galvanometer, which is, of course, independent of the boxes, Prof. Baily uses one of the D'Arsonval type with a fairly low resistance. The scale for the same he makes about 6ft. long, so that a clear reading can be obtained, which is visible to everyone in a lecture theatre. The author was complimented by the president on the arrangement of the instrument.

ELECTRICITY SUPPLY FOR LIGHTING AND TRAMWAYS, WITH SPECIAL REFERENCE TO SMALL TOWNS.†

BY HORACE BOOT, M.I.E.E., CONSULTING AND RESIDENT ENGINEER TO THE TUNBRIDGE WELLS CORPORATION.

A local authority having obtained powers, the following questions immediately crop up: (1) selection of site; (2) choice of system; (3) the question of an expert to advise; (4) the extent of area of supply; (5) the capacity of the generating plant; (6) should street-lighting be undertaken? (7) the price of supply, and whether a rebate should be given according to the consumption of electricity; (8) should free wiring be undertaken.

The difficulties presented in supplying small towns as compared with large ones are manifold, and it may be taken as a general rule that it is much easier to supply large towns in a successful manner than small ones. There are at the present moment a number of small towns which are hesitating as to whether it would pay them to undertake the work themselves, or to allow a company to commence operations, and, as the local conditions in each case must be carefully studied before a reliable and correct decision can be arrived at, it is advisable to call in an expert to draw up a report. For large towns it is almost always advisable that the local authority should start their own undertaking, both for lighting and traction purposes.

The vexed question of a combination of power stations—capable of supplying electric energy for tramways, motors, lighting, heating, and other industrial purposes—has been discussed very frequently for the past two or three years, and for those members who desire to possess a more intimate knowledge the author would recommend them to read the papers that have been written on the subject by various writers; but there is no doubt that whatever that, wherever it is possible, there should be one power station to supply the whole area, and the policy of multiplying these power stations is incorrect from an economical as well as a practical point of view. A number of towns have thought it advisable to separate the production of electricity for tramways and lighting into different works, which they will find in the future has been a mistake, and has only been brought about by the fact that in all probability the original site selected for the lighting works was badly chosen and unsuitable for future development for the supply of electric energy on a large scale. Only those who are intimately associated with the industry can appreciate the difficulties experienced in obtaining a good supply of fuel, and works should never be placed in such a position that fuel can only be obtained by carting. The site should be selected, if possible, where a railway siding can be obtained, or "water-borne" coal can be used.

An important point to bear in mind is also the question of nuisances, as works of any magnitude cannot be run without creating a certain amount of nuisance, such as smoke, vibration, and noise; and the author ventures to think that if the sites already selected for the supply station were again considered, a large number of them would prove to be unsuitable, hence their necessity for constructing more than one power station. There are, of course, certain conditions which arise in towns necessitating the adoption of more than one power-house, but the author is of the opinion that the future will see the development of large power stations supplying large areas, in preference to little stations supplying local areas. The advantages of such will be: facilities for obtaining fuel; all nuisances localised to one spot; the advantage of water carriage, with an adequate supply of water for condensing purposes; the small amount of labour required for one works to work successfully, as compared with that for a number of small works; the advisability and advantage gained by having the staff in one place. The only objection that can be raised to it, is the question of fire or total disablement of the works, causing a complete stoppage of the supply. The likelihood of fire should be impossible if the works are properly designed—as nothing inflammable should be permitted in their construction. The other item to consider is an accident to the boilers, causing a serious explosion. This, again, is not likely to happen where first-class supervision and a good water supply can be obtained; but is more likely to happen where a number of works, without sufficient supervision, are established. In fact, too much consideration cannot be given to the selection of the site, as, to a large extent, the whole question of successful working—both financially and from an engineering point of view—hinges on it. In selecting the site, it is therefore advisable: (1) to obtain a good water supply to enable condensing operations to be carried out cheaply, and without a great deal of auxiliary machinery; (2) the facilities for obtaining coal at the cheapest possible rate, either sea or rail borne; (3) the site should be chosen where the works are likely to be the least nuisance to surrounding property; (4) facilities should be obtained for getting goods of a heavy nature; (5) provision should be made for future extensions, without having to buy up surrounding property; (6) the nearest point to the centre of the demand which complies with the above conditions should be selected, although it is not difficult to transmit electric power to large distances economically.

In the case of large works, it is very convenient to find accommodation in or near the site for the principal workmen employed; as should anything go wrong with the machinery, necessitating a temporary extinction of the lights, the men can be easily fetched. This especially applies to the mains superintendent, who should always be accessible, and for this purpose it is often found advisable to buy up the surrounding cottage property, or build cottages for the men.

The employment of "experts" to advise is rather a

* Abstract of paper read before the British Association at Bradford.

† Paper read before the Incorporated Association of Municipal and County Engineers, at a meeting held at Tonbridge and Deal, on Sept. 14 and 15.

Digitized by Google

vexed question, but for towns to commence operations without having the advantage of expert advice is suicidal, as a mistake made in the selection of site will prove fatal to the undertaking, and unless a town can afford to pay an adequate salary to a first-class resident engineer who is competent to advise them, it is advisable for them to obtain a report, and carry out the work under instructions of the practical expert, appointing a resident engineer to act under him; and the author suggests that a good practical expert, who is or has been employed in similar practical work, should be called in to advise on the selection of the site, the policy to be adopted, and the system used, afterwards engaging a resident manager to look after the commercial and technical sides of the undertaking, retaining the consulting expert, either by means of a percentage, or paying him an annual retaining fee. This arrangement enables small towns to obtain expert advice at a minimum expense. The advantages of starting works in small towns is greater than that in large, because large towns usually possess sufficient industries to find employment, whereas in a small town it creates an entirely new industry, gives employment to many men, and improves the town from a sanitary point of view, and where public lighting is undertaken provides a means of decreasing crime.

Small Works.

It is impossible to find a man willing to accept a small salary and be capable of advising on all the intricate questions met with in the maintenance and construction of an undertaking, which, though it may be small in size, has the same principles involved as that of a large undertaking. Many towns have started, or are contemplating starting, dust-destructor works in combination with electricity works, and there is no doubt that from the figures recently obtained from the various combined works throughout the country a considerable saving in fuel is effected by burning refuse, and it has been found that in the latest type of destructors 1lb. of refuse will evaporate ·79lb. of water from, and at 212deg. F. Shoreditch was one of the first works put down, and has been able to produce exceedingly low fuel consumption figures compared with other electricity works. However, a refuse destructor should be designed to fulfil the following conditions: (1) it must not be a nuisance to the surrounding neighbourhood; (2) there must be very little smoke issuing from the shaft; (3) there must be no dust scattered about or taken up the chimney shaft; (4) the destruction of the refuse must be complete; (5) it must be capable of raising high-pressure steam in sufficient quantity to be able to utilise it for commercial purposes.

It has been found from experience that the refuse in watering places is worth nearly five tons of Welsh steam coal per 35,000 inhabitants per day. I have been able to make a careful inspection of the working of the Llandudno dust destructor during a short stay in that town, which is built on the Beaman and Deas principle, with Babcock and Wilcox boilers. I do not consider that this destructor complies with the conditions necessary, although as an economical steam generator it has proved a very big success, and the figures arrived at in fuel by the Llandudno electricity works of something under ½d. per Board of Trade unit generated is much below the average for a similar undertaking. These results are better than were ever anticipated. However, the principal difficulty appears to be that when one is 100 yards away from the works, in the windward direction, a considerable smell exists. Another disadvantage is that during the time the refuse is being destroyed white or brown smoke issues from the shaft, which smoke is a nuisance to the surrounding property. So far as the other advantages are concerned, this destructor fulfils them absolutely. No doubt there are many members present who are more competent to speak and to give us their opinions on the subject than the author, and it will be interesting to hear their remarks upon the same, as everybody must be agreed that the only way of dealing with refuse in a sanitary manner is to cremate it. A very interesting paper was read before the Institution of Civil Engineers (in which the author took part in the discussion) by Mr. Charles Russell, electrical engineer of Shoreditch, in which he deals minutely with the troubles and difficulties and the value of dust-destructor plant. In the *Proceedings* he gives a curve showing the actual amount of work done by the refuse and the amount of coal burnt, also a curve showing the available steam pressure. Of course, the value of the residue for roadmaking and builder's purposes is an item which is worthy of consideration, and from Mr. Russell's paper I cull the following percentages of which the residue is composed:

	Per cent.
Common clinker	29·0
Fine ash	2·7
Fine dust	0·5
Old tins	0·6
Total	32·8 per cent.

There is a tendency on the part of most destructors to emit from the shaft particles of fine dust. However, several of the contractors have endeavoured to obviate this difficulty by "dust catchers," which can be readily cleaned out. Another use for the residue is the making of artificial paving stones, and I believe I am right in saying Shoreditch uses these stones very largely. The labour item is a very important one, as at Shoreditch it works at 2s. 6d., at Llandudno 1s. 4d., and Hereford 1s. 1d. The most satisfactory way of running refuse-destructor works in combination with electricity works is to have some of the boilers arranged for hand firing with coal, so that these boilers can act as a reservoir of steam and assist in steadying the general steam pressure throughout.

The capital outlay for the establishment of electricity works varies to a large extent with the local circumstances, and if a consulting engineer be employed to draw up a scheme he will, no doubt, give the capital outlay required to carry out this scheme in the report. However, it must not be forgotten that since the loans to corporations in the provinces are only granted for 25 years, every £100 saved in the capital outlay represents £6 less to be charged against the revenue account for interest and redemption fund. There are many methods by which corporations can raise money for this purpose. It is, however, always necessary to obtain the sanction of the Local Government Board for the requisite loan, after which stock may be issued or any of the well-known financial arrangements entered into. Precautions should be taken that the corporation does not borrow the capital before it can be actively employed, or, in other words, produce a return. A rough idea of the amount of capital required is given in the following table:

Number of lamps in 8 c.p. or their equivalent. Lamps.	Approximate capital outlay required. £
2,000	8,000
5,000	12,000
10,000	20,000
20,000	35,000
40,000	69,000
100,000	170,000

In selecting a site, consideration must be given to the system by which it is proposed to supply the town, whether high or low pressure. Should it be proposed to generate high-pressure currents at the works, it will not matter if the site be chosen outside the area of supply, but should the town lend itself to a low-pressure system, then the site must be chosen as near as possible to the centre of the demand, otherwise useless expenditure will be incurred on heavy copper feeders.

In the early days there was great diversity of opinion possessed by experts as to which was the best system to supply, and there is no doubt that what might be the right system for one town is not necessarily so for another, as both systems have their respective disadvantages. Large scattered areas can only be supplied by high tension, whereas towns of a compact nature can be more cheaply supplied with low tension. For those members who are not familiar with the technical expression "high" and "low tension" the author submits the following explanation: Electricity is simply a form of energy existing in nature, which requires special machinery to set it in motion—the same way, as in coal, there is no energy or life until it is burning. The measurement of electricity is composed of two factors. The product of the factors when multiplied

Digitized by Google

together are termed "watts." Either factor may be altered, and yet the amount of energy would remain the same. For instance, one unit of current, called the "ampere," multiplied by 100 units of pressure, called the "volts," equals the energy which would be 100; or it would equal 100 units of current multiplied by one unit of pressure. In the former case you might call it high pressure; in the latter you might call it low pressure, except for simplicity sake the Board of Trade have stated that anything over 500 volts must be considered as high pressure. The systems are: (1) the high-pressure alternating-current system; (2) the high-pressure continuous-current system; (3) the low-pressure continuous-current system; (4) the low-pressure alternating-current system. But the principal ones adopted are: (1) the high-pressure, and (3) the low-pressure continuous-current—in fact, all the schemes are based on these.

There are at the present moment no less than 112 electricity works in operation owned by local authorities, and 94 companies. There are 81 local authorities who have decided to establish electricity works at once, and there are no less than 115 provisional orders granted to local authorities, but works not yet finally decided upon. From the financial results of the undertakings which have been working for more than one year, ample proof can be found that, if well managed, they can be a financial success. It must not be forgotten, however, that many of the undertakings that show deficits, are in reality buying their works on what might be termed "the easy payment system"—that is to say, in 25 or 42 years, as the case may be, the works will become the property of the general ratepayers—having been bought by the consumers by setting aside so much per annum before declaring a net profit, keeping the works in thorough repair all the time.

The distribution from the works may be effected by several means, but the latest practice for low tension is to lay three conductors side by side in the same trench of the following types: (1) Bare conductors carried on insulators in concrete or iron conduits. This system is being superseded now on account of the increase in the pressure of supply to consumers. (2) Three insulated single conductors laid in troughs, and run up solid with some suitable material. (3) Concentric cables, armoured, and laid directly in the ground, with bricks or timber to protect them from picks. (4) Single cables drawn into stoneware conduits. (5) Three-core armoured cable laid directly in the ground.

For distribution by alternating currents the system most used is the armoured concentric cable, laid directly in the ground or in troughs, run in some hard compound, in which case it is not necessary for the cable to be armoured. This forms a cheap means of laying cable, besides being very durable. There are, of course, a number of different means by which the energy can be regulated from sub-stations, but in this paper there is no time to deal with them. With regard to the overhead system, which is unfavourably entertained by the Board of Trade, the author believes that in the future we shall see more use made of this for transmission of high-pressure currents to long distances, for the lighting purposes of country villages, and for farming industrial purposes, as there is no donbt that high-pressure energy can be transmitted perfectly safely, the same as is done in Switzerland and other countries on a large scale. The water proposed to be used should be carefully analysed before a decision is come to with respect to its suitability. If possible, it should be obtained simply for the cost of pumping—that is to say, a well should be sunk and ample supply be obtained at a figure not exceeding 6d. per 1,000 gallons. There should, of course, be an independent supply from the town mains in the event of a spring failing in the very dry weather. In making arrangements for the water supply, it is important that due regard should be given to the extensions and the heavy demand that will be required at a future date; it is not enough to arrange for a sufficient amount of water for two years, but the quantity should be at least trebled in making calculations. If the works are situated near a river or canal care must be taken with the foundations, as any settling will cause serious trouble with hot bearings, leaky joints, etc. The Tunbridge Wells water for steam-raising purposes is extremely troublesome water to deal with. Its corrosive properties are very high, and it may be interesting to give you the analysis of the water used:

Well Water.	Grains per gallon.
Calcium carbonate	·70
Calcium sulphate	7·43
Sodium chloride	5·61
Oxide of iron	·81
Nitrates and nitrites of lime and magnesia	3·95
Total	18·50

Town Water.	Grains per gallon.
Calcium carbonate	1·75
Calcium sulphate	·53
Magnesium sulphate	·72
Magnesium nitrate	·90
Sodium chloride	2·64
Total	6·54

Of course, one of the most successful treatments for the purification of water is that known as the "Archbutt-Deeley" process, by which the carbonates of lime, or calcium carbonate, can be got rid of, and the hardness reduced to something under 4 per cent. It will be noticed from the analysis of the waters given above that the carbonates are low and the sulphate high, and it has been found from experience that calcium sulphite is one of the most objectionable constituents of boiler water on account of the hard scale it produces. Mr. Archbutt read an excellent paper before the Institution of Mechanical Engineers on the subject of "The Softening of Water," in which he shows clearly that certain classes of water do not render themselves amenable to treatment, and in most cases the source has to be given up and a fresh one sought after. This water difficulty has affected the costs in Tunbridge Wells considerably, and it is only those who are familiar with steam raising when using good and bad water who can appreciate what trouble bad water will give.

In Tunbridge Wells the cables are armoured, concentric, lead-covered, laid direct in the earth with bricks over them to protect them from mechanical damage. The insulation is paper, and they have now been laid some six years, and have been found to be exceedingly satisfactory. Tunbridge Wells is a very scattered area to deal with, and there are no less than 100 yards of cable laid per consumer. The total length of cables laid in Tunbridge Wells amount to 41¾ miles. The author has found it necessary (owing to the damage done to the cable by contractors breaking the surface of the roads for the purpose of water, sewer, and other surfaces) to require that contractors, before disturbing the surface, must give notice of their intention of so doing in order to enable a representative to be sent to indicate the position of the main, and see that care is taken when crossing or exposing the cable. Since this system has been in vogue, not one cable has been damaged. All the cables have been laid by the Corporation's own men, under the author's supervision.

Price.

The question of price charged for electricity must depend upon the cost of production, which cost of production is made up of the capital outlay, the works costs, and other items. In Tunbridge Wells the price charged is based on the maximum demand system. For the first hour's supply the price is 6d.; for units consumed over and above this the price is 3d., from which it will be seen that consumers who burn their supply for one hour per day per annum pay 6d. per unit. Consumers that burn it on an average of two hours per day per annum, pay 4½d. per unit; three hours per day per annum, pay 4d. per unit.

Method of Charging for Electricity.

Engineers are agreed that that there is only one fair and equitable way of charging for electricity, based on the "maximum demand system." The cost of production is made up as follows: (1) fuel; (2) water; (3) oil, waste, and petty stores; (4) salaries and wages; (5) repairs and maintenance; (6) rents, rates, and taxes; (7) sinking or redemption fund; (8) interest on the capital; (9) depreciation; (10) contingencies. Items 1, 2, and 3 increase in proportion to the number of units generated—that is to say, if four times the number of units are turned out, items 1, 2, and 3 will be nearly four times as much. This is not the case with items 4 to 10; it would be possible for us to turn out four or five times as much energy without

Digitized by Google

increasing these items at all, provided the maximum demand was not greater. The financial value of the above may be taken as follows:

	Per unit.
Coal, oil, water, and waste cost	1·03d.
Salaries, repairs, sinking fund, interest, and depreciation	6·00d.
Total cost of production for first hour, per unit sold...	7·03d.

Now, it is clear from the above that if a consumer burns his lamps for more than one hour per day, the extra additional cost to us will only be 1·03d. per unit; and, again, the same applies if he goes on burning it for a large number of hours. Take, for instance, an hotel consuming, on an average, its maximum demand for five hours a day; the total cost of supplying energy to this hotel per unit would be one hour 7·03d., plus four times the cost of oil, coal, water, and waste, divided by 5, which equals 2·23d., arrived at as follows:

Cost of supply—first hour	7·03d.
,, ,, second hour	1·03d.
,, ,, third hour	1·03d.
,, ,, fourth hour	1·03d.
,, ,, fifth hour	1·03d.
	11·15d.

Average cost per hour $\frac{11 \cdot 15}{5} = 2 \cdot 23$d. per unit.

It is for this reason that it has become almost a universal practice to charge on the maximum-demand system, because it is a system which endeavours to obtain an equal rate of profit from all consumers, and does not place the best consumers—*i.e.*, hotels, public-houses, and clubs—at an unfair advantage to the consumer who burns his lights for only a short period. It will be seen that we are actually losing money on the consumer that only burns his lights for 365 hours per annum, and that loss has to be made up out of the profits obtained from the paying consumer. In order to establish a successful electricity undertaking every encouragement should be given to those consumers who burn their lights a large number of hours, even if it means the discouragement of the consumer that would be a loss to the works. A uniform charge can never be so low as the average price charged on this system, because a uniform price encourages people to burn their lamps only for a short time, and that uniform price would be too expensive for the best customers, such as hotels, public-houses, clubs, etc., to adopt electricity as an illuminant. Short-hour consumers do not care for this method of charging, and they would prefer a uniform price, where the loss caused to the works by having them on the mains would be paid out of the profits that would be obtained from the profitable class of consumer. Unfortunately, however, experience proves that this good class of consumer finds a uniform price too expensive, and eventually gives up the illuminant, not caring to pay for the losses caused by other consumers. A great point in favour of this system is that the rate of profit is uniform for all classes.

The instrument used for ascertaining the maximum of each consumer consists of a hermetically-sealed tube, containing air and a liquid, a conductor of short length and a slightly higher resistance than copper. Current passing through the conductor causes a slight generation of heat, which expands the air inside the tube, and forces a portion of the liquid up to the tube adjoining, where it remains permanently, until it is reset by the meter inspector. The amount of liquid forced up the tube is proportionate to the consumer's maximum demand, or in other words, "the capital outlay that consumer has put the electricity undertaking to, to supply him." There is no mechanism to get out of order, nor can their accuracy be doubted.

There are certain laws which govern the principle of trading successfully: (1) All consumers should be a source of profit. (2) The tariff should provide an equal rate of profit from all consumers. (3) It is sound commercial practice to encourage the profitable, even at the risk of losing the unprofitable. (4) The cost of supplying electricity depends upon the length of time the necessary plant and mains to supply the maximum demand are used. (5) It is only by adopting a correct sliding scale, in direct proportion to the costs, that it is possible to make the tariff sufficiently low to reach the many. (6) The uniform rate usually means that a consumer pays two lighting bills. He instals electricity in his shop windows, and in the places where the light is only burnt for a short time per day, and refuses to put it in such places as cellars, basements, etc., where it is burnt for many hours, because he looks upon it as a luxury. It is this habit which the sliding scale system corrects, because electricity is only installed in corridors, kitchens, bedrooms, workrooms, etc., if it is cheaper than gas, and competition must simply be based upon the cost. (7) The conditions of gas and electricity production are essentially different. In the case of gas, its cost per 1,000 cubic feet delivered does not bear any relationship to the maximum, or the number of hours, because gas is never delivered direct, but stored in gasometers.

There is perhaps no business in which capital is employed for so small a number of hours as that of electricity supply, and we ought to do everything within our power to stimulate the large number of hours of demand. In our own undertaking we have expended the sum of £40,000 approximately, which sum has to earn sufficient revenue to pay all the expenses in 1,460 hours per annum, whereas had the consumers been burning the light evenly all through, we could have employed it profitably for 8,760 hours.

Four hours per day per annum pay 3¾d. per unit.
Five ,, ,, ,, 3¼d. ,,

It is interesting to note the relative prices obtained from various classes of consumers in Tunbridge Wells:

Public-houses and hotels—average price paid for electricity	3·9d.
Shops	4·8d.
Private houses	4·89d.
Offices (early closing)	6·00d.
Churches	6·00d.

From which it will be seen that the public-houses and hotels obtain their supply at an exceedingly low rate, and far cheaper than they could ever hope to generate it themselves.

There are many ways of charging for electricity: (1) sliding scale, giving long-hour consumers the lowest rate; (2) uniform price; (3) percentage rebate on the amount consumed; (4) percentage rebate on the number of units consumed per lamp. There are, however, only two of these systems worthy of consideration—viz., the uniform price and the long-hour consumer rate.

The works should be organised into various departments: (1) the meter department; (2) the distribution department; (3) works department; (4) public lighting department; (5) the clerical department. Each department should have a responsible official, who, again, should be responsible to the chief engineer. Of course, this is not easy to arrange in small towns of less than 30,000 inhabitants, but where it can be done greater efficiency and satisfaction is given.

Power.

In manufacturing towns it pays to develop a motor load—that is to say, that electricity forms one of the best and cheapest methods by which power supply can be given at a reasonable rate, and in Bradford this question of power supply has been largely developed, there being no less than 411 motors on the Corporation mains, and the units sold to these motors are 463,630 per annum. They are used for every industrial purpose, and a very interesting description of the motors in use is given in Mr. Gibbings's book (section 4), "Electric Motive Power." It is, of course, equally important that the power supply should be developed in small towns as well as large, although in residential and pleasure-seeking towns there cannot be much demand. The price charged for the motor supply should be low, as the energy is used during the daytime, when it is not required for lighting purposes, and otherwise the plant at the works would be standing idle, so that it pays to supply the energy at a rate lower than that charged for lighting, especially as the motor load is a long-hour one.

There are few towns of over 30,000 inhabitants that are not considering the question of establishing tramways, and, especially in residential towns, considerable opposition is experienced; but it must not be forgotten the advantages of tramways are very great: (1) tramways conduce to rapid transit from place to place, thus improving the prosperity of the town; (2) tramways are found by expe-

Digitized by Google

rience to increase trade along the line of route; (3) tramways form the solution to the "housing of the masses"; (4) a tramway may be called the "people's carriage"; (5) in the near future, tramways will play an important part in the conveyance of merchandise, and will become severe competitors with the railway companies; (6) tramways are the only means by which cheap fares and rapid transit can be provided; (7) tramways mean starting another industry in the town that benefits the community in general.

There are, however, objections which may be summed up as follows: (1) tramways convert residential districts into business ones; (2) the unsightly overhead trolley system must be weighed against the advantages gained; (3) the noise along the route; (4) tramways tend to drive carriage people away.

It is, of course, a well-accepted fact that the only means to propel tramways is by electric energy: (1) on account of the working expenses—*i.e.*, the low cost per car mile; (2) the ease, comfort, and speed in travelling; (3) on account of the easy surmounting of heavy gradients; (4) on account of the freedom from wear and tear on the roads: (*a*) fouling the streets; (*b*) absence of noise; (*c*) the freedom from accidents.

It will be seen from the opinion expressed above that, where possible, the lighting and tramway works for the generation of electricity should be under one roof and one management, as only by that means can the full benefits of the combination be obtained. The plant which is available at night-time for supplying energy for lighting purposes, in the daytime will be available for running the cars, and during the hours of lapping load it might be advisable in the case of small towns to "horse" the tramways, or have sufficient storage capacity to cope with the demand. There is no doubt that works can be put down at a much cheaper rate per kilowatt than they would be if the works were separated, as the machinery in the case of the lighting works would only be used a very few hours per day, whereas if it were used for both purposes it would be almost in continual use, and the load factor would be improved.

Most of the members no doubt are aware, and have studied the question of tramways for their own respective towns, and I need only refer them to the very successful system in operation at Dover to show what can be done on a small scale. Space or time does not permit going into details of construction for tramways in this paper, but an account of same can be obtained in the author's fourth year's report, which contains in the appendix a copy of the tramway report presented to the committee, in which are given details, such as the weight of rails, the relative merits of the different systems, the construction of the permanent way, the overhead gear, feeders, gradients, working expenses, etc.

Public Lighting.

It is important for towns undertaking electricity supply to commence with a thorough system of public lighting, and to light the whole of the district either by arc or incandescent electric lamps along the line of route in which the cables are laid, and the author advocates the policy of laying the mains well in advance of the demand; this especially applies to small towns, where it has been found that consumers will not come on until they see the actual cable laid, and the policy of extensions may be considered the only speculative part of the business, as it is useless having the works too large with a great deal of idle plant, and the mains only laid in a few streets. The author has introduced a system of reflectors, by which he obtains far greater efficiency out of an ordinary lamp for street-lighting purposes, and commends it to the notice of the members of this association. It can be seen in operation, lighting many of the streets of Tunbridge Wells. The Council have decided to erect 262 additional ones. In this paper the author has purposely refrained from giving a detailed description of the Tunbridge Wells electricity works, as he hopes to have the honour of showing the members of this association round, when they will see for themselves what has been done, and he hopes the paper will prove a valuable contribution and promote a good discussion at the association's meeting.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

Questions.

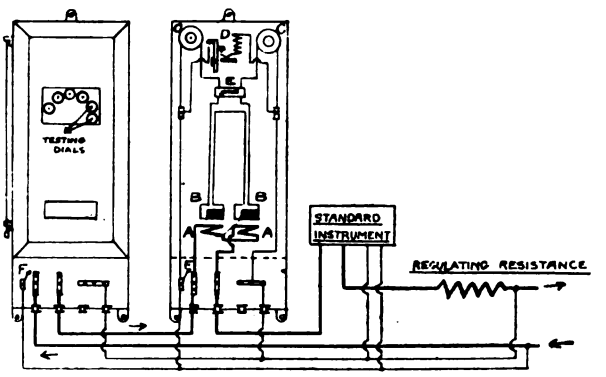
311. What is the advantage gained by setting the cranks of small compound vertical engines at angles other than 90deg.—for instance, about 145deg. ?—F. H. P.

312. Having a ring armature (laminated), 9½in. outside diameter, 5in. inside diameter, and 3¼in. deep, I wish to wind same as a step-down transformer for use on a 100-volt 60-cycle circuit so as to yield 40 volts from secondary at its maximum capacity. What size of wire and number of turns will be required on primary and secondary? Would it be possible to subdivide secondary circuit so as to yield various voltages ?—C. L.

Answers.

Question No. 305.—Explain how to test the Aron new model watt-hour meters for alternating current at ordinary periodicity, if possible, with direct current.

Answer to No. 305 (*awarded* 7*s.* 6d.).—The new type Aron self-winding watt-hour meter consists of two series coils, A A, through which the main current passes, and two pressure coils, B B, connected in series, and in series with which are two supplementary non-inductive resistances, C C. E is the commutator for reversing the direction of the current through the coils, B B. D is the self-winding



arrangement. The internal connections of the meter can be plainly seen in the sketch. As the action of the meter depends upon the difference in the oscillations of the two pendulums, a short test cannot be taken as with meters with a revolving disc. It will be advisable first to consider the principle of the action of this meter. When the meter is put on circuit, the meter is immediately wound up, and the pendulums begin oscillating. When current passes through the series coil, it causes one pendulum to be accelerated and the other retarded; the difference between these oscillations is recorded by very accurate mechanism, which works in conjunction with the time-keeping arrangement, so that a very accurate watt-hour meter is the result. When the meter is running on an open circuit, the two pendulums should theoretically swing in synchronism, but in practice this is found to be impossible. To overcome this difficulty the current is reversed every 20 minutes* through the pendulums, by means of which the error caused by want of natural synchronism is eliminated. It is obvious, then, that no test which covers a period of less than 20 minutes can in any way be considered a test. To take a very accurate test, it should be taken throughout the entire range on the basis that the full-load test occupies three complete

* We believe that 10 minutes is the interval, so that 20 minutes represents the complete cycle.—Ed. *E. E.*

Digitized by Google

cycles of the reversing apparatus, and the lower the load the longer the test. For example, a test with a quarter load should occupy four hours, and so on throughout the range.

It is advisable to test the meters in batches, and take a test on the face dial. Two dials (coloured red) are provided for this purpose, one reading in ·01 unit and the other ·1 unit; pointers are supplied by the makers, and can be affixed for testing. The meters should be hung perfectly perpendicular; a plumb bob is provided at the side of the meter to enable this to be done. The meters should be connected up according to the diagram, the shunt connection at F being broken. This the writer failed to do, and found that No. 1 meter read correctly, No. 2 read correctly plus shunt current of No. 1, No. 3 the same plus shunt current of Nos. 1 and 2, and so on. The best instrument for testing watt-hour meters is the Kelvin watt-balance, which can be used for both alternating and direct current, a useful size being the one with a range from about 0 2 to 120 amperes, which is provided with a box of resistances to put in series with the movable or shunt coil, so that it may be used on a 50, 100, or 200 volt circuit. A non-inductive regulating resistance is also required for varying the load, and a fly-back centre second chronograph for accurate work. First adjust to the load that is required, switch off, take readings of the meter, then switch on, keeping the watts constant at the specified load for at least 40 minutes, entirely open the circuit, and again take readings. It is known what has exactly passed through the meter, so that the percentage error is easily obtained. ("The above method of testing is for alternating current; the meter could not be used on direct current, as the winding arrangement would require to be rewound. By disconnecting the winding gear circuit and driving it by a separate alternating current, the meters could then be tested with direct current. The registration alone is constant for both alternating and direct current. This also applies to periodicity, as the winding gear has to be wound to suit the periods.") The meter will register the smallest fraction of a watt, and it has been found to register the leakage on an installation. Consumers have to be assured that the meter is not recording anything, even if they can hear it ticking, when no lamps are in use.—W. A. J.

Answer to No. 305 (*awarded 7s. 6d.*).—The alternating-current type of the new type Aron watt-hour meter can be tested quite as well on continuous as on alternating current, but the precaution should be taken of connecting the winding circuit to the alternating mains, as if continuous current of the full voltage were put on this circuit, it would probably be burnt out. To test these meters satisfactorily it is necessary to have a small testing battery of storage cells (of, say, five or six ampere-hours capacity) from which the pendulum circuit may be excited. Of course, we may use the ordinary lighting circuit for this purpose; but it will be found almost impossible to get steady enough volts. The shunt circuit must first of all be split and the pendulum circuit connected through a suitable adjusting resistance to the testing battery, and the correct voltage got across the terminals; the winding circuit must then be connected to the alternating mains. There is no necessity to measure the volts on this part during the test. Having got the shunt circuits alive, it now remains to run the various currents through the main coil and take the advance on the meter, at, say, full load, three-quarter load, half load, quarter load, and one-eighth load, running each load long enough to give a fair advance. It will be found advisable to have an advance of at least one unit at one-eighth load, as, owing to the amount of back-lash in the gearing, it is rather difficult to read the meter very closely, and the larger the advance the smaller this error becomes. Readings should be taken of the current in the main and the volts on the pendulum at intervals of five minutes during each test so that a true mean can be got.

The following full-load test of a 50-ampere meter will show the method of calculating the constant from the figures obtained as above:

Mean current = 49·28 amperes; time = 20 minutes; mean volts on pendulum = 200·15; advance on meter = 3·33 units.

Actual units passed through meter

$$= \frac{200{\cdot}15 \times 49{\cdot}28 \times 20}{60 \times 1{,}000} = 3{\cdot}287.$$

∴ Constant for units at full load

$$= \frac{3\,287}{3{\cdot}33} = {\cdot}987.$$

The constant is worked out for each load and the mean taken, which gives us the working constant for the meter. Of course, if no testing battery is available for the pendulums, the shunt circuit, as a whole, may be run off the usual lighting circuit.—ELECTRICIAN.

Question No. 306.—When running a dynamo and cells in parallel, if the voltage of both are the same, the current will be equally divided. Now, if the voltage of the cells drops one-eighth of a volt, will the whole of the current be supplied from the dynamo, presuming its capacity to be great enough and its regulating qualities perfect?

Best Answer to No. 306 (*awarded* 10*s.*).—To answer this question fully, exception must be taken to the statement which prefaces it. As a matter of fact, the current in such a case is not divided equally between the dynamo and battery, but inversely to their respective resistances, as the following equation will plainly show. Let C_1 and C_2 be the respective currents, R_1 and R_2 the resistances of the dynamo and battery, and E the voltage of both (it is assumed that in the statement the E.M.F.'s are taken to be equal "on open circuit," as they must of necessity be equal when both sources are joined to the same pair of 'bus bars); then on closed circuit

$$E - C_1 R_1 = E - C_2 R_2,$$

from which we get $C_1 = \frac{C_2 R_2}{R_1}$.

It will be noticed that if R_1 of the dynamo be smaller than R_2 of the battery, then, to satisfy the equation, C_1 must be proportionately greater than C_2. If the voltages on open circuit are unequal, then, on closed circuit,

$$E_1 - C_1 R_1 = E_2 - C_2 R_2,$$

from which we get

$$C_1 = \frac{(E_1 - E_2) + C_2 R_2}{R_1}$$

Dealing with the question proper, the dynamo will not supply the whole of the current were the battery voltage to fall slightly or by ·125 volt, for the simple reason that the armature possesses resistance. What really happens in this case is that the dynamo will supply a little more and the battery a little less, the amount of increase in the dynamo being such that it will bring down its voltage to that of the decreased battery E.M.F. A numerical example will demonstrate the action more clearly. Let the letters have the same significance as before, and the terminals of the dynamo and battery be connected to the same 'bus bars feeding a circuit possessing a resistance of four ohms, R_3, and let the E.M.F. of both be 100 volts on open circuit, the resistance of the armature (including brushes, etc.), be ·11 ohm, and the battery resistance ·3 ohm.

Then $E - C_1 R_1 = R_3 (C_1 + C_2)$ . . . (1)

also $E - C_2 R_2 = R_3 (C_1 + C_2)$ . . . (2)

$$\therefore C_1 R_1 = C_2 R_2.$$

Substituting values, we have

$$C_1 \times {\cdot}11 = C_2 \times {\cdot}3.$$

$$\therefore C_1 = 2\,7272\ C_2 \quad . \ . \ . \ . \ (3)$$

Applying (3) to (1)—

$$100 - (2{\cdot}7272\ C_2 \times {\cdot}11) = 4\ (2\,7272\ C_2 + C_2)$$

from which $100 = 15{\cdot}2087\ C_2$

$$\therefore C_2 = 6{\cdot}575 \text{ amperes}$$

and from (3) $C_1 = 17\,931$,,

Total output... 24·506 ,,

Voltage across 'bus bars = 98 024 volts.

Considering now the case when the battery E.M.F. drops ·125 volt, and using the same formula, but with the altered quantity in (5), we have

Digitized by Google

$$100 - \cdot 11\ C_1 = 4\ (C_1 + C_2) \quad . \quad . \quad . \quad (4)$$

and $$99 \cdot 875 - \cdot 3\ C_2 = 4\ (C_1 + C_2) \quad . \quad . \quad . \quad (5)$$

$$\therefore 100 - \cdot 11\ C_1 = 99\ 875 - \cdot 3\ C_2$$

from which $$C_1 = \frac{\cdot 125 + \cdot 3\ C_2}{\cdot 11}$$

$$= 2\ 7272\ C_2 + 1 \cdot 136 \quad . \quad . \quad . \quad . \quad (6)$$

Applying (6) to (4)—

$$100 - (2 \cdot 7272\ C_2 + 1 \cdot 136)\ \cdot 11 = 4\ (2 \cdot 7272\ C_2 + 1 \cdot 136 + C_2)$$

$$100 - \cdot 3\ C_2 - \cdot 125 - 4 \cdot 544 = 10\ 9088\ C_2 + 4\ C_2,$$

and $$95 \cdot 351 = 15 \cdot 2087\ C_2$$

$$\therefore C_2 = 6 \cdot 269 \text{ amperes,}$$

and from (6) $C_1 = 18 \cdot 232$ „

Total output... 24·501 „

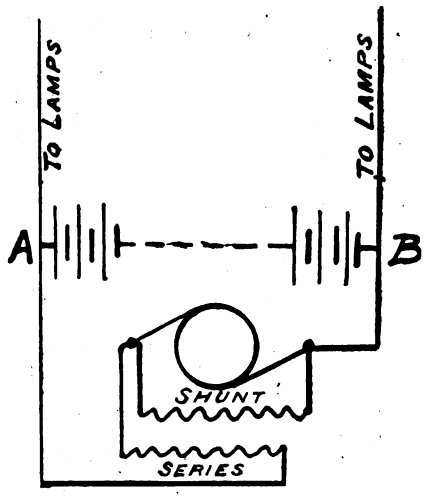
Voltage across 'bus bars, 98·004 volts.

The dynamo current, C_1, has slightly increased, and that of the battery, C_2, decreased. This is what generally happens in an installation with accumulators, the dynamo being kept at constant voltage, and the battery current gradually decreasing as discharge goes on until a balance is effected, when no current is given by the battery, such as is obtained with the potentiometer. At this stage of balance the E.M.F. of the battery equals that of the dynamo, minus the armature drop. Applying, again, the formula with $C_2 = 0$, it will be found that in order to obtain this balance the battery E.M.F. has to fall to 97·32 volts, thus conforming to the conditions in the question.

It will be noticed that in the second case, although we have taken ·125 volt as the decrease (on open circuit), the difference in the ultimate voltages across the 'bus bars is only ·02 volt. This is accounted for by the smaller current given by the battery, consequently a smaller drop.—E. J. EVANS.

Answer to No. 306 (*awarded* 5*s.*).—The first statement in the question is true only if the internal resistances of dynamo and battery are about the same. In any case, if the battery is giving current, its E.M.F. must be equal to the volts between the mains, together with the volts lost in the battery (C R). When the E.M.F. falls the result will be that the current from the battery will diminish slightly, and the lost volts will thus be reduced. The volts lost in a battery at full load are something like 1 or 2 per cent. of the total volts, and when the E.M.F. is reduced by this amount the battery current will fall to zero, and the whole load current will be supplied by the dynamo. Any further reduction in the E.M.F. will cause a current to flow from the mains, tending to charge the battery, but, unless the E M.F. is much reduced, the current will not be large, since it is opposed by the back E.M.F. of the battery. It should be noted that the E.M.F. of a battery depends to some extent on the magnitude of the current, and also on the direction of the current—*i e*, whether charging or discharging. If a discharging current is increased the E.M.F. falls, while if a charging current is increased the back E.M.F. rises. This action, it will be seen, acts to some extent as an automatic regulator on a battery used in parallel with a dynamo, and it explains why switching in, say, one extra cell does not raise the voltage on the mains by anything like two volts.—W. E.

Answer to No. 306 (*awarded* 5*s.*).—The question tells us that the regulation of the dynamo is perfect, and, referring to the figure, I take this to mean that the potential difference between A and B is constant at all loads. It is also stated that if the voltage of the dynamo equals that of the cells, the load is equally divided between them. Now this is a very vague and misleading statement. Does it mean that the voltages at the terminals of each are equal on open circuit? For if so, the load will certainly not be equally divided when current is running, because the dynamo is compensated for pressure loss due to the current, and the cells are not. Under these circumstances the battery would be just neutral, neither giving nor receiving current. Yet what else can the statement mean, for when connected up as in figure, A and B are, practically speaking, common terminals of both dynamo and battery, and one cannot imagine these points having one potential difference with respect to the dynamo and another due to the battery. One of the elementary laws of the electric circuit is that if current is flowing through a conductor of any kind, whether liquid or solid, a certain loss of pressure results from overcoming the resistance of the conductor, and this loss is proportioned to the current



passing. Consequently, apart from regulation, the voltage at the terminals of both cells and dynamo would be largely dependent upon the current flowing, if each were running upon a separate circuit. They are not running separately, however, but in parallel, and, moreover, the dynamo is automatically compensated against a drop in voltage. It is evident, therefore, that the battery must accommodate itself to circumstances. This it does by allowing just such a current to pass as would cause a voltage drop at its terminals equal to the difference between its open circuit voltage and the constant potential difference between A and B.

If V = potential difference between A and B;
v = open circuit voltage of cells;
b = internal resistance of cells × leads between A and B;
C = current flowing from the cells;

$$V = v - b \times C, \text{ or } C = \frac{v - V}{b}.$$

Referring directly to the question: if, when the cells are in a certain condition, and the load upon the external circuit is such that an equal current flows from dynamo and battery, then any depreciation in the cells will be followed by a drop in the current given out by them of just such an amount as would cause a pressure loss equal to the depreciation, if overcoming the internal resistance of battery + leads between A and B.—W. G. MURRIN.

Answer to No. 306 (*awarded* 5*s.*).—If we assume that not only the dynamo, but also the cells, have perfect regulating qualities—*i.e.*, give exactly constant volts at all currents—the smallest drop in cell voltage relatively to the dynamo voltage would not only transfer all the external load to the dynamo, but would also cause a charging current to pass from the dynamo into the cells until the two voltages were made equal again. Such a combination would, in fact, not be workable. In practice, of course, the curve of battery voltage is not an absolutely level line, but droops as the load increases. This is due to the resistance of the electrolyte and of the connections from cell to cell, which causes an increasing ohmic drop with increased current. Should the battery voltage when working at a certain current drop, therefore, as suggested in the question, the result would be that the amount of current given by it into the external circuit would merely fall off until a point on the discharge voltage curve was reached at which the battery voltage was again equal to the dynamo voltage, when a steady state would have again been obtained. At the same time, the dynamo current, assuming it a perfectly self-regulating machine, would increase by the same amount as that by which the battery current is diminished.—Q.

Digitized by Google

OLDHAM ELECTRICITY ACCOUNTS.

The following is the report of Mr. Arthur Andrew, superintendent, on the working of the Oldham electric light station for the year ended March 24, 1900, together with abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc. :

The expenditure on capital account during the year has been as follows: Supply station—buildings and plant, £4,380. 7s. 11d.; street mains, £4,933. 17s. 6d.—total, £9,314. 5s. 5d. The gross revenue for the year amounts to £8,481. 15s. 1d., and the gross expenditure to £5,049. 15s. 2d., the balance carried to the net revenue account being £3,431. 19s. 11d. The interest on loans amount to £1,781. 7s. 6d., and sinking fund instalment to £1,426. 5s. 1d., the net profit for the year being £224 7s. 4d. The balance brought forward from last year was £884. 12s. 6d., making a credit balance to be carried forward of £1,108. 19s. 10d. The amouns in the reserve fund on March 24 was £4,411. 18s. 5d The amount of energy generated has been 679,475 units, of which 576,853 units have been sold, being increases over the previous year of 89,842 units and 120,683 units respectively. The number of lights supplied on March 24 last, equivalent to 8 c.p., was 32,615, being an increase during the year of 4,144. The number of consumers added has been 75, and additional meters fixed 73 The number of consumers on March 24 was 396, and the total number of meters fixed 453. The maximum demand was on Oct. 20, 1899, the load at the station being indicated at 608 kw.; as compared with the previous year, 542 kw.; showing an increase of 66 kw. The greatest quantity supplied in 24 hours was on Dec. 23, 1899, being 3,883 units, against last year 3,198 units, an increase of 685 units. The supply mains have been extended a distance of 2,277 yards in the following streets: Henshaw-street, Barker-street, Wellington-street, Park-road, Brook-lane, Hardy-street, Waterloo-street, Gas-street, Greengate-street. The total length of mains laid on March 24 last was 14,768 yards. The prices charged for energy during the year have been as follows: without demand indicators—first 1,000 units or under per quarter, 4d. per unit; second 1,000, 3½d.; third 1,000, 3d.; fourth 1,000, 2½d.; fifth 1,000, 2d.; all in excess of 5,000 units, 2d. With demand indicators—all current consumed under two hours daily average maximum demand, per quarter, 4d. per unit; all current consumed in excess of two hours daily average maximum demand, per quarter, 2d. per unit; minimum charge for each meter fixed, 5s. per quarter. During the year contracts have been let for an additional engine and dynamo of 360 h.p. capacity, and for the extension of boiler-house, and four additional steam-boilers, etc. When these are completed the site of the present station will be fully utilised. The total horse-power in the station on March 24 was 1,800. Application was made to the Local Government Board for powers to borrow a further sum of £36,000 to carry out the extensions and additions to plant, and an enquiry was held on Jan. 9, 1900, but up to the present time their reply to the application has not been received. A plot of land at Greenhill, 17,360 square yards in extent, has been secured for the purpose of further extensions.

Revenue Account.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Coal or other fuel	£1,659	17	10			
Oil, waste, and stores	90	8	9			
Wages at generating station	842	11	11			
Repairs and maintenance: buildings, £61. 4s. 11d.; machinery, £868. 9s.	929	13	11			
				3,522	12	5
Distribution.						
Wages of linesmen	25	13	10			
Repairs, etc., of mains	182	12	10			
Repairs, etc., of meters, switches, etc., lamps sold, as *per contra*	106	6	9			
Uniforms	4	7	0			
				319	0	5
Rents, Rates, and Taxes.						
Rents (less income tax)	64	11	6			
Rates and taxes	465	10	8			
				530	2	2
Management.						
Salary of engineer	252	2	0			
Salaries of accountant, etc.	117	7	0			
Stationery, etc.	93	17	3			
General establishment charges	109	17	10			
Auditing	7	10	0			
				580	14	1
Law expenses, mortgage deed stamps, etc.				67	19	5
Insurance				27	14	0
Bad debts				1	12	8
Balance carried to net revenue account				3,431	19	11
				£8,481	15	1

Cr.	£	s.	d.
Sale of current per meter	7,987	13	7
Public lighting	160	10	6
	8,148	4	1
Rental of meters and indicators	284	5	11
Sale and repairs of lamps and other apparatus	45	3	7
Interest on mains	4	1	6
	£8,481	15	1

General Balance-Sheet.

Dr.	£	s.	d.
Capital account—amount received	51,300	0	0
Sundry creditors	2,376	11	3
Balance at credit of net revenue account	1,108	19	10
Balance at credit of sinking fund account	2,593	7	11
Balance at credit of reserve fund account	4 411	18	5
Deposits	33	0	0
Balance—cash due to treasurer on general account	12,753	13	0
	£74 577	10	5

Cr.	£	s.	d.
Capital account—amount expended for works	66,424	2	6
Stores on hand	5,503	1	6
Sundry debtors	2 650	6	5
	£74 577	10	5

Statement of Electricity Generated, Sold, etc.

Quantity generated in Board of Trade units		679 475
Quantity sold { Public lamps	15,411	576,853
Quantity sold { Private consumers by meter	561,442	
Quantity expended in distribution		81 350
Quantity used on works		20,173
Total quantity accounted for		678,376
Quantity not accounted for		1,099
Number of public lamps		28
Total maximum supply demanded (kilowatts)		608

The reader may be reminded that a low-tension continuous-current system of supply is in vogue at Oldham, with a pressure at the consumers' lamps of 210 and 105 volts. Supply was started in March, 1894, the plant installed being of the non-condensing type. The loans sanctioned aggregate £52,000, of which sum £51,300 had been borrowed up to March, 1900, as against £49,600 to March, 1899. The analysis given below (supplied to us by the borough electrical engineer, Mr. S. Wilmott Newington) enables an interesting comparison to be made between the figures for the year ended March 25, 1900, and those for the previous financial year.

Analysis of Accounts for Year ended March 24, 1900

	1899-1900.	1898-1899.
Year of working—	Sixth.	Fifth.
Capital expended to March 24	£66,424 2 6	£57,110
Revenue from electricity supply	8,148 4 1	6,549
Revenue from meter rents, etc.	288 7 5	212
Total revenue	8 436 11 6	6 561
Total costs	5,004 11 7	3,200
Gross profit	3,431 19 11	3,561
Percentage of profit to capital (averaged)	5·55%	6 71%
Interest on loans	1,781 7 6	1,397
Sinking fund	1,426 5 1	1,279
Percentage of sinking fund to capital (averaged)	2 31%	2·41%
Financial result (surplus)	224 7 4	885
Capacity of dynamos in kilowatts	1,107	1,107
Maximum load reached in kilowatts	608	542
Load factor	10·83 %	9 60 %
Number of lamps connected, 8 c.p.	32,615	28,471
Number of units sold	576,853	456,170
Units sold per 8-c.p. lamp (averaged)	18·63	18·4
Statutory maximum price	8d.	8d.
Price charged—Private	4d. and 2d. and scale.	4d. and 2d. and scale.
Public	2½d.	2½d.
Average price obtained—total	3·39d.	3 49d.
Private	3·41d.	3·485d.
Public	2 5d.	2·5d.

Analysis of Costs.

Generation and distribution—	1899 1900. £ s. d.	Per unit. d.	1898-9. £	Per unit. d.	In. + or Dec. d.
Coal and other fuel	1,659 17 10	0 690	1,103	0 580	+0 110
Oil	90 8 9	0 038	60	0 032	+0·006
Wages	842 11 11	0 350	601	0 316	+0·034
Repairs and maintenance	1,203 10 9	0·501	593	0·312	+0·189
Works costs—	3 796 9 3	1·579	2 357	1 240	+0·339
Rates and taxes	530 2 2	0 221	276	0 145	+0·076
Management expenses	678 0 2	0 282	567	0 298	−0·016
Total costs	5,004 11 7	2 082	3,200	1·683	+0·399

Financial Result for 1899 1900.	£ s. d.	Per unit sold.
Gross profit on year's working	3,431 19 11	1·427
Less interest on loan capital (£1,781 7 6)		0·741
Amount set aside for sinking fund (1,426 5 1)		0·593
	3,207 12 7	1 334
Surplus for year	£224 7 4	0 093

Digitized by Google

TRURO ELECTRIC LIGHTING.

REPORT BY MR. F. H. HEADLEY.

The following is the text, condensed in parts, of a report now being considered by the Lighting Committee of the Truro City Council. Mr. F. H. Headley deals with both lighting and traction, and evidently has gone most carefully into the local conditions:

The area proposed to be lighted is that comprised within the municipal boundary of Truro. The boundary is extensive, the area within which contains a large mileage of roads, adjacent to which are very few houses, the lighting of which ceases at midnight, at an average cost of £1. 19s. per lamp per annum. I am of opinion that it will not pay you to lay cable and connections to light these, as the difference in the saving in the cost of lighting (if any) will not pay interest on the capital outlay. I therefore advise that the lighting be confined to what may be termed the habitable area, and only that portion of the area from which a private demand for lighting or power may be expected, and of such streets that form convenient connections for uniting the general network of distributing mains. From a cursory examination there would appear to be a large number, and, comparatively speaking, extensive areas of low ratable property, especially to the right and left of Kenwyn-street, Calenick-street, Charles-street, Fairmantle-street, Carclew-street, and others on the north side of the river, from which only in the ordinary way a very limited demand for private lighting may be expected, unless special inducements are offered to obtain such. For the size of the city there would appear to be an especially large amount of this class of property, and I consider for the success of any electrical undertaking the Corporation should undertake the free wiring of these houses, the payment for which shall be by prepayment meters; under these conditions I advise that the lighting of the habitable area be undertaken.

Public Lighting.—I understand that some lamps are left burning all night, others until midnight. I therefore advise that the streets be lighted by three classes of lamps—*i.e.*, (*a*) five-ampere enclosed arc lamp to burn until 11 o'clock, to have two brackets, one on either side of standard, for incandescent lighting to burn after that hour; (*b*) three 16-c.p. lamps in one lantern; (*c*) one 25-c.p. lamp in lantern. The three 16-c.p. lamps would, in the case of all-night burning, be so arranged that two can be turned off and one left burning. Under these conditions I estimate the lighting as follows: for convenience sake I propose to divide the city into two halves by the roads Richmond-hill, Frances-street, River-street, St. Nicholas-street, Boscawen-street, Princes-street, Quay-street, Boscawen Bridge, and Malpas-road, which should be lighted by means of 14 arc lamps, as per (*a*), as the bulk of the traffic would seem to concentrate in the above-named streets as far as Boscawen Bridge.

Then follows a schedule, which, while of interest locally, is hardly so valuable to our readers. Mr. Headley advises in the south of the city 15 groups of three 16-c.p. lamps and 55 25-c.p. lamps for street-lighting, while 2,520 8-c.p. lamps are expected to be required by private consumers. In the middle portion of the city the street-lighting would be done by 14 arc lamps, nine 25-c.p. incandescent, and one group of three 16-c.p. lamps. About 2,380 8-c.p. lamps are expected from private consumers. The northern division of the city would, it is assumed, take one arc lamp, 28 groups of three 16-c.p. lamps, and 50 25-c.p. lamps in its streets and 2,380 8-c.p. lamps for private supply.

The foregoing figures I believe to be practically the maximum, but it is not likely that the total of 8,000 8-c.p. lamps (or their equivalent) will be reached for some time. Still, I advise that the plant equal to this capacity be installed, as it is better to have too much than not enough, so as to obviate the error of not being able to supply your would-be customers (as was the state in Plymouth and elsewhere). Again, I advise that the streets as scheduled be lighted, believing that the fact of mains being in these streets often creates a demand which would never otherwise arise; in fact, it advertises the supply.

System of Distribution.—I advise that the system of distribution be by continuous current on the three-wire system at 460 volts across the outers, with 230 volts across the inners, at which pressure current would be supplied to consumers.

Maximum Load.—I estimate that, presuming with lamps installed both for public and private lighting as per the schedule herewith, the current required for 8,000 32-watt lamps burning would be equal to about 268 kw., but this is a condition that never occurs, as all lamps are never burning together at one period. I find the maximum load at Burton is in proportion to 1 to 1·5 lamps installed; at Bristol, 1 to 1·4; at Manchester, 1 to 1·6; at Altrincham, 1 to 3; and at Whitehaven, 1 to 1·3. Truro, however, will differ considerably to this. The high ratio of private houses to shops, and, again, the large number of ecclesiastical buildings and places of worship, will not produce so large a maximum load to the number of lamps installed. I consider that the ratio of 1 to 2 will meet your requirements. This, then, will give a maximum load of 147 kw.

Size and Site of Generating Plant.—I therefore advise that the generating plant be divided into two units of about 75 kw. each, with a third unit as a stand-by for breakdown, repairs, etc. The question of site is an important one, and should be as central as possible to the area of supply. I examined three sites, either of which might be made suitable—*i.e.*, Moresk Mills, by the river by new sewage works, and Lemon Quay. Moresk Mills offers a very advantageous site, especially as it has a small water power for about nine months in the year, and which I consider may be valued at worth about £75 per annum—that is, it will save coal to that extent. The buildings are, however, of little value for the class of machinery to be installed, except to make serviceable coal stores and workshops. There does, however, appear to be plenty of land suitable for the buildings, and the ground appears to be solid and firm for foundations. The site, too, is sufficiently far from habitation as not to be a nuisance to anyone. The site by the river by new sewage works is not so advantageous as the above, and is very de-central to the area of supply. I fear, too, it will be a costly matter to secure the foundations. On the other hand, if there is no purchase price to pay, the site can be made serviceable, but there will be a considerable increase in the price of mains on my estimate herewith. Lemon Quay offers by far the most central position, if the property can be obtained, but I fear the erection of a supply works here might be constituted a nuisance. Generally Moresk Mills offers the most serviceable site, but the question of expediency depends on the price of purchase, which has to be added to this estimate.

Capital Expenditure.—I advise that the generating plant consist of gas-engines working with Dowson or producer gas, and I estimate that the approximate cost of this will be:

Engines and dynamos	£4,000
Producer gas plant	1,000
Balancers	600
Accumulators, boosters, etc.	1,500
Switchboards, etc.	250
General equipment of engine-house	500
Mains, feeders, distributing boxes, and connections to houses	6,000
Meters and free wiring	1,500
New public lamps and alterations to others with connections	900
Buildings, etc.	1,250
Total capital expenditure	£17,500

Or equal to £81 per kilowatt.

Revenue.—I append a characteristic statement which shows at a glance the cost and profit, together with the price per unit sold, of various undertakings. I consider that the public lighting can be undertaken at 3d. per unit with the following results:

Candle-power of lamps.	Hours of burning per lamp.	Units consumed per lamp.	Cost of current per lamp.	No. of lamps.	No. of units.	Cost of current for lamps.
			£ s. d.			£ s. d.
500 c.p. arc lamp until 11 o'clock ...	1,233	616	7 14 0	15	9,315	116 8 9
Three 16-c.p. incandescent lamps until 12 o'clock	1,491	161	2 13 6	44	7,084	88 11 0
One 25-c.p. incandescent lamp	1,491	149	1 19 8	114	16,986	212 6 6
Extra for all night ..	1,375	137	1 14 3	50	6,850	85 12 6
Total cost of current per annum					40,235	502 18 9

In reality, however, the public lighting should only be charged the actual cost, which, by the appended table, ranges anything, from Manchester 1½d. per unit to a general average of 2½d. per unit. It is probable that the public lighting can be reduced. For the present, however, I estimate it at £502. 18s. 9d. Note 1.—This sum does not represent the total cost of public lighting, as there will still be about 50 to 60 gas lamps remaining in parts of the city where I have already described it will not pay to lay the mains. Note 2.—The method of switching on and off the public lamps may be done in several ways. In this case it is a somewhat costly matter to arrange the turning on from the station, as some lights are left burning all night. In some towns arrangements are made with the Watch Committee by which the police on their rounds switch on and off the light. I have therefore estimated for switching on and off the lights at about a dozen centres in the city, and which should be done by the undertaking in the cost of 3d. per unit. I estimate that with 8,000 8-c.p. lamps installed,

Digitized by Google

that the current consumed will be an average of 15 units per 8-c.p. lamp per annum, or equal to 120,000 units. The charge for current should be on a sliding scale—for instance, in those houses in which free wiring is undertaken, depreciation and interest on the capital expended must be added on the price to be charged per unit consumed. I consider that an average of 6d. per unit should be obtained, or equal to, say £3,000. There should also be a large demand for power, and this is a factor which should be thoroughly encouraged, as it provides a day load, and is therefore worked at, comparatively speaking, except for fuel, at little or no extra cost. It is difficult to place a figure for this, as the demand should be large, there being so many places where power is employed. I estimate, however, £200. Meter rents, sundries, etc., £150—a total revenue of £3,822. 18s. 9d.

Expenditure.—Coal, 400 tons of anthracite at 30s., £600; oil, waste, and stores, £50; wages, five men at 30s. per week, £390; repairs and maintenance, £200; public lamps, £100; rents, rates, and taxes, £100; management and office expenses, £500; interest, say 3 per cent. on £20,000, £600; redemption, 3 per cent. on £20,000, £600—a total expenditure of £3,140, leaving a balance of about £682 in profit. I might cite as proof that Tunbridge Wells, which has a plant about double the capacity, paid £900 towards the district rate, and carried forward a substantial balance. Of course, this result could not at first be expected, but represents the earning and paying capacity of the station.

Conclusions.—In conclusion, there would seem every reason and every prospect for an undertaking as described being a success. I scarcely need to detail the many advantages of municipalising the lighting undertakings. The fact that out of 155 provincial supply stations 95 belong to the governing authority, together with the chart which I append to this report, speaks for itself. Should you desire further information, I should be pleased to meet you to explain more fully verbally.

Electric Traction.

This question is a somewhat difficult one, and will require most careful consideration, more than it is possible to give at present in a report of this description. In the first instance, the traffic cannot be said to be heavy, but it can be said to be continuous.

Track.—In the second place, part of the track is exceedingly heavy, and, therefore, for the present purpose, I propose to treat it under two sections—*i.e.*, (1) Great Western Railway Station to Boscawen Quay; (2) from quay to Malpas. Practically speaking, from the quay to the junction of Richmond-hill with Frances-street there is a gradient or rise of about 1ft. in 300ft.; quay to Richmond-hill, 800 yards, 1 in 300 rise; Frances-street to George-street, 120 yards, 1 in 20 rise; Richmond-hill, 200 yards, 1 in 12·5 rise; Richmond-hill to Great Western Railway Station, 200 yards, 1 in 20 rise—total length, 1,320 yards. Taking a double-decked car with a seating capacity of 44 passengers, the total weight of which when full will be 11 tons, the car weighing eight tons when empty, the power required to drive such a car at eight miles an hour on level is 7·5 h.p.; at six miles an hour on level is 5·3 h.p.; on a gradient of 1 in 12, which is the steepest it has to negotiate, will be nearly at six miles an hour, 40 h.p. You will at once note that there is a vast difference of power required on the level and on the hill.

Size of Car.—I do not think it is possible or probable that a double-decked car will ever be filled, and I am inclined to advise single-decked cars of a capacity of 20 passengers each. These will weigh considerably lighter, and on the hill take much less power. I advise that in the event of traffic becoming too heavy for the cars in ordinary service, that more cars be run, believing that a continual or constant service of lighter cars would be more profitable than a less service of cars of larger capacity. I advise that there be three cars working on this section, each of which shall average six miles per hour, the three together giving a five-minute service.

System.—The system should be by means of the overhead wire and trolley system, the wire being supported on cast-iron columns, the same acting as the arc lamp standards. There should also be three turn-outs for crossing purposes.

Generating Plant.—It is scarcely practical to run the cars from the generating plant of the lighting system, as the switching on of the current, especially when manipulating Richmond-hill, would be too noticeable to the lighting. The same gas producer plant would, however, do, but it would be necessary to add another 75-kw. plant installed, together with a separate storage battery and booster. The plant should be so arranged that the stand-by set, or any set, can be used for either purpose, the same staff controlling all.

Capital Expenditure.—I estimate the capital expenditure—

Generating plant and accumulators	£3 500
Line equipment, mains, and feeders	6 500
Four cars, one as a stand-by	2,600
Total estimated expenditure	£12,600

Annual Expenditure.—I estimate the current consumption to be 2·2 units per round trip, or, say, a total of 97,032 units per annum—

Say at 2d. per unit, or at a cost of	£808	12	0
Five men at 30s. per week	390	0	0
Four boys at 7s. per week	72	16	0
Uniforms, etc.	30	0	0
Office expenses	75	0	0
Repairs, etc.	200	0	0
Three per cent. on £12 600, interest	378	0	0
Three per cent. on £12,600, redemption	378	0	0
Total expenses	£2,332	8	0

Revenue.—Presuming that the cars covered four round trips each per hour, I estimate the total mileage would be 67,176 car miles per annum, or equal to an expenditure of 8·55d. per car mile, and as each trip constitutes about 1·475 car miles, it practically means that if the fare is 1d., 13 people must be carried per round trip; anything above this number is profit. (The revenue at Dover is 10·92d. per car mile; South Staffordshire tramways, 13·95d. per car mile). You will notice that I have estimated the current at 2d. per unit; I do not think it is going to cost this to generate, as it constitutes mostly a day load, and the day staff can look after this. There is no doubt this will add some considerable profit to the lighting; but I have thought it safe to take this figure as a basis. You will see, on account of the heavy gradients, the working expenses are heavy. For instance, with a double-deck car the current consumption at Dover is only ·98 unit per car mile, but at Truro with a single-decked car it is 1·5 units per car mile.

Malpas.—I have not thought it worth while to go into the Malpas section; the character of the traffic seems to me to be so intermittent that I would prefer to discuss this section personally with you, as, indeed, I should be pleased to do with the whole matter generally. I trust this information will help you as a basis to formulate a scheme, for there is, undoubtedly, every element to ensure a successful undertaking.

Mr. Headley was also asked to report on the suitability of Carvedras Works as the central station, and he states:

The site is one of the best I have examined, being level, whilst it is sufficiently far from buildings as not to constitute a nuisance. The buildings, with very little alteration, could be made suitable for all purposes required. For the lighting scheme it is not quite so central as Moreak Mills; as a result an additional £1,200 may be required for extra feeders. For the traction scheme from Boscawen Bridge to station it is by far the best site, as it is so adjacent to that portion of the track which requires the heaviest amount of current, whilst there will be a considerable saving in the construction and feeders, equal at least to the extra expenditure on the lighting. If, however, the Malpas extension should be undertaken, the cost saved on the present traction scheme would be required for additional feeders. The water power at Carvedras is practically a negligible quantity, and is not worth consideration. In the event of coal being brought by rail the site is most convenient, as the coal could be tilted into bunkers.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Varna.—The Municipality invite tenders for the lighting of the town by electricity for 40 years by Oct. 15 (concession).

Warrington.—The Corporation invite tenders for the installation of mains and fittings at their station and depôt at Howley.

Beetle.—The Corporation invite tenders for a steam dynamo. Tenders by Oct. 13. Details in our advertisement columns.

Rochdale.—Tenders for the supply and fixing of a 1 ft at the infirmary, to be worked by electricity, will probably be advertised shortly.

Bermondsey.—The Vestry invite tenders for the erection of steam dynamos, etc. Tenders by Oct. 15. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and erection of arc lamps, etc. Tenders by Oct. 10. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for 24 car bodies and electrical equipment. Tenders by Oct. 15. Details in our advertisement columns.

Maidstone.—The Corporation invite tenders for a surface condenser and feed pumps. Tenders by Oct. 16. Details in our advertisement columns.

Pozuelo (Province of Albacete, Spain).—The Municipality invite tenders for the lighting of the town by electricity for 40 years by Oct. 7 (concession).

Hackney.—The Electric Lighting Committee of the Vestry invite tenders for electricity supply mains. Tenders by Oct. 3. Details in our advertisement columns.

Birkenhead.—The Corporation invite tenders for the supply delivery, and laying of feeder mains, etc. Tenders by Oct. 2 Details in our advertisement columns.

Digitized by Google

Manchester.—The Tramways Committee invite tenders for the supply of cast-iron bases for tramway poles. Tenders by Oct. 1. Details in our advertisement columns.

Santiago.—Offers are invited for the laying down and working of a telephone system in Santiago de Compostela, in the province of Coruna, Spain. Tenders by Oct. 19.

Cortegana.—Offers are invited for the installation of electric lighting and the working of same for five years in this town, in the province of Huelva, Spain. Tenders by Oct. 19.

Azuaga.—Offers are requested by the Municipality of this town, in the province of Badajoz, Spain, for the installation and working of the electric light for 20 years. Tenders by Oct. 11.

Melton (Suffolk).—The Visiting Committee of the Suffolk County Lunatic Asylum invite tenders for wiring and fittings. Tenders by Oct. 5. Details in our advertisement columns.

Callosa de Ensarria.—Offers are requested by the Municipality of this town, in the province of Alicante, Spain, for the installation and working of the electric light for 15 years. Tenders by Oct. 12.

Fuenteovejuna.—Offers are requested by the Municipality of this town, in the province of Cordoba, Spain, for the installation and working of the electric light for 20 years. Tenders by Oct. 9.

Manchester.—The Directors of the Lancashire and Yorkshire Railway Company invite tenders for the supply of various stores. Tenders by 10 a.m. on Oct. 8. Particulars in our advertisement columns.

Ilford.—The Urban District Council invite tenders for meters (direct-current) and cut-outs. Specification may be obtained from Mr. J. W. Benton, clerk, Council Offices, Cranbrook-road, Ilford. Tenders by Oct. 8.

Whitehaven.—The Water and Lighting Committee of the Corporation invite tenders for the supply and erection of a switchboard at their electric lighting station. Tenders by Oct. 13. Details in our advertisement columns.

Aberdeen.—The Tramways Committee invite tenders for the manufacture and supply of 25 electrical tramcars, and equipments for six horse cars, about to be converted. Tenders by Oct. 17. Details in our advertisement columns.

Grimsby.—The Corporation invite tenders for the wiring of the free library for electric lighting. Specifications and forms of tender can be obtained from Mr. W. A. Vignoles, borough electrical engineer, Grimsby. Tenders by Oct. 6.

Middleton (Lancs.).—The Corporation invite tenders for buildings required for electricity station. Specifications, etc., may be obtained at the offices of Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester. Tenders by Oct. 11.

Dublin.—The Corporation invite tenders for electric motors and pumps for Ringsend drainage works. Specifications may be obtained at the office of the consulting engineer, Mr. Chatterton, 6, The Sanctuary, Westminster. Tenders by Oct. 3.

Nottingham.—The City Council invite tenders for 1,500 tons of steel girder tramrails and 76 tons of fishplates. Specifications, etc., may be obtained from Mr. Arthur Brown, M.I.C.E., city engineer, Guildhall, Nottingham. Tenders by Oct. 8.

Bradford.—The Corporation invite tenders for the construction and delivery of an engine and dynamo, also switchboard apparatus, etc., for their destructor works, Southfield-lane, Bradford. Tenders by Oct. 9. Particulars in our advertisement columns.

Limerick.—The Town Council invite tenders for erection and completion of an electric generating station building at Frederick-street, Limerick. Drawings and specification may be seen at the office of Mr. J. J. Peacocke, B.E., city surveyor, Town Hall, Limerick. Tenders by Oct. 4.

Bray.—The Urban District Council invite tenders for supplies required at their electric light works for 12 months, including cables, carbons, house wires, switches, lampholders, incandescent lamps, etc. Particulars may be obtained from Mr. P. MacDonnell, clerk of the Council, Town Hall. Tenders by Oct. 4.

Glasgow.—The Corporation invite tenders for the supply of 1,000, 2,000, or 3,000 tons steel straight track rails; 100, 200, or 300 tons steel curved rails; 50, 100, or 150 tons steel fishplates. Specifications, etc., can be obtained from Mr. John Young, general manager, 88, Renfield street, Glasgow. Tenders by Oct. 23.

Eastbourne.—The Corporation invite tenders for the supply and erection of a water-tube boiler, with fittings, feed pump, etc., a 400-kw. steam alternator, with exciter (vertical enclosed high-speed engine), and main switchboard and connections. Tenders by Oct. 4. Particulars appear in our advertisement columns.

Sheffield.—The Corporation invite tenders for specification No. 3 (a) two two-phase steam alternators and exciters, 600 kw. each; (b) alteration of present single-phase plant to two-phase. Specifications can be obtained from Mr. S. E. Fedden, chief engineer and manager, Commercial-street, Sheffield. Tenders by Oct. 6.

Brighton.—The Council invite tenders for the supply and delivery of 2,000 tons of steel girder tramrails, 78 tons of steel fishplates, 90 tons of steel joists. Specifications and form of tender and all necessary information may be obtained on application at the office of Mr. Thos. B. Holliday, tramways engineer, Town Hall, Brighton. Tenders by Oct. 1.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and laying of electricity supply mains and accessories. Specifications and form of tender may be inspected at the office of the city engineer, Mr. Spencer Harty, M.I.C.E., City Hall, Dublin, and at the offices of Mr. R. Hammond, consulting engineer to the Corporation, 64, Victoria-street, S.W. Tenders by Oct. 4.

Medomsley (Durham).—The Parish Council invite tenders for the supply and erection of electric lamps, posts, cables, etc., necessary for the lighting of the road leading from Black Hall Mill to Medomsley Village, via Westwood Colliery. Particulars may be obtained from Mr. M. T. Milburn, Medomsley, R.S.O., clerk to the Council, and the ground may be viewed on making an appointment by letter.

Hackney.—The Electric Lighting Committee of the Vestry are prepared to arrange a sub-contract for the constructional ironwork required for the buildings of their combined electricity and refuse destructor works. Specifications, etc., may be seen at the office of Mr. Robert Hammond, M.I.C.E., 64, Victoria-street, Westminster, London, S.W., and may be obtained from the architects, Messrs. Gordon and Gunton, Finsbury House, Blomfield-street, E.C. Tenders by Oct. 3.

Brighton.—The Corporation invite tenders for the supply and delivery of 25 electric motorcars. The work is divided into three sections, and contractors may tender in respect of all or any one or more of such sections—viz.: (Section 1) 25 electric motorcar bodies; (2) 25 electric motor trucks; (3) 25 electric motor electrical equipments. The specification and form of tender and all necessary information may be obtained on application at the office of the tramways engineer, Mr. Thos. B. Holliday, Town Hall, Brighton. Tenders by Oct. 1.

India.—The Secretary of State for India in Council is prepared to receive tenders for the supply of a complete electrical installation for supplying power to a factory from a waterfall about three miles distant from factory. The generator will be required to develop about 500 kw., and the installation is to include complete plant of generators, line, transformers, cables, motors, etc. Conditions, etc., may be obtained from the Director, General Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office by 2 p.m. on Oct. 16.

Long Eaton.—The District Council invite tenders for the construction of a line of poles, also two wires (about 5·10 miles in length), with other accessories, for the purpose of establishing a telephonic and electro-mechanical transmitting and registering and recording apparatus between their waterworks pumping station at Stanton-by-Bridge, near Derby, and the service reservoir at Castle Donington, Leicestershire. Plan may be seen at the offices of the Council, Long Eaton, and specification, with form of tender, obtained on application to Mr. Frank Worrall, surveyor and waterworks manager, Council Offices, Long Eaton. Tenders by Oct. 1.

RESULTS OF TENDERS.

Witney.—The Hart Accumulator Company, Limited, have secured the contract for the supply of storage batteries required for the electric lighting.

Southampton.—The Guardians have accepted the tender of Lankester and Son for carrying out an electric light installation at the new workhouse infirmary at Shirley Warren, at £3,499. 10s.

Worksop.—The Urban District Council have accepted the tender of Mr. W. Hall, Potter-street, Worksop, in connection with the erection of electricity supply works in Canal-road, Worksop, at £3,950.

Greenock.—The Police Board have accepted the tender of the India Rubber, Gutta Percha, and Telegraph Works Company for Contract No. 6, and that of Messrs. Babcock and Wilcox for Contract No. 5, for the supply and erection of traction plant.

Shipley (Yorks.).—The Council have accepted the following tenders for steam exhaust pipes, storage battery, switchboard and connections, and cables: (Section A), J. Spencer, Limited, Globe Engineering Works, Wednesbury; (B), Eclipse Brass and Copper Company, Limited, Hull-road Works, York; (C), Mavor and Coulson, Limited, 47, King-street, Mile End, Glasgow; (D), Western Electric Company, North Woolwich, E.

BUSINESS NOTES.

TRACTION.

Sedgley.—On Monday a trial trip was made on the electric tramways at Sedgley which was considered to be satisfactory.

Falkirk.—Draft heads of agreement between the Council and Falkirk and District Tramways Company have been agreed to.

Gateshead.—The *Newcastle Daily Chronicle* comments favourably on the rapid progress which is being made in the laying of the tramways.

Nantwich.—The members of the Crewe Carters' Association have a strong objection to the proposed tramways on the ground of the narrowness of the streets.

Strike of Motormen.—We understand that the motormen and conductors in the employ of the Oldham, Ashton, and Hyde Electric Tramway Company came out on strike on Saturday night in consequence of the manager's discharging union employés and replacing them by non-unionists.

Glasgow.—The Corporation have agreed to take over the building contract at Pinkston power station and have appointed Mr. William Irving, works manager to Messrs. James Carmichael and Co., engineers and boilermakers, Dundee, to be mechanical engineer in charge of that station.

Digitized by Google

Preston.—Councillor Yates Foster (mayor) has been appointed chairman and Councillor Copland vice-chairman of the Tramways Committee. The town clerk is about to obtain from other towns information on the subject of tramways, so as to bring the return of information obtained in July, 1899, up to date.

Devonport.—We understand that the various road works necessitated by the tramways scheme, are making satisfactory progress. One or two sections are already well advanced, but it has been decided not to open the lines until the whole of them are completed. This it is expected will be about Christmas.

Bardsley.—At the Ashton County Police Court last week a carman was fined 5s. and costs for obstructing a tramcar belonging to the Oldham, Ashton, and Hyde, Electric Tramcar Company. Considering the trouble these people give as a rule the fine cannot be held to be deterring, especially as the advocate's fee was not allowed by the Court.

Accident.—For about two hours on Wednesday evening the electric train service between Moorgate-street and London Bridge Stations, *vid* the Bank, was suspended owing to an accident on the line. A train, the engine of which had broken down, was run into by a second train. The damage was evidently slight as no passengers complained of injuries, and soon after 8 p.m. traffic was re established.

Huddersfield.—The Town Council last week discussed the recommendation for the carrying out of new tramway works, relaying of old ones with electrical equipment, and the purchase of land, plant, and cars, involving an expenditure of £68,953 6s. 11d., already referred to by us. Finally it was agreed that application be made to the Board of Trade for powers to borrow £38,305 for tramway purposes, to be repaid in 30 years.

Chester.—The Chester tramways extension has been considered by the Local Government Act Sub-Committee of the Town Council, who have discussed the question of extensions generally, the desirability of taking powers for extensions in several directions, and carry out experimentally, in the first instance, the most important of them, and the question of double or single lines on various routes. The committee desired the surveyor and Mr. Thursfield to reconsider the subject, and authorised them to visit other towns.

Camberwell.—The London County Council have resolved, subject to the Vestries of Lambeth and Camberwell and the Lewisham District Board giving their consent to the proposed tramway and agreeing to contribute between them one-third of the net cost of the necessary street widening, to make application to Parliament in the session of 1901 for powers to widen certain thoroughfares with a view to the construction of a tramway. The estimated cost of acquiring the necessary property in the parish of Camberwell was £68,700, whilst the cost of the necessary paving works in Camberwell, excluding the cost of laying down and paving the tramway track, was estimated at £52,500. The Camberwell Vestry have decided to defer the consideration of a contribution to the cost of the new road to the Tower Bridge to the Borough Council.

Mersey Railway.—The first meeting of the Mersey Railway Company since the passing of the Bill enabling the company to be worked by electricity, extending the time for redeeming the redeemable first debenture stock, and constituting a joint committee with the Wirrall Railway, was held on Tuesday. Mr. James Falconer, who presided, said the effective working of the line by electricity would prove the practical salvation of the company. In reply to a question as to the cost of altering the system to electric traction, the Chairman said that for a joint scheme with the Wirral Railway Company they had provided in the scheme for borrowing powers of half a million. That was a rough estimate made by Messrs. Preece and Cardew. If the company did not come to terms with the Wirral Company, and had to raise the money on their own account, then he thought that the cost would be £300,000. This included provision for the rolling-stock—in fact, everything.

Folkestone.—The borough surveyor has been instructed to proceed with the preparation of the necessary plans for deposit in connection with the proposed application for powers to construct tramways in Folkestone. The report of Mr. J. E. Waller (of the firm of Messrs. Kincaid, Waller, and Manville) upon the proposal for the construction of tramways by the Corporation of Folkestone, together with the estimate of the cost thereof, was discussed at the last meeting of the Town Council. It was resolved that the routes of the proposed tramways be as follows: (No. 1) from the boundary of Cheriton to Radnor Park-road; (2) Radnor Park-road to Park-road; (3) Foord-road to Tontine-street; (4) Tontine-street and Harbour-street; (5) Black Bull-road, Canterbury-road, and Dover-road to Tontine street; (6) loop between Black Bull-road and Foord-road; (7) loop from the east to the west side of the Congregational Church in Tontine-street; (8) loop in Cheriton-road and Radnor Park-road; (9) Cheriton-road from Radnor Park-road to Guildhall-street; (10) Sandgate-road from the boundary of the urban district to Guildhall-street; (11) Rendezvous-street and Dover-road between Rendezvous-street and Tontine-street; (12) from the harbour along Marine-terrace, Marine-parade, and Lower Sandgate-road to Victoria Pier; (13) from the boundary of the urban district of Folkestone or Sandgate-road to the South-Eastern Railway Company's tramway in Sandgate. The recommendation of Mr. Waller to have a double line in Rendezvous-street has also been approved of, and the requisite steps will be taken for the promotion of a Bill in the next session to obtain powers for the Corporation to construct and work tramways as above indicated. The estimate is £95,000. It is calculated that the cars would run 360,000 miles per annum at a cost of 10d. per mile. The total cost of working expenses and repayment of capital would be £14,595. If the Corporation should purchase current of the existing company instead of erecting their own generating station, the capital cost would be reduced by £18,000.

LIGHTING AND GENERAL.

Buxton.—Application is to be made for £25,000 for electric lighting extensions.

Wisbech.—The Town Council have decided to apply for an electric lighting order.

Removal.—We notice that Messrs. B. Jackson and Co. are removing from 28, Fenchurch street to 38, Lime-street, E.C.

Globe Telegraph and Trust Co.—The directors announce a quarterly dividend of 1s. 9d. per share on the ordinary shares.

Walker.—The District Council have received £1,937 from the Electric Supply Company, this being the cost of the Council's opposition to the gas company.

Bishop's Stortford.—The North British Electricity Supply Company propose to apply for a provisional order authorising them to supply electrical energy in the district.

Carmarthen.—On Tuesday the Town Council appointed a committee to discuss the question of getting a preliminary report on the cost of an electric lighting scheme for the town.

Eastern Extension, Australasia, and China Telegraph Co.—The directors have declared an interim dividend for the quarter ended June 30 of 2s. 6d. per share, payable 15th prox.

Ormskirk.—The Guardians have appointed a sub committee to take into consideration the question of putting down an electric installation in the workhouse and offices for lighting purposes.

Walsall.—The Electric Lighting Committee's last report gives the total number of consumers supplied on Aug. 31 last at 167. The total units generated at the station during the month of August was 23,554

St. Olave's.—The Board of Works have given consent for the London Electric Supply Corporation, Limited, to lay distributing mains, etc., in Great Maze Pond, Tooley-street, Tower Bridge approach, and other thoroughfares.

Cannock.—The Urban District Council have decided to apply for a provisional order empowering them to provide electricity in the urban district. They will oppose the application of the North British Electricity Supply Company.

Poplar, E.—The electric light was turned on in the Poplar streets for the first time on Wednesday. The installation, when completed, will also take in the streets of Bow and Bromley, and has been laid down at a cost of £70,000.

Stock Exchange Settlement.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Telegraph Manufacturing Company's further issue of 5,000 shares of £5 each, fully paid.

City of Buenos Ayres Tramways Co.—The directors have declared the following interim dividends for the half-year ended June 30: upon the old shares 4s. per share; 3s. 10d. per share upon the shares of the eighth issue; and 2s. 8d. per share upon those of the ninth issue; £10,000 is added to the reserve fund, and £2,057 carried forward.

British Power, Traction, and Lighting Co.—This Company has been registered with a capital of £52,000 in £1 shares, of which 50,000 are preference, the object being to adopt and carry into effect agreements made between the Engineer Cycle Works, G. J. Gibbs, and the Anglo-American Motorcar Manufacturing Company, and the Power Transmission and Traction Company, and others, to carry on the business of machinery manufacturers, electrical and general engineers, and builders of and dealers in all kinds of tramcars, etc.

Bristol.—The following report of the Electrical Committee will come before a special meeting of the Town Council to-day: "Your committee report that serious differences of opinion have arisen between the engineer and the architect with regard to the foundations for the proposed central electric lighting station at Avonbank. Your committee have given the matter their most careful consideration, but find that the points in dispute are of an important and complicated nature, and they therefore recommend that they be authorised to submit the matters in dispute to Sir Benjamin Baker, in order that he may advise which of the two schemes put forward should be adopted by the committee."

Appointments Vacant.—The Vestry of St. Mary, Islington, require the services of a mechanical draughtsman and an engine driver.—The Urban District Council of Barnes require an electrical engineer to act as clerk of works in connection with their electrical supply undertaking under the Council's consulting engineer, Mr. W. Fairley.—The Tramways Committee of the Manchester Corporation require the services of a thoroughly qualified person to act as lady superintendent of the ticket and cash counting department.—The Peterborough Corporation invite applications for the position of foreman jointer, at a salary of £1. 10s. per week. Full particulars of these vacancies appear in our advertisement columns.—An engineer is required by the Leicester Corporation at the new isolation hospital at Gilroes, Leicester, to take entire charge of the steam boilers, electric lighting plant, laundry machinery, heating apparatus, hot-water supply, sewage ejector, etc., for which he will be held responsible. A stoker will be provided. Wages, £2. 5s. a week. Applications must be endorsed "Engineer," and delivered at the office of Mr. James Bell, town clerk, Town Hall, Leicester, by 29th inst.

Digitized by Google

Wellington.—The Council intend to apply for a provisional order under the Electric Lighting Act for the present lighting area.

Harrow.—Notices have been published to the effect that the Urban District Council intend to transfer their electric lighting order to the Harrow Electric Light and Power Company, Limited, for a period expiring on Oct. 14, 1937.

Hanley.—Mr. H. P. Boulnois has held an enquiry into an application of the Corporation for sanction to borrow £9 500 for the provision of a refuse destructor near the Cauldon Canal at Sandyfield, and £4,000 for purposes of electric lighting.

Electro-Ceramic Syndicate.—This Company has been registered with a capital of £2,000 in £1 shares, the object being to acquire certain inventions relating to electro-ceramic photography, etc., from F. J. Shippey or Messrs. Shippey Bros., Limited.

Harrogate.—By invitation of the Mayor (Councillor Wilkinson), the members and officials of the Ripon Corporation, in view of the proposed introduction of electric lighting into Ripon, paid a visit to the Harrogate Corporation electricity works last week.

Paddington.—The Electric Lighting Committee, acting under instructions from the Vestry, have informed consumers of electrical energy that the consent of the consumer is necessary before any change can be made in the voltage under which current is supplied.

Southgate.—The Urban District Council have decided to apply for an electric lighting provisional order. A conference of the representatives of the Councils of Tottenham, Wood Green, and others combining in the electric lighting movement, was held on the 26 h inst.

Lymington.—The Council have approved of the manner in which the electric light company propose to carry out the work under their provisional order, and the contract with the company to light the town from Sept. 29 has been sealed. It is generally understood that the light will not be available until November.

Holyhead.—The Lighting Committee of the Urban District Council have been considering a scheme for lighting the town with electricity. It is contended that a great force of water is going to waste two miles away that could be utilised for this purpose. Mr. Thunderbolt has been requested to prepare a scheme for the town.

Clitheroe.—The National Telephone Company have declined to alter their rates for proposed telephonic communication, and the Corporation refuse to increase their offer. At the same time the Council have come to the conclusion that the town was not large enough to successfully maintain a local telephone exchange of their own.

Meyra Electric Co.—This Company has been registered with a capital of £10,000 in £1 shares, the object being to acquire a certain invention for improvements in galvanic batteries, with the trade mark "Meyra," and an invention or secret process for dry batteries, and to carry on the business of machine makers, electrical and general engineers, etc.

Northfleet.—On the agenda for the last meeting of the District Council was a motion to the effect that the necessary steps be taken for obtaining an electric lighting order for the district in the ensuing session of Parliament. It was not put to the vote, the mover withdrawing it so as to allow the clerk to ascertain the cost of an application for an order.

Accumulator Industries.—This Company has been registered with a capital of £10,000 in £1 shares the object being to adopt agreements (1) between H. Leitner, F. W. Manley (for the company), and B. Küttner, and (2) H. Leitner and F. W. Manley (for the company), to acquire certain benefits, rights, and inventions, and to carry on the business of electric accumulator, motor, controller, vehicle and dynamo makers, etc.

Post Office Telephones.—The application of the General Post Office to carry pipes through the galleries of the two subways running east and west between Farringdon-street, and situated on the north side of Holborn Viaduct, has been acceded to by the Court of Common Council, subject to the work being carried out to the satisfaction of the engineer, and to the payment of any reasonable fees to the city engineer for his services.

'English Illustrated Magazine."—Amongst the usual bright stories and sketches in the October number, we notice an article an article by Mr. Fred. A. Talbot, entitled "The Most Remarkable Railway in the World." It is an exhaustive description of the Wappee Valley Railway, well illustrated, with about 10 photographs and drawings, and giving the reader an excellent idea of one of the most daring as well as the most ugly mono-railroad constructions in existence.

Zschocke's Patent Water-Cooling Towers.—We understand that MM. Doherty and Donat, engineers and contractors, 40, South King-street, Manchester, are the sole licensees for Great Britain for these cooling towers for cooling the condensed water from steam-engines. We are informed that there are already over 600,000 i h.p. of Zschocke's patent cooling plants, including 35 electric light and power stations, in successful operation all over the world.

Craigo.—The electric light was switched on for the first time on Thursday last week at the local spinning mills. Messrs. J. D. Mackenzie and Co., Glasgow, were the contractors. The dynamo, of the multipolar type, is of American manufacture, having been made by the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, and is capable of giving 130 amperes at 100 volts (when driven by belting from the main shaft) at a speed of 950 revolutions per minute.

Hackney.—At the Vestry meeting on Wednesday the Electric Lighting Committee reported on the applications received for the appointment of clerk of the works to supervise the erection of buildings for the electricity and refuse destructor works, and submitted the names of the three following candidates for the appointment of one of them by the Vestry—viz.: W. J. Davenport, 133, Rendlesham-road, Clapton; J. Saunders, Clifton Villas, Barclay-road, Walthamstow; P. Watkins, 1, Cleveland-villas, Ilford.

Nuneaton.—The Local Government Board have written, with reference to the Urban District Council's scheme for the extension and development of their electric undertaking, that the Board will raise no objection to the District Council proceeding with the erection of the chimney shaft, and ordering the machinery as proposed. When the Board have been furnished with a copy of the resolution of the District Council applying for sanction to borrow the further sum of £2,000, they will be prepared to sanction the total amount required.

Leicester.—The last report of the Gas and Electric Lighting Committee states that the accounts of the electric lighting undertaking have been submitted, and the result of the working of this department for the half-year ending June 30 last is a net profit, after paying interest on the capital of the undertaking, of £1,430. 8s. 5d. Out of this has been paid £1,068. 3s. 1d., the half-year's amount of sinking fund, leaving a balance of £362. 5s. 4d. The committee also report that good progress is being made with the extension of the electric lighting central station.

Barnsley.—The Park and Lighting Committee reported on Tuesday that they had given instructions to the electrical engineer to place standards for arc and incandescent electric light lamps—viz, one at the junction of the Sheffield and Doncaster roads, one at the junction of Cheapside and New-street, three on Mayday Green, one in Queen-street, one in Peel-square, three on Market-hill, one in Church street (at the top of Regent-street), two in Regent-street, one in Eldon-street (at the top of Kendray-street), and one in Kendray-street—and also to prepare specifications and tenders for an additional engine and dynamo for the electricity works. The committee will inspect the lamps and decide on alterations on Oct. 2.

London Gazette.—The first meeting in the estate of R. Foster, Bradley House, Nelson, Lancashire, and W. Baker, 27, Ormerod-road, Burnley, Lancashire (trading as R. Foster and Co. at Adlington-street, Burnley, also trading as the Nelson Electrical Engineering Company at Stobb-street, Nelson, Lancashire), will be held to-day at 12 30 p.m. at Exchange Hotel, Nicholas-street, Burnley, and the public examination at 11 a.m. at Court House, Burnley.—A meeting was held on the 25th inst. for the purpose of receiving the liquidator's final statement *re* the Electrical Pioneer Syndicate Limited.—Messrs. W. W. Feast, T. K. Freeman W. Langley-Smith, and W. Pering Paige have been appointed liquidators for the purpose of winding up the Croydon Tramways Company.

Catalogues.—We have received from Messrs. Mather and Platt, of Manchester, a revised list of their steel-clad motors and accessories. The list gives the weight, capacity, voltage, and price of the various types and sizes of motors manufactured by the firm. We have also received a copy of the illustrated pamphlet which they prepared for the purposes of the Paris Exhibition, in which is described some of their recent manufactures in electrical plant. This latter booklet is very well illustrated, the details in the machine shown being very clear. Messrs. Mather and Platt have, we notice, secured a gold medal at the Paris Exhibition for a combined engine and dynamo set.—We have also received from Messrs. Johnson and Phillips their new price list. They have, they state, owing to the slight fall in the market prices of raw materials, been enabled to give an additional 5 per cent. on the trade discount previously allowed off vulcanised rubber cables listed in their February, 1900, catalogue. Their additional cable factory for the manufacture of lead-covered and armoured cables for town lighting is now in working order, and they are at present executing a contract for the Manchester Corporation in it. The list is printed in black and red figures, and is very handy for reference.

Hampton.—Messrs. H. W. Handcock and A. H. Dykes, consulting engineers, of Westminster, and Mr. J. Kemp, surveyor to the District Council, have submitted a report on the proposed supply of electrical energy for lighting purposes in conjunction with a refuse destructor. There are at the present time 250 public gas lamps in the district, the cost, including repairs and cleaning, being £912. The lamp-posts belong to the Council, and it is proposed to adapt them by fitting them with 16 c.p. lamps with diffusing globes, which will give a far more effective illumination than the present 12-c.p. gas jets. The power taken by the 250 lamps when all alight would be 15·5 kw., or, allowing for loss in distribution, say 17 kw. Without considering the current which might be required for the lighting of the palace, the engineers estimate that within a very short time from the opening of the station there would be required for private lighting in Hampton Hill 600 16-c.p. or 1,200 8-c.p. lamps; Hampton, 600 16-c.p. or 1,200 8-c.p. lamps; Hampton Court, 300 16 c.p. or 600 8-c.p. lamps—making a total of 1,500 16 c.p. or 3,000 8 c.p. lamps. Of these 3,000 lamps, only about half would probably be alight at once, requiring (allowing for loss in distribution) an output of 50 kw. The maximum output of the station would therefore be: public lighting, 17 kw.; private, 50 kw.—total, 67. The most suitable position for the station would be, in our opinion, at the sewage works. Having in view the double purpose for which the destructor is required, first and foremost, the effective disposal of all refuse without nuisance from smell or dust; and, secondly, the production of steam. The adoption of the Meldrum type is recommended. The estimated total cost of the schemes, allowing for feeders sufficient for 10,000 lamps, as set forth is: electric

Digitized by Google

light station and mains, £15,450; and for refuse destructor, £3 425; while working expenses for electric light are estimated at £1,732 per annum, and for destructor at £398 per annum. As to revenue from electric lighting, the report says: "The number of units consumed per annum per lamp connected to mains varies in different districts, but from analogy with Kingston, where it is 26 units, and Ealing 23·2 units, and other neighbouring districts, we assume that each separate lamp in your district will take 22 units per annum. Taking the average price obtained as 6d. per unit, which is as cheap or cheaper than gas at the present moment, the annual revenue from the electric lighting department will be as follows: sale of electrical energy, £1,650; meter rents, £70; public lighting, £912—total, £2,632." Free wiring is advocated.

Brighton.—It appears that the Watch Committee have made a three years' arrangement with the Telephone Company in connection with the fire station telephones, notwithstanding the fact that it is expected to see municipal telephones well at work in Brighton within the next 12 months. A committee of the Guardians are considering a report as to the advisability of installing electric light at the workhouse, in which Mr. Christie, the resident electrical engineer of the Corporation, stated that he found, in the first place, it would cost the Corporation about £700 to extend the present main in Elm-grove to the workhouse, but by doing so 20 street lamps *en route* could be lighted electrically. Mr. Burden, the master, had informed him that there was approximately 1,000 gas-jets in use. Of these 400 were in use at once, and might be taken as the average maximum demand. The maximum demand, however, might be raised to 500 by using more light on special occasions. The hours of use of various lamps, he understood, might be taken as follows: 50, dusk to 8 p.m., equalled 730 hours per annum, or 36,500 lamp hours; 200, dusk to 11 p.m., equalled 1,820 hours per annum, or 364,000 lamp hours; 150, dusk to dawn, equalled 4,380 hours per annum, or 657 000 lamp hours, which altogether gave a total of 1,057,500 lamp hours. Assuming that all gas jets were replaced with lamps of an average of 8 c.p., each using 35 watts per hour, the annual consumption would be 37,012 units per annum. If the maximum demand did not exceed 400 lamps, or 14 units consumption per hour, then the cost worked out as follows: 5,110 units at 7d., £149; 31,902 units at 1d., £133—total £282, or an average cost of 1·8d. per unit. The capital cost of the whole installation, consisting of 1,000 lights wired, two 10-h.p. motors, and all accessories, might be taken at about £1,500.

Tewkesbury.—We are indebted to the *Tewkesbury Weekly Record* for the following description of Mr. W. Jackson's schemes, referred to by him at a recent meeting of the Town Council: "The system adopted should be the low-tension, the pressure on the lamps being from 220 to 440 volts, the generating plant to consist of two steam loco.-type boilers and two sets of combined engines and dynamos coupled direct and running at high speed and of the enclosed type. A battery of accumulators to be provided to take the light and night loads, and concentric armoured cables to be laid in the three principal streets, and also any cross streets between the same where current is demanded, the said generating plant to be capable of lighting 2 000 16-c.p. lamps, or 4,000 8-c.p. ditto. The street-lighting to be also on the incandescent principle, having one 25-c.p. lamp in each; the said street lamps to consist of a wood standard, on top of which will be fixed a wrought-iron bracket, with approved shape lantern with electric lamp inside, the whole well painted. This scheme is based on the understanding that the piece of ground at back of town hall be utilised for the building of the generating station, as by the same being so central considerable saving is effected in the initial outlay on plant and cables. There is also plenty of room for future extensions, or refuse destructor later on if required. The above site is undoubtedly the best, most central, and economical site for a generating station which could possibly be obtained. The working expenses would be reduced to a minimum by adopting such a scheme, as the generating station could be closed at 12 o'clock (or before) midnight, the demand afterwards being met by the battery. The charging of the battery would have to be done during the day, and the heavy load from sunset till 12 o'clock would be run direct from the engines with the battery as a regulator. For this plant, an electrician, fitter, stoker, and apprentice or lad would be sufficient for running satisfactorily. Installing work could also be undertaken from the same station by the Council, which is a very remunerative addition to the generating plant, needing a showroom, office, and stores, which we should be happy to superintend, paying the said Council a percentage on the turnover yearly. The price for current, we should say, should be 7d. per unit, equivalent to gas at 3s. 4d. per 1,000 cubic feet, and considering the latter to be well over 4s. per 1,000 cubic feet at present, we should say it would be very advantageous, profitable, and more economical to the Council and ratepayers to adopt an electric lighting scheme. We feel certain that in the course of two years after station has been opened, the price for current may be reduced to 6d. per unit (equivalent to gas at 3s. per 1,000ft.), and then will well repay the initial outlay on plant. An approximate estimate, to include the following: plain buildings, boilers and engines, pumps, etc., dynamos and switchboard, foundations, battery of accumulators, cables and laying, providing 100 lamp-posts and brackets, etc., would be £5,500-£6,000. The following is the estimate of returns: price for current 7d. per unit, one unit consumption of 18-c.p. lamps for one hour; calculating that the average consumer takes three units per day all the year round, and that 500 16 c.p. lamps are connected to main, £2. 9s. per day. So that it can be seen that if 1,000 8-c.p. lamps, or 500 16-c.p. lamps, can be connected to mains, that after interest, etc., depreciation, has been deducted, the scheme will very well pay."

Alloa.—The electric lighting of the burgh was discussed at considerable length at the last meeting of the Burgh Commissioners, and ultimately it was agreed that at the next meeting a small committee be appointed to determine the number of arc and incandescent lamps to be erected, the situation of these and the route of the feeders from the mains, and report accordingly to the engineers. Meantime Mr. Hogarth has been instructed to apply to the Secretary for Scotland to borrow £12,000 for the purposes of the scheme. This action was taken in consequence of a full report by Messrs. Buchan and Hogarth, electricians, Edinburgh, submitting a scheme of public and private lighting, prepared in view of the agreement entered into between the Commissioners and the British Electric Plant Company for the supply by that company of electricity in bulk. The current will be brought from the supply company's works by means of main feeder cables to the sub-station, which is proposed to be located at the burgh chambers, and from which sub-feeders will be led out to different points in the distributing mains. Current will be distributed upon the three-wire system, the declared pressure at the consumers' lamps being 220 volts. It is proposed that the principal streets should be illuminated by means of arc lamps, and about 32 lamps would be necessary for efficient lighting. Each arc lamp pillar would carry two incandescent electric lamps for use, say, after 11 p.m. Two hundred and sixty pounds might be saved by having only 24 arc lamps, with eight special incandescent gas lamps placed in positions where there is a considerable gap between the arc lamps. It has been arranged that the arcs should be run in circuits of eight each, and these could be switched on from the sub-station at the burgh chambers, thereby obviating the necessity of a man going round to each group of lamps. The solid system of cables is advocated. The capital outlay is estimated as follows: private lighting mains and sub-feeders, £2,594; public lighting mains, arc and incandescent lamp pillars, switches, etc., £1,300; roadwork—*i.e.*, excavation and making good of footways, etc.—£894; main feeders from company's works to Corporation sub-station, £2,700; sub-station switchboard and registering meters, main pilot wires, telephones, etc., £370; contingencies, £400; to which should be added: provision for consumers' services and meters, £600; engineering charges, and incidental expenses, £400, making a total of £9,258, and a loan of £10,000 is recommended. The engineers say, assuming that 5,000 lamps are connected, and that the supply company's estimates of maximum demand are realised, the annual cost would be as follows: private lighting maximum demand, say 70 kilowatts at £9, £630; street-lighting maximum demand, say 12 kilowatts at £9, £108; private lighting, say 70,000 units at 1½d., £417; street-lighting, say 31,200 units at 1½d., £195; arc lamp trimmer, £52; carbons, lamp renewals, etc., £20; office and sundry expenses, say £65; capital charges, 5¾ per cent. on, say, £9,000, £510—total, £2,005. They also append estimates showing how the revenue might work out, but consider that in Alloa the maximum demand method of charging would give eventually the best results. Revenue at 8d. and 2½d.: 24 street lamps at £20, £480; 105 kw. × 365 hours = 38,325 units at 8d., £1,277. 10*s.*; balance 70,000, less 38,325 = 31,675 units at 2½d., £330—total, £2 087. 10*s.* Revenue at fixed charge of 5½d.: 24 street lamps at £20, £480; 70,000 units at 5½d., £1,604—total, £2,080. Revenue at 7d. and 3d: 24 street lamps at £20, £480; 38,325 units at 7d., £1,118; 31,675 units at 3d., £396—total, £1,994. The charges for street-lighting are based on the assumption that each arc lamp burns until 11 p.m. all the year round, and the two incandescent lamps on each arc lamp pillar burn from 11 p.m. each night till sunrise all the year round. This would give respectively about 1,820 hours for the arc lamps and 2,500 hours for the incandescent lamps burning per annum. The actual cost of current for each combined arc and incandescent pillar would be about £13, and, adding a sum for carbons, lamp renewals, and proportion of trimmer's time, and also capital charges on outlay, this amount is brought up to about £19, which would be reduced to £18 if the 32 arc lamps scheme were adopted. The engineers also recommend that wherever consumers' mains are extended street-lighting should be adopted simultaneously, with incandescent electric lamps in the less important thoroughfares. The actual cost of current (exclusive of capital charges and lamp renewals) of a 16 c.p. street lamp burning till 11 or 12 p.m. each night, all the year round, would be less than 20*s.*, and burning all night, about 31*s.* per annum.

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON.

Directors: Mark Robinson, Esq., M.I.C.E. (chairman); Sir Gilbert A. Clayton East, Bart. (deputy-chairman); Captain H. Riall Sankey, R.E. (retired), M.I.C.E; Lieut.-General Sir Richard H. Sankey, K.C.B., R.E.; Thomas O. Lazenby, Esq., J.P.

Thirteenth half-yearly report of the directors, to be submitted at the ordinary general meeting of the Company to be held at the Victoria Works, Rugby, on Oct. 3, 1900, at 2.45 p.m.:

After writing off as depreciation from plant, patents, etc., the sum of £5,630. 19*s.* 4d., and paying interest upon debenture stock, the balance to the credit of profit and loss account at the end of the half-year (including £5,212. 1*s.* 1d. brought forward) is £31,399. 8*s.* 11d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares, and 10 per cent. per annum upon the ordinary shares, together amounting to £14,923. 17*s.* 10d. The

Digitized by Google

amount payable to the original directors, in accordance with the articles of association, being £4,218. 8s. 2d., the balance available is £12,257. 2s. 11d. From this the directors propose to carry £2,000 to the debenture redemption fund and £3,500 to the reserve fund, leaving £6,757. 2s. 11d. to be carried forward. The balance of the capital remaining to be issued under the authority of the extraordinary resolution passed on March 29, 1899—viz., 10,000 preference and 10,000 ordinary shares—was allotted to the shareholders in June last. The allotments were taken up as regards 8,788 preference and 9,425 ordinary shares, and the balance was so greatly over-applied for by the shareholders that it could only be allotted in about the proportion of one preference share for every 10 applied for, and of one ordinary share for every 50 applied for. The large engine, capable of working up to 3,000 i.h.p., exhibited by the Company at Paris, in conjunction with a dynamo by Messrs. Siemens Bros. and Co., Limited, has been awarded a grand prix, another similar award being made for the dynamo. The balance upon the share premiums account stood, at the commencement of the half-year, at £29,656 2s. Of this, in accordance with intentions expressed at previous meetings, £5,000 has been applied to a special writing down of the Company's property at Thames Ditton, and £20,000 has been transferred to the reserve fund. The balance, £4,656. 2s., has now been brought up again to £21,493. 2s. by payments under the first instalment of the premiums upon the last issue (1900). As one of the principal objects of both this and the preceding issues of capital was to enable the Company to make engines of large size, the directors are of opinion that the expenses incurred at the Paris Exhibition, which has served to introduce the Company's new work to the public, may fairly be defrayed out of the premiums account. Owing partly to difficulties in obtaining dynamos from the makers, and partly to other causes for which the Company is not responsible, an unusually large value of completed or nearly completed engines (all on order) remained in the accounts at the end of the half-year under the head of "unfinished work." Had it been possible to deliver and invoice these engines in the half-year, a larger amount of profit would have been brought into the accounts.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rent, rates, and taxes	576	1	2
Interest on debenture stock	2,125	0	0
Salaries, including directors' remuneration	6,353	6	5
Contingent salaries to employés	1,386	19	2
Fire insurance	133	18	7
Fire insurance fund	400	0	0
Legal and professional charges	91	8	1
Advertising	496	11	2
Books, stationery, and printing	668	2	5
Postages and telegrams	227	1	7
Travelling, hotel, and general charges	473	2	9
Auditors' fee and expenses	93	19	0
Company's subscription to sick club, doctor's club, and benevolent fund	273	19	0
Allowances to reservists' families and subscriptions to works' war relief fund	219	12	11
Works' volunteer corps	36	10	3
Depreciation of property, plant and machinery, and patents	5,630	19	4
Balance (carried down)	26,187	7	10
	£45,373	19	8

	£	s.	d.
Contingent salaries to directors	4,218	8	2
Balance (available for dividend or reserve)	21,968	19	8
	£26,187	7	10

Cr.	£	s.	d.
Gross profit for the half-year	43,680	18	0
Royalties	400	0	0
Interest on investments, etc.	1,277	0	8
Transfer and registration fees	16	1	0
	£45,373	19	8

	£	s.	d.
Balance profit (half-year), brought down	26,187	7	10
	£26,187	7	10

PROVISIONAL PATENTS, 1900.

SEPTEMBER 17.

16500. **An improved high-voltage electric cut-out.** August Ecketein and Albert Julius David Krause, Peel Works, Adelphi, Salford, Manchester.

16501. **Improvements in arc lamp suspension apparatus, applicable also to other purposes.** August Ecketein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

16507. **Improvements in or connected with the regulation and control of electric motors.** Wilfrid L. Spence and the British Electric Plant Company, Limited, 19, Waterloo-street, Glasgow.

16508. **An electric motor switch gear.** John Lenderyon and Edmund Francis Smart, 34, Clyffard-crescent, Newport, Mon.

16523. **An automatic safety clutch and ceiling rose for electric arc lamps.** Eric Philip Barfield, 8, Grosvenor-gardens, Muswell Hill, London.

16534. **Manufacture of porous metal plates for electric accumulators.** Frederic William Bühne, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London.

16541. **Improvements in electric switching and metering apparatus.** James Grieve Lorrain, Norfolk House, Victoria-embankment, London. (Hector Alan Macdonald, France.)

16543. **Improvements in or relating to telephonic switch-boards and the like.** Koloman Nagy von Szopori, 322, High Holborn, London.

16545. **Improvements in arc lamps.** Charles Frederick Walter Dudding, 46, Lincoln's-inn-fields, London.

16567. **Improvements in or connected with therme-electric batteries or thermopiles.** Wilhelm Buchner, 47, Lincoln's-inn-fields, London.

SEPTEMBER 18.

16590. **Improved ear piece for telephone receivers.** Peter Maclellan and Thomas Rattray Small, 62, St. Vincent-street, Glasgow.

16644. **Improvements in electricity meters.** Sebastian Ziani de Ferranti, 18, Southampton buildings, Chancery-lane, London.

SEPTEMBER 19.

16667. **Improvements in and relating to the working of electric or other tramway or railway points.** William James Stewart, 96, Buchanan street, Glasgow.

16696. **Improved method of treating the animal or human body by electric forces.** Charles M. Johnson, Denmark House, Redhill, Surrey.

16697. **Improvements in systems of electrical distribution.** The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

16698. **Improvements in conduit ploughs for electric railways.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Joseph Hoffmann, United States.) (Complete specification.)

16699. **Improvements in lightning arresters.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Louis Bell, United States.) (Complete specification.)

16700. **Improvements in systems of electrical distribution.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

16701. **Improvements in electrically-operated pumps.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

16702. **Improvements in dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

16703. **Improvements in controlling electric motors.** The British Thomson Houston Company, Limited, 83, Cannon-street, London. (Maxwell W. Day, United States.) (Complete specification.)

16704. **Improvements for adjusting brush holders for electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.) (Complete specification.)

16705. **Improvements in systems of train control for electric railways.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles E. Barry, United States.) (Complete specification.)

16706. **Improvements in means for preventing hunting of dynamo-electric machines.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Harold W. Buck, United States.) (Complete specification.)

16738. **An improved electric energy meter.** Felipe Saldanya, 4, South-street, Finsbury, London.

SEPTEMBER 20.

16777. **Improvements in or connected with electrically-ignited motorcars, cycles, or the like, applicable for other analogous purposes.** Joah Spencer Stafford, 8, Quality-court, Chancery-lane, London.

16798. **Improvements in underground conduits for electric conductors.** Josef Zappe, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16801. **Process and apparatus for the electrolytic decomposition of alkaline salt solutions.** Alberto Julio de Brito e Cunha, 4, South-street, Finsbury, London.

SEPTEMBER 21.

16808. **Improvements in and relating to the method of and apparatus for electrolytically depositing metal.** Reginald James Houghton and Walter Eskrigg Cook, 70, Market-street, Manchester.

Digitized by Google

16845. Improvements relating to electric igniters for explosion motors. Jean Marie Ricard and François Clement Gary, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SEPTEMBER 22.

16865. Improvements in and relating to devices for carrying electric cables, wires, and the like. Daniel Paul Regan, '96, Buchanan-street, Glasgow.

16881. Improvements in wireless telegraphy and telephony. Sidney George Brown, 9, Putney-hill, Putney, London.

16896. Electrical fittings for discharging cisterns. James R. Davidson and John Don, 53, King-street, Peterhead, N.B.

16898. Improvements in apparatus for electrically transmitting orders or signals, such apparatus being suitable for navigable vessels and other purposes where it is required to transmit a series of signals or orders. George Charles Shankster, 11, Church-street, Landport, Portsmouth.

16903. A new or improved device or apparatus for fixing electric lamps in the sockets of overhead electroliers, brackets, and the like, or for detaching them therefrom. William Veasey Biggs, 111, Hatton-garden, London.

16912. Improvements in or relating to covers or lids of telephone cases or the like. Horace Ashmore Jackson, 111, Hatton-garden, London.

16915. Improvements in the production of filaments for incandescent electric lamps. Fritz Dannert, 40, Chancery-lane, London. (Complete specification.)

16916. Improvement in or connected with electromagnets. Jasper Wetter, 37, Essex-street, Strand, London. (The Elektrizitäts-Aktiengesellschaft, vormals Schuckert und Co., Germany.) (Complete specification).

16930. Improvements in means and apparatus used for propelling boats by electricity. William Rowland Edwards, 65, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Oct. 13.

1899.

19810. Construction of wicks for oil lamps which are electrically lighted. Best.

20572. Air and water-tight telegraph transmitter keys for use in mines and other exposed places. Oppenheimer. (Actiengesellschaft Mix und Genest.)

22020. Telegraphy without the use of continuous wires. Thompson. (Braun.)

24297. Electric accumulators. Relin and Rosier.

1900.

6974. System or means for controlling or regulating electrical installations. Thompson. (Coerper.)

12321. Collector or commutator for electrical machines. Kaeferle.

12424. Manufacture of carbon for electrical and other purposes. Lake. (Burke, Kaufhold, and Russell.)

18810. Storage batteries. Rooper.

13972. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Lunt.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Sept. 22	715	527	+ 188	—	—
Birmingham Trams.	,, 22	4 630	4,314	+ 316*c*	165,087	157,112
Blackburn Corp'rat'n	,, 22	499	438	+ 61	17,147	15 030
Blackpool Corporatn.	,, 21	1,358	806	+ 552	23,438	17,649
Blackpool-Fleetwood	,, 22	1,044	833	+ 211	16,895	16,767
Bradford City Trams	,, 23	590	345	+ 245	12,918	10,276
Bristol Tramways Co.	,, 21	3,554	3,402	+ 152	—	—
Carlisle Tr'mw'ys Co	,, 15	214	—	—	2,291*f*	—
Central London Ry.	,, 22	4,891	—	—	37,199*e*	—
City & South London	,, 23	1,519	914	+ 605	18,047	11 221
Cork E. T. and L. Co.	,, 20	477	437	+ 40	15,723	14,453
Dover Tramways ...	,, 22	285	279	+ 6	7,978	7,662
Dublin & Lucan E.R	,, 22	103	92	+ 11	1,401	1,140
Dublin U.T., elec. cars	,, 21	3,637	2,008	+1,629	—	—
Dublin S.D. Electric	,, 21	999	848	+ 151	—	—
Glasgow Corporation	,, 15	9,932	9,590	+ 342	—	—
Halifax Corporation	,, 23	860	584	+ 276	20.276	15,800
Hull Corporat'n E.S.	,, 22	1,306	—	—	31,304*a*	—
Liverpool Corporat'n	,, 15*b*	9,053	7,499	+1,554	286 263	253,267
Liverpool Overhead	,, 23	1,789	1,383	+ 406	20 995*c*	20,136
St. Helens Tramways.	,, 19	—	—	+ 176	—	—
Sheffield Corporation	,, 23	2,630	—	—	—	—
Swansea Tramways.	,, 21	511	291	+ 220	6,201	3,930

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *e* From July 30. *f* From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Arco Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	—	—	10½-10⅝
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5⅝-6¼
—— 5 per cent. Mortgage Debentures	100	—	96-103
British Electric Works, Ordinary, 50,001-95,000	1	—	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅛-¼
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	—	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	105-111
—— 4½ per cent. 2nd Debenture Stock	100	—	101-108
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-13½
—— 5 per cent. Pref.	5	—	5-5½
Crompton and Co.	3	—	3¾-4¼
—— 5 per cent. Debentures	—	—	96-102
Edison and Swan United, Ordinary	3	—	1¾-2¼
—— 5 per cent. Debentures	5	—	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	..	68-72
Electric Construction	2	—	2-2½
—— 7 per cent. Cumulative Pref.	2	—	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-13½
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½-21¼
—— 4 per cent. Debentures	100	—	99-102 xd
Telegraph Construction and Maintenance	12	—	84-88
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5½-5⅝
Willans and Robinson, Ordinary, 1-80,000	5	—	10½-11½
—— 6 per cent. Cum. Pref., 80,001-90,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	9½-10½
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6¼-6¾
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	4½-5¼
Chelsea Electricity Supply	5	—	6¼-7½
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	8¾-9¼
—— 6 per cent. Cumulative Pref.	10	—	12½-13½
—— 5 per cent. Debenture Stock	100	..	124-129
County of London and Brush Provincial, Ordinary	10	—	8¾-9¼
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	—	100-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	—	1¾-2¼
—— 6 per cent. Pref.	5	—	4½-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-102
Metropolitan, Ordinary	10	—	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	—	97-100
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1-1⅛
—— £5 Shares	5	—	7¼-7¾
—— £4½ Shares, New	4½	..	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185 xd
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	—	2-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	3-5
Westminster, Ordinary	5	—	12-13
—— 80,001-100,437	2	—	3½-3¾
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	4¾-5⅛
—— ,, ,, deferred	5	..	4¾-5⅛
City and South London, Consolidated Ordinary	100	..	80-81
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	..	138 143
—— ,, ,, ,, '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	18-18½
Waterloo and City, Ordinary	100	—	92 95
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	14-16
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary	10	—	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	122-126
—— ,, ,, ,, 1900	100	—	122-125
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	4¼-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	3¾-4¼
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9½-10½
New General Traction, Ordinary	5	—	2¼-2¾
—— 6 per cent. Cum. Pref.	5	—	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-19
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
—— 4½ per cent. Debenture Stock	100	—	104-107
Telephones.—			
National Telephone, Ordinary	5	—	4¼-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	98-101
Oriental Telephone and Electric Company	1	—	¾-1

Digitized by Google

NOTES.

The Electro-Harmonic Society.—We have received the list of the committee and members of the Electro-Harmonic Society for the season 1900-1901. This is the fifteenth season of the society, and the monthly concerts will take place at the St. James's Hall Restaurant on Friday evenings, with the exception of that on Dec. 12, which is on a Wednesday. The concerts include four smoking concerts and two ladies' nights.

Santa Cruz Tramways.—We learn from a correspondent that in Santa Cruz, Teneriffe, an overhead trolley system of electric traction is being erected, and is shortly to be opened. The company which owns the line is a Belgian one, and it is stated that the King of the Belgians is a large shareholder in it. He has, we gather, visited the island recently in his yacht "Alberta," but whether to visit the tramway works or merely for pleasure we are unable to state.

Telephones in Hungary.—There is, we learn, about to be constructed at Budapest, at the expense of the Royal Treasury of Hungary, a central telephone station. This it is proposed to erect with a capacity of 10,000 subscribers at first, and capable of being extended to carry 20,000 subscribers. It is interesting to note that in the tenders which are now being invited for the work in this station all nationalities can tender, and we should think that some English manufacturers might well take advantage of the fact.

Electricity in Factories.—A new application of electricity as a motive power for workshop purposes is being planned at Sharpsburg, Philadelphia. The installation is being fitted in a tube mill, in which tubing from 9in. to 24in. is to be made. The rolls in the mill are to be equipped with independent electric motors driven by powerful dynamos, these being contained in a roomy power-house, which has already been erected. This mill, when finished, will form one of the largest tubemaking mills in America, and will be the only one at present existing which is run entirely by electricity.

Coast Lighting.—The new light which has recently been placed in the new lighthouse at Pendeen, on the north-west coast of Cornwall, was tried for the first time last week. The coast at this point has been the scene of numerous wrecks, and the light and the siren fog signal will be welcomed by navigators. The light gives four flashes in 15 seconds, and has an intensity of 57,000 c.p. Another new light was also inaugurated last Friday, this being in a bad portion of the Bristol Channel, and it forms part of a scheme for the better lighting of that portion of the coast. The light is similar to that in the Pendeen Lighthouse, and has the same intensity.

The Armour Technical College.—We have received a copy of the prospectus for the coming session of the Armour Institute of Technology, Chicago. The volume is similar to those issued by our own technical schools, and the subjects taken are practically the same. There are conducted in the college five courses of instruction—viz., mechanical engineering, electrical engineering, civil engineering, architecture, and the course in science. These include, broadly, the many technical and commercial subjects taken in our own institutions. The Armour Institute, of which an illustration is given, was founded in 1892 at Chicago by Mr. Philip D'Armour, of that city.

Electric Railways for Heavy Traffic. — The German Society of Mechanical Engineers is, we learn, offering a premium of £60 and a gold medal for the design of the best system of high-speed electric railways for heavy traffic. The conditions are for plans for a railway to connect two distant cities, upon which trains having a minimum seating capacity of 150 passengers may be operated at not less than 124 miles per hour. The contest closes Oct. 6 next, but we shall be surprised if any workable scheme will be sent in. Inventors who might possibly make a design which would work as required, would hardly be tempted to prepare plans for the sake of £60 and a medal.

A Hasty Spaniard. — That business gentlemen in England should, on using a telephone and finding they have been put on to the wrong number or switched off suddenly in the middle of a conversation, protest in a very vigorous fashion, is now a standard joke, but the anger exhibited does not usually go farther than words. The hasty temper of the Spanish race is proverbial, but one would not think that any man, however angry, would do deadly injury to the telephone instrument. This, however, is what occurred recently in Paris, when a Spaniard, who had been switched through by telephone from his hotel in Paris to a stranger instead of a friend, lost his temper and fired four shots into the instrument, entirely wrecking it. Naturally, he had to pay heavily for the repairs, and also to leave the hotel.

The London and Brussels Telephone. — The scheme which has several times been mooted for connecting Brussels and London by telephone seems at last to be on a fair way to becoming a fact. Thus it is stated that two proposals have been under consideration, one of which would involve the laying of a new cable across the North Sea. The other scheme proposes to use the Anglo-French line as far as the French coast, and from that point to use land lines to Brussels. This latter scheme seems to be the more practicable, and is said to be the one which will most likely be adopted. Either scheme would be costly, but the advantage to commercial men in both cities should quite justify the expense. The line is expected to be opened early next year, when the cost for a three-minute conversation is to be 2s. 6d., which would not be very dear, the present price for communication with Paris being 8s. for three minutes.

The Institution of Civil Engineers.—The council have, we learn, in addition to the medals and prizes given for communications discussed at the meetings of the institution in the past session, made the following awards in respect of other papers dealt with in 1899-1900: A George Stephenson medal and a Telford premium to Mr. L. F. Vernon Harcourt; Telford premiums to Mr. H. J. S. Heather, Mr. Walter Rosenhain, Mr. James Glover, Mr. A. B. Brady, Mr. R. C. Farrell, Mr. C. F. V. Jackson, and Mr. G. B. Walker. For students' papers, the James Forrest medal and a Miller prize have been awarded to Mr. C. B. Fox the James Prescott Joule medal and a Miller prize to Mr. J. W. Smith, and Miller prizes to Mr. B. Humphrey, Mr. H. E. O'Brien, Mr. H. E. Wimperis, and Mr. A. H. Morton. The council have nominated Mr. R. F. Whitehead to the Palmer scholarship at the University of Cambridge in succession to Mr. A. H. Kirby, who graduated last June.

Sweden.—What is probably the largest transmission plant in Sweden was recently inaugurated between Zoarnsweden and Domnarfoed. It has been put down for the Stora Kopparbergs Bergslag Company, and consists of four generators, each of 1,200 h.p., which transmit untransformed electrical energy at a pressure of 7,000 volts through 12 cables, partly to the Domnarfoed Ironworks, situated at a distance of 2¾ miles from the generating

Digitized by Google

station, and partly to paper works belonging to the same company. At both centres of consumption the high-pressure current is transformed down to 520 volts by means of nine transformers of 350 kw. capacity each. The transmission lines are run overhead, about 20½ tons of copper having been used for their construction. The generators are driven by water power, about 10,000 h.p. of the 18,000 h.p. at hand being available for electrical transmission, so that there remains still about 5,000 h.p. available for future extension.

Electric Canal Haulage.—An installation of electric traction has been made by the Société de Traction Electrique sur Voies Navigables along a distance of about 47 miles, from Béthune to L'Escaut. The boats to be drawn carry from 270 to 300 tons, and draw about 5ft. of water. The piece of canal fitted has six locks. The cost of steam traction or animal haulage is ·427d. per kilometric ton; for electrical haulage this is reduced to ·285d. The actual length of canal fitted for electricity is about 16 miles, and this is effected by two stations about 6¾ miles distant from each other and having installed a total power of 400 h.p. Continuous current at 500 volts is produced by eight generators. Overhead wires are hung on posts about 44 yards distant from each other at a height of 21½ft. above the towpath. The tractive apparatus consists of about 30 electrical haulers, each weighing two tons and mounted upon four wheels, of which only two are driven. The length of the haulers is about 14ft., the breadth being about 4½ft. The electric hauler can easily draw two 300-ton barges at a speed of nearly two miles per hour.

Loofah Storage Batteries.—We notice in the *Electrical World* that Mr. W. Bowker, sen., of Waltham, Mass., has taken out a patent for a method of cheapening and simplifying the production of secondary battery plates by utilising a natural vegetable fibrous network, such as loofah or luffa, as the binding medium for the lead oxide or active material, into which the active material or lead oxide is placed in the form of a paste. The network is thoroughly filled with this paste, after which the battery cell or plates are formed through a long and continuous charging of electricity, say, for 100 hours, more or less, or until the paste and network form a solid mass. After this the plates are in a condition to store electricity. The advantages claimed are as follows: The plates are light in weight and may be manufactured cheaply. The liquid acid can percolate through them quicker and more freely than in the ordinary way. It is found by actual test that the loofah resists the action of the acids used in secondary or storage batteries. The question of conductivity is conveniently ignored by the author when stating the advantages of his construction.

The Conductivity of Telegraph Cables.—There has been some question as to the reason why certain cables lose their conducting properties, and have, in some instances, to be replaced. Mr. Rheims has been endeavouring to find out the reason for this, and in consequence has submitted a paper on the subject to the Academie des Sciences. In this paper he states that when cables lose their electrical properties it is because they are always used for one kind of current only, either positive or negative. If used sometimes for positive and sometimes for negative, they will, he states, preserve their conductive qualities indefinitely. He illustrates this by an observation on an underground line between Paris and Dijon, the line having nine wires. Of these, wire No. 7 received alternately positive and negative currents. This line kept its conducting properties, while the eight other wires, which were used with Morse and Hughes instruments and only received positive currents, had all lost more or less of their conductivity. The remedy for this loss was stated to be obvious—namely, that all currents sent in one direction should be positive, those in the contrary direction being negative, thus destroying the action of the first current by that of the second.

A Heated Insulator.—Mr. A. Sinding Larsen, of Frederiksvaern, Norway, has protected a new form of high-voltage insulator designed with the object of getting over the condensation trouble. It is known that when very high voltages are used on overhead lines, it is not always possible to prevent a considerable amount of leakage which is due to the condensation of moisture on the surface of the porcelain or glass insulators. Mr. Larsen proposes to prevent this condensation by maintaining one portion of the insulator at a higher temperature than the air. This increase of temperature need be exceedingly small, and the author states that 1deg. C. is quite sufficient to prevent the moisture in the air condensing on one part of the insulator, as it will always choose the colder portion on which to be deposited. In order to obtain the heat at one portion of the insulator, a resistance coil is inserted into a cylindrical recess which is formed in the porcelain. This resistance wire can either be supplied with a current by means of an independent circuit, or when the main current passing along the high-voltage conductors is alternating, the heating current can be obtained by a small local circuit energised by induction. Of course, the energy required is quite small, so that it hardly enters into consideration when a large amount of power is being transmitted.

Proposed Pyrenees Railway.—Various schemes have been projected from time to time for bridging the Pyrenees by means of a railway, but hitherto without definite result, the consent of the authorities concerned not being forthcoming. However, we understand the well-known engineer, M. L. Rouvière, has taken up the attack. A scheme has been prepared by him which, it is understood, will probably find favour with the French Minister for Public Works. The route of the proposed railway is between Lerida on the Spanish side and the valley of Aran on the French side. Besides being the shortest, this route presents the least engineering difficulties. A tunnel 4,180 yards in length, with a station at either end, is included in the scheme. The necessary electrical energy for working the French section of the line could be obtained by utilising a series of waterfalls in the upper reaches of the Garonne, while the rapids of the Noguera-Ribagazzana would furnish the requisite power on the Spanish side. In order to improve the prospects of the undertaking, provision would be made for supplying the surplus energy from these sources to chemical or other works in the surroundings. It is reported that a German firm have declared themselves prepared to examine into the scheme, with a view to giving it effect should the necessary sanction be forthcoming.

Australian Tramways.—The use of electric tramways seems to be spreading to a very large extent in the various divisions of Australia. Thus, on July 11 the Electric Tramways Bill was read a second time in the South Australian Parliament. In this Bill it was proposed to altogether abolish the antiquated system of horse traction and substitute the modern system of electricity. The powers were asked by the Westinghouse and Callender Companies, who had obtained the right to purchase 60 out of the 70 miles of tramways in Adelaide and its suburbs. The cost of purchase is estimated at £400,000, and the expenditure to be incurred also £400,000. This latter, however, did not include the conversion of the whole of the lines. At Sydney also

Digitized by Google

the trams are being gradually converted from steam and horse traction to electricity, and a car-shed is being built which is to have a capacity for 120 electrical cars. Though not actually part of Australia, New Zealand is usually included in the Australasian Colonies, and it is interesting to note that in this large country also electricity is displacing other methods of traction for tramways. The Harbour Board engineer of Wellington has, we learn, been sent to America to decide as to the best system of electrical traction to be adopted on the Wellington tramways. The Auckland electrical tramways scheme is also shortly to be put in hand, and a very extensive system is contemplated.

The London United Tramways.—The conversion of the extensive system of tramlines owned by the London United Tramway Company to electric traction is practically completed, and the generating works are also in such a state that the tramways could be run almost immediately. The whole matter, however, is hung up because the report of the commission appointed by the Board of Trade to consider the protective clauses which should be enjoined on the company for the benefit of the Kew Royal Observatory has not yet issued its report. This committee was appointed in November last, and carried out, we believe, some very extensive experiments in the early part of the year. The composition of the committee, to which we referred at the time, was all that could be desired, in that it comprised the extremists of either side, ranging from Prof. Ayrton, who was inclined to accept nothing but an insulated return, to Mr. Parshall, who believes in insulating the Royal observatories by transporting them to uninhabited regions. We regret, therefore, that this collection of gentlemen, who have the matter at their fingers' ends, have not been able to come to a prompt decision as to the case before them. In the meanwhile the tramway company has not cared to suspend work altogether, and has equipped the overhead line on the single trolley wire system, while the rails have been bonded for an earth return. We trust that when the tardy decision of the committee is at length given, no extensive alterations will be required in the work already done.

The War Fund.—The gas and electric lighting department of Leicester have, during the past 11 months, endeavoured to prove their loyalty to their country. In the first instance, many of the employés in this department were called out as reservists, and again, some of the electric lighting department joined the service contingent of the Electrical Engineers Volunteers which is now with Colonel Crompton in the Transvaal. They have also shown their patriotism in another way, and since December last the employés have contributed amounts according to their station, and in the 42 weeks up to Sept. 21 last the large sum of £322. 4s. 6d. has been raised in the department for the "Soldiers' Fund." The object of the fund was to help support the wives and children of the local men who were called to the front, and £205 was, for this purpose, contributed to the Leicestershire Army Reservists' Fund. The sum of 15 guineas has, however, been expended in other things—viz., the Leicester Regiment "Shirt' Fund, the Ambulance Equipment Fund, and the Yeomanry Hospital Fund. The war being now practically at an end, the committee have now decided to close the fund, leaving £101. 9s. 6d., which is to be voted on the conclusion of peace or the return of the troops. The engineer, Mr. Alfred Colson, who is also president of the fund, in the financial statement which we have before us expresses his personal gratification at the large sum raised, and thanks the men who contributed to the realisation of this good result.

A New Automatic Cut-Out.—An article contributed by Mr. Hermann Müller to the *Elektrotechnische Zeitschrift* calls attention to the fact that in the ordinary type of maximum current cut-out, the hand lever is so interconnected with the circuit-making spring that the closing of the hand lever simultaneously effects the closing of the main circuit, the latter remaining closed so long as the lever handle is held in the closed position by electromagnetic influence or otherwise. But this feature might be attended with undesirable consequences should the excess current, which in the first place caused the automatic opening of the circuit, be still extant at the moment of switching in. In order to remedy this defect, resort is had in practice to the provision of a supplementary hand switch, which must always be closed after the automatic cut-out has been readjusted. The arrangement, however, entails increased vigilance on the part of the attendant. The article in question then goes on to describe a form of automatic cut-out recently introduced by Messrs. Schuckert and Co, of Nürnberg, whereby the above-mentioned defect is remedied in a seemingly simple manner. In this cut-out, between the lever handle and the movable parts of the switch which close the circuit, is placed a spring detent, which is released automatically by the influence of the line current so soon as the current flowing through the switch reaches the prescribed maximum. Thereby the circuit-closing portions of the switch are also released, and assume the "off" position either in virtue of their own gravity or with the aid of a spring. The article describes the construction of the switch in detail, the text being supplemented by several diagrams and photographic reproductions. It will be remembered that Mr. L. Andrews, of Hastings, has designed a non-return and maximum cut-out which has the same properties.

Telephones in the Philippines.—There is, we notice, in the *Western Electrician* an interesting account from its special correspondent in the Philippines of the difficulties met with in building telephone lines in the Philippine Islands. There is, we learn, a telephone service in Manila, but this was erected by the Spaniards, and is so inefficient that it merely serves to show the necessity for a better service. The system has, however, improved considerably since the American occupation, and some benefit is now to be derived from the line. The reason given for the bad state of the Manila telephone service is that the Spaniards have used such frail poles, and have generally secured the wires in a very insecure fashion. The American system is, however, about to be adopted in consequence of the great demand, and a good up-to-date service is to be installed. In the southern islands the state of things is much worse, the inhabitants never having seen telephones, except perhaps such ones as have been fitted by the American Army Signal Corps. In many places the natives are afraid of the lines, and are, in consequence, not very likely to damage them. Anything loose is, however, a special mark for the Filipino, and while in one instance the poles and wires were left alone, everything loose, such as a box of insulators, nails, screws, coils of wire, etc., was taken. The poles and fittings once in position are usually safe from the average native, the danger of destruction being from the insurgent Filipinos. The penalty the native has to expect for tampering with the wires is to be shot on sight by the line guards, and this prevents much damage. Occasional shocks, also, from the wires tend to make the natives fear the lines, and the insurgents also has this fear to some extent. This was shown by the fact that, when wishing to destroy some line, they chopped down the posts for about half a mile, but did not dare to touch the wire, which still worked without interruption.

Digitized by Google

Becquerel Rays.—The subject of Becquerel rays has been much discussed recently, and Mr. Oscar M. Stewart has thought fit to bring up to date, in the *Physical Review*, a *résumé* of the matter given in that journal some two years ago. In the present *résumé* he speaks of the substances, in addition to uranium, which have been found to emit these radiations. He goes on to deal with the fluorescence and phosphorescence of these rays, their relation to the conductivity of gases, the absorption of the rays, their chemical effects, their secondary or induced activity, the thorium radiations, and the magnetic and electrostatic effects of the rays. The *résumé* is too long to describe with more detail, but the theories given concerning the origin of the Becquerel radiation are of great interest. Thus the author states that many theories have been suggested concerning them. Madame Curie first suggested that the energy may be due to a very penetrating radiation hitherto unknown, which could excite fluorescence in some substances. Sir William Crookes suggested to the British Association in 1898 that in some way the energy might be obtained from the rapidly-moving air particles. Messrs. Elster and Geitel took a salt of uranium into a deep mine, where it was protected by 2,785ft. of earth from external radiations, and the salt was still active. When kept in a high vacuum the radiations were still emitted, the energy thus not being due to a mechanical or chemical action of the air. The impact of X-rays or cathode rays was also found to produce no change in the radiation. Messrs. Elster and Geitel suggested that the energy may come from an unstable molecule gradually passing over into a stable state, this idea being also supported by Behrendsen. Until the discovery of the magnetic deflection of Becquerel rays, it was thought that they were X-rays of feeble intensity. As the rays belonging to the deflectable group carry negative charges, they probably consist of small particles of matter, as matter and electrical charges are, as far as is known, inseparable. According to the theory used to explain the Zeeman effect, each molecule has revolving round it at a high speed one or more small satellites negatively charged. Measurements based on this theory have shown that the ratio of charge to the mass of a satellite is of the same order of magnitude as that obtained for the cathode ray particle or for the deflectable Becquerel rays. In the molecular groupings of the radio-active elements they may, the author thinks, be conditions of instability such that some of these satellites could be lost from their molecules, and moving off at high speed become the deflectable Becquerel rays. The theory that Becquerel rays consist of extremely short ultra-violet rays is now almost abandoned, and it is believed that they, like the cathode rays, are negatively-charged particles of matter moving at extremely high velocity. Prof. J. J. Thomson has shown that the ratio of charge to mass for the negatively-charged particles in gases at low pressures is a constant, and if this is true, it is the velocity which varies. The difference in penetration is then explained by a greater velocity for the Becquerel ray particle—the greater the velocity the higher being the value in the cathode rays.

The Production of High Temperatures.—The paper read by Mr. E. D. Lange before the Paris meeting of the Iron and Steel Institute is of great interest to all engineers, although its particular applications deal with metallurgical operations. The author does not refer in this instance to the electrical furnace as a means for producing extremely high temperatures, but to the system invented by Dr. Hans Goldschmidt. This system, which is being experimented with largely at Essen, is not altogether new, and is based upon the heat of combination given off when aluminium is ignited in contact with certain metallic oxides. The author in his paper refers to the work which had been done previously on the same lines, particularly mentioning the work of Mr. R. A. Hadfield, who in 1895 succeeded in producing extremely pure iron by reducing ferrous oxide with aluminium. Dr. Goldschmidt's experiments were made with the object of discovering a mode of controlling the violent reaction obtained by the heating of aluminium in contact with metallic oxides, and these brought to light the important fact that it was not necessary to heat the whole mass up to the requisite temperature for ignition, but that it sufficed to start ignition at any one time. When combustion once started the reaction proceeded steadily with more or less speed throughout the whole mass, thus generating within itself the whole of the heat required. In the case of the refractory oxides, it would have been a difficult matter to apply the requisite heat for ignition at any point had not Dr. Goldschmidt made the still more important discovery that, although certain oxides combined with aluminium at so low a temperature that they could be ignited with an ordinary match, yet they nevertheless, in their combustion, developed so much heat that if a small quantity of these oxides was placed upon a mixture of refractory oxide and aluminium and ignited, a reaction was started in the same, which, thus originated, then proceeded automatically as before. The heat developed by the combustion of a mixture of alumina and iron is sufficient to start the reaction between the aluminium and iron oxide mixture, and as this proceeds, more and more of the same is added until within a minute or two there is a crucible containing reduced iron covered by a thick coating of alumina slag. On pouring off the slag, the temperature of the underlying liquid iron can be tried by pouring it on to a mild-steel plate or along the side of a mild-steel bar, when the hot iron cuts its way through with ease. Pyrometer experiments have established the temperature reached in the operation at between 2,900deg. C. and 3,000deg. C., that is to say, 1,000deg. C. more than that reached during the hottest period of the Bessemer blow. In the case of the reduction of chrome from its oxide by this method, the temperature of 3,000deg. C. is certainly reached—a temperature hitherto obtainable by the electric arc alone. In the paper a system of welding together iron bars or rails was also described, in which the heat for the weld was obtained from the combustion of aluminium and iron oxide. It is estimated by Dr. Goldschmidt that it is commercially economical to connect in this way the rails of a tramway system, and he maintains that the cost of upkeep will be considerably less with joints made in this way. It would, of course, considerably increase the conductivity at the joints, and perhaps do away with the bonding which is now absolutely necessary.

Accumulator Traction.—In a contribution to the *Centralblatt für Accumulatoren und Elementenkunde*, Mr. Johannes Zacharias takes exception to certain statements which have appeared in the daily Press with regard to the abandonment of accumulator cars on the Berlin tramways. He admits the high initial outlay and subsequent cost of working entailed by accumulator traction, and, further, that the system requires greater skill and technical knowledge on the part of the staff than the former service of horse cars, while the considerable dead weight represented by the accumulators is also undisputed. But these, he points out, are facts, which it requires no experiments to prove. The cost of a battery, its weight, etc., were fully known long before the introduction of the mixed system of working in Berlin. It was known exactly how heavy the battery would be, how often it would have to be recharged, and also that the battery would be capable of

Digitized by Google

accomplishing from 25,000 to 27,000 car miles before it became necessary to renew the bulk of the positive plates, while the negative plates might have to be renewed earlier. The difficulties presented to the efficient working of the system in winter are next dealt with, the inevitable loss of energy through the slipping of the driving wheels on ice-covered rails, and the increased consumption of energy entailed by more frequent stoppages, tending to untimely exhaustion of the battery, being pointed out. The latter faults, however, would not be serious in effect were it not for an apparent defect in the calculations for the overhead trolley system with which the accumulator cars work in conjunction, whereby in the event of a number of trolley cars coming to a standstill within a short distance of each other and then starting up together, there is so considerable a drop in the line voltage as to render liable a discharge from the accumulators into the line, whereby the battery is discharged instead of being charged. It is stated that drops of as much as 100 volts in the line pressure have been frequently observed, so that it was naturally impossible when these drops occurred to charge the accumulators during the journey of the car, and as no serviceable instruments have been provided whereby the current and voltage might be observed, the conductor consequently has not known whether the battery was being charged or discharged, and it has happened that a battery instead of receiving a charge has discharged itself, acting meanwhile in the capacity of a buffer battery. Considerable variations in the line voltage have occurred, especially over the suburban stretches of the trolley-equipped track, and at outlying depôts, so that even after the return of the cars in the night it has been impossible to charge the accumulators. These facts do not prove the uselessness of accumulators for traction purposes, but rather the difficulties attending the correct initial calculation and apportionment of such an extensive system of conductors and feeders. The defects of the system have been lessened by adding new feeders at suitable points, but not entirely removed. In the author's opinion, a complete remedy will not be effected until buffer batteries have been provided at the extremities of the system, especially as considerable excess voltage has also been observed, varying up to 600 volts from the normal line pressure of 500 volts. As a practical proof of the adaptability of accumulators for traction work, even over extensive systems of lines, the author instances the Hanover tramways, in which case, however, the problem has been tackled in quite another manner. Not only has Hanover adopted the accumulator system of traction with intelligence and care, but has also proceeded so far as to establish an accumulator factory of its own, where it manufactures its own plates. Mr. Zacharias's exposition of his case certainly tends to show that accumulator traction in conjunction with the overhead trolley system of working has not been accorded a fair trial in Berlin, and that the failure of the accumulator service of cars may have been due rather to temporary defects in the allied system than to inherent faults of its own. However, it is impossible to come to a definite conclusion in the absence of all the facts.

Electric Light Provisional Orders.—The report of the Board of Trade respecting the applications made to them for the past year has just been published. The report is dated June 22, and only contains information up till then. In it particulars are given as to how the Board of Trade has treated the various applications, and this will be found in full elsewhere in this issue. It must be remembered, however, that after the Board of Trade has given its decision in any particular case that decision has to be confirmed by Parliament. As an example of this, we may quote the Marylebone order, which was recommended by the Board of Trade to be granted to the company known as the Marylebone Electric Supply Company, Limited. This order was not confirmed by Parliament. Interest centres round the reasons given in the report for the granting or refusal of certain provisional orders. It will be noted that where the local authority applies for an order, the Board of Trade has in every case granted the necessary powers to enable them to supply electric lighting. When, however, the application is made by a company, the result is by no means certain. Thus, amongst the applications made last year by companies, no less than nine provisional orders have either been refused altogether or have had their area of supply considerably restricted because the company has not been able to obtain the consent of the local authority interested, or to prove to the Board of Trade that there are reasons why this consent should be dispensed with. We are pleased to note, however, that in four of the cases this consent of the local authority was done without. Amongst these four was the Marylebone order, which was not confirmed by Parliament. Still, by its decision in this case and the other three instances, the Board of Trade clearly shows that it will not allow a local authority to obstruct the introduction of electric lighting into their district unless there is a reasonable ground for the obstruction. The most reasonable ground in these cases is the fact that the local authority themselves will undertake the work, and that they propose to obtain a provisional order. This was so in the case of Hebburn, which objected to be supplied by the County of Durham Electric Power Distribution Company. In one other case, where both a company and a local authority applied at the same time, the local authority naturally obtained the desired powers. Another reason for refusing the order was that given in the case of Southwold, where the order was not granted on the ground that the promoters failed to prove that they were financially capable of carrying out the work. This is a very reasonable ground for refusal, as the Board of Trade rightly condemns all trafficking in electric lighting orders. In one case the order failed because the promoters did not prove their compliance with the Electric Lighting Acts and also the rules of the Board of Trade. The Board of Trade also refused to grant an order to cover areas which were not contiguous. Thus in one case, where a company applied for the burghs of Bridge of Allan and Dunblane, because the consent of the local authority over an intermediate piece of land could not be obtained, the order was granted only for Dunblane burgh. The same thing occurred in one other order. This seems to us to be somewhat unreasonable, as of late there has frequently been permission given to owners of provisional orders to erect their works outside their area, and to lead their mains from the stations through a district which is not served. If this is so, we fail to see why absolute continuity in areas should be a *sine quâ non* in provisional orders if the two districts which are to be served are not widely separated, and are suitable for a joint supply. The session's work results in 59 orders having been issued to local authorities and 39 orders to companies, out of a total number of 108 applications, 10 being refused. These figures show that there is good prospect for electrical manufacturers obtaining contracts for electric lighting plant in the near future. Amongst the other interesting items in the report is a tabular list of all the orders which have ever been granted, with notes as to whether they have been revoked or repealed. We gather from these lists that two Irish orders—the Kilkenny and Waterford—were revoked in August last, because the Corporations of those towns had not proceeded to carry out the same.

Digitized by Google

THE ELECTRIC LIGHTING OF THE CITY OF GLASGOW.

St. Andrew's Cross Station.

In addition to the Port Dundas station already described, the electrical necessities of Glasgow are met by the Waterloo-street station and by the Kelvinside station; the latter was acquired by the municipality from the Kelvinside Electricity Supply Company about a year ago. All these stations are situated on the north side of the River Clyde, and until recently no attempt was made to provide a supply of electricity on the south side, which contains, in addition to a fairly large business area, several important residential districts. To serve these, the St. Andrew's Cross station was planned, and although officially opened on the same day as the Port Dundas station, it is as yet in an unfinished state. At the time of our visit some machinery had been installed, and the officials hoped to be able to supply current in about six weeks.

The buildings, an elevation of which we give in Fig. 14, are of terra-cotta brick, and, unlike the Port Dundas station, have all been erected at once to save any delay when extensions are decided upon. As the buildings stand, accommodation is provided for some 15,000 h.p. It is interesting to note in this connection that 1 h.p. is got for every 3·4 square feet occupied by the engine and boiler house, while at Port Dundas station, which has a capacity of more than double that of the station now under consideration, a horse-power is obtained for every 2·85 square feet of ground covered by engine and boiler houses, showing the economy of large stations where ground is costly. In some provincial towns we have observed that the space occupied by small works gives about 1 h.p. for every five to seven square feet of engine and boiler space.

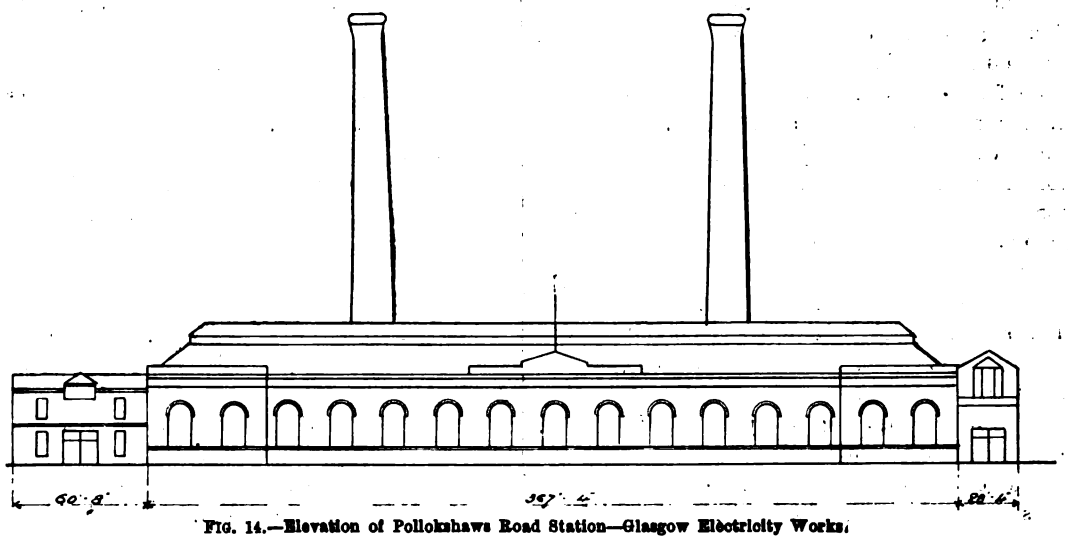


FIG. 14.—Elevation of Pollokshaws Road Station—Glasgow Electricity Works.

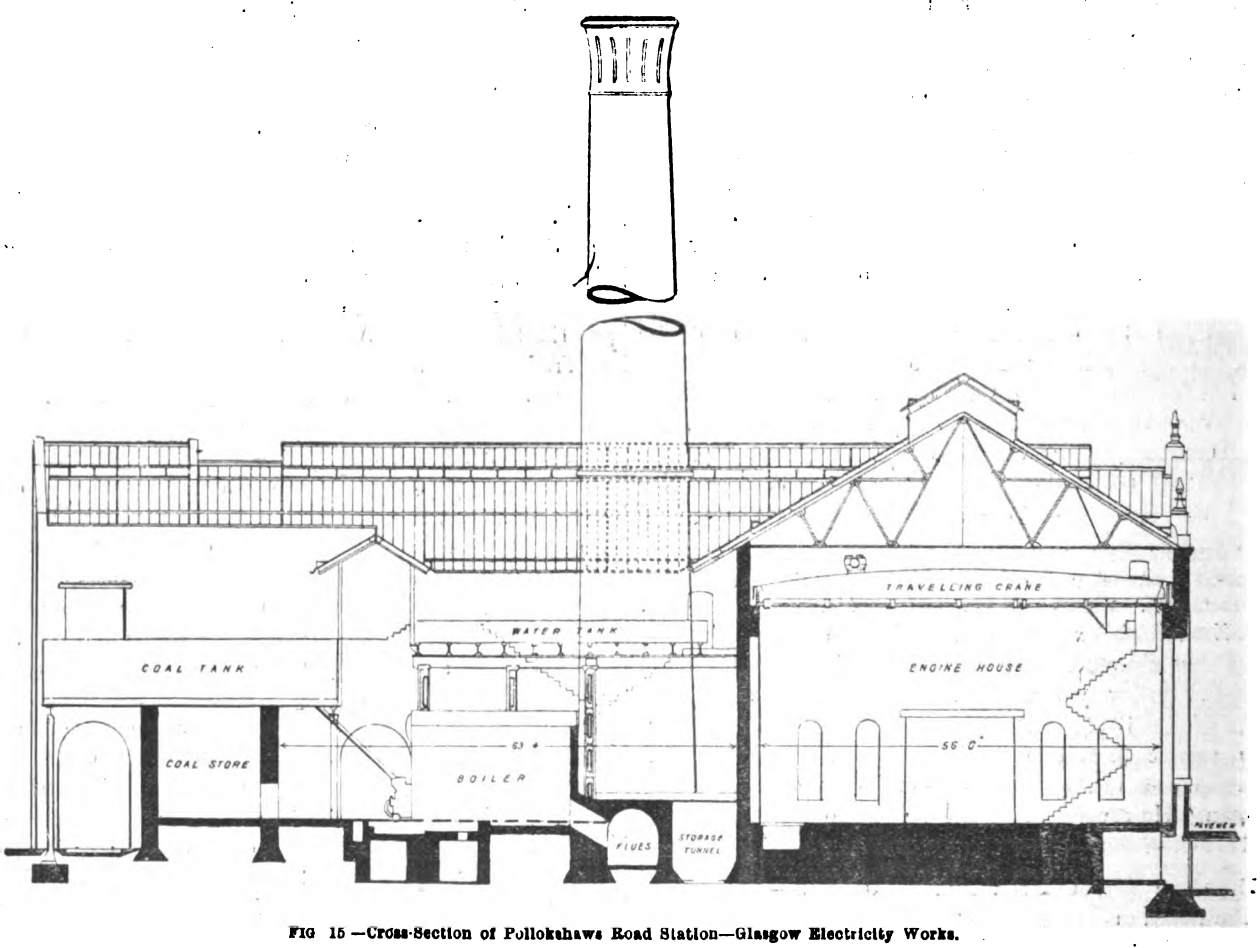


FIG 15.—Cross-Section of Pollokshaws Road Station—Glasgow Electricity Works.

Unlike the Port Dundas station, the St. Andrew's Cross station is situated alongside a railway siding instead of a canal, and this fact has necessitated a different method of handling the fuel when it arrives at the works. From the section (Fig. 15), it will be seen that the coal is stored in a large tank over the coal store. Running parallel to the coal store for the entire length of the boiler-room is a

Digitized by Google

tunnel, seen on the extreme left; the railway wagons are shunted into that siding, an entire train at a time, and at the distant end each wagon, which holds from seven to ten tons, is raised by an elevator to the platform seen on the top of the coal-tank, where its contents are tipped into the tank at any convenient point; it is then run along rails to the other end of the boiler-house, where it is lowered on to the siding. By this means the coal is handled with scarcely any labour, and with greater speed than is possible by any other method. As at Port Dundas station, the portion marked coal store is used to hold a reserve of fuel. At the time of our visit the two elevators which are to raise and lower the wagons were being erected. They will be operated by electric motors. Coal is conveyed from the coal-tank direct to the boiler furnaces by chutes, seen in the section (Fig. 15), and practically similar to that shown in the photograph (Fig. 5, p. 413). The boilers are in all respects duplicates of those already described at Port Dundas. The same may be applied to the steam-piping.

The engine-room differs only slightly. There are at present two 400 h.p. Bellis and Morcom engines. They are three-crank compound, of the type now well known to our readers. These are coupled to Crompton bipolar dynamos, and the combination runs at 375 revolutions per minute. Also one Alley and MacLellan tandem compound single-acting engine of 200 h.p., coupled to one of Messrs. Mavor and Coulson's dynamos; the latter has six poles. This set also runs at 375 revolutions per minute. Preparations are being made to receive another unit, a duplicate of the above, while in course of erection is a Willans three-crank triple-expansion engine of 1,500 h.p. coupled to a Crompton 12-pole dynamo, a duplicate of the set already erected at Port Dundas. At the close of the Glasgow Exhibition next autumn two more 1,500-h.p. units will be installed. These will consist of Willans engines, one coupled to a Crompton dynamo, and one to a British Schuckert Company's machine. These two units are first to be exhibited in the machinery section of the coming exhibition, and will supply a portion of the electrical energy required by the exhibitors. The engine-room is spanned by a 25-ton overhead electric crane made by Messrs. Broadbent and Sons, Huddersfield. It is worked by a single motor, and all the motions are operated by leather belting running on fast and loose pulleys. On the extreme left of Fig. 14 will be seen the offices and staff rooms, beyond which are a smiths' and a joiners' shop, enabling all repairs to be carried out on the premises. The switches and switch gear are practically a duplicate of the Port Dundas apparatus, and no further description is necessary.

THE TENDENCY OF MODERN DYNAMO DESIGN.

BY WILLIAM CRAMP.

Just as the modern cycle frame has, from a variety of forms almost innumerable, come down to the now practically universal "diamond," so in the Paris Exhibition of this year there are distinct signs among the Continental makers of the weeding out and casting aside of certain well-known forms of dynamo, and almost universal adoption of a certain shape of frame for a certain output. It is not altogether a matter for congratulation to the English draughtsman that some of the forms apparently considered as "weeds" by the foreign makers are essentially English, and are still being produced largely by English firms. Of course, it is only fair to admit that the number of English exhibits is very small, and hence there is no possibility of comparison between the *actual working* of the English machine and its foreign rival; still, in the matter of form, and, to some extent, of actual over-all dimensions and total weight, the signs of standardisation are very apparent. The analogy to the development of the cycle frame holds good in the matter of weight, for in dynamo construction abroad it is now an all-important feature to reduce the weight of the frame as far as possible, since the cost of carriage is thereby so much lessened. Hence, by the best makers, cast steel is almost universally used for the frames of all machines above about 5 kw., and in many cases cast steel is used for all sizes. The close agreement in over-all dimensions of machines by various makers is in some cases very marked. The following table, in which are given approximate dimensions of four machines of similar type, and nearly the same output and speed, by four different makers, and which were chosen quite at random, serve to show the general agreement in dimensions. The type of machine was similar to Fig. 1, but the height and width are taken over the slide rails.

Machine.	A	B	C	D
Output	15 kw.	15 kw.	14 kw.	14 kw.
Length	4ft. 0in.	3ft. 0in.	4ft. 6in.	3ft. 9in.
Width	2ft. 6in.	2ft. 9in.	2ft. 7½in.	2ft. 5½in.
Height	2ft. 10in.	3ft. 3in.	3ft. 1in.	2ft. 10in.

The only great discrepancy is in the length of the machines. This may be accounted for in many ways. For instance, the position of the pulley on the shaft—*i.e.*, whether it overhangs the bearing or not—the length of the bearings and commutator, the arrangement of end connections, and clearance allowed between them and the oil catcher. Taking into consideration the difference in output, the width and height agree closely, and the weights are all about 1,900lb.

The similarity in dimensions will be found to be quite as clear in machines of larger output. For instance, in 50-kw. machines of the "Schuckert" type, by four different makers, the length did not vary by more than 4 per cent., and the likeness in other respects was quite as striking.

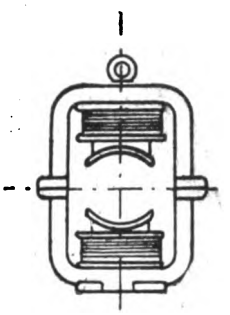


Fig. 1.

Coming, lastly, to the question of "form," we will begin with direct-current machines, and consider the field magnets. Perhaps the first thing that strikes one in the Exhibition is the question, "Where are all the familiar English bipolar machines?" One looks in vain for the standard overtype, for, with the single exception of the Société Gramme, the bipolar as built by all or nearly all the leading English firms practically does not exist. The bipolars that are there (and they are not many) are generally of the form shown in Fig. 1. This form has all the advantages of the Manchester type, with few of its disadvantages. The coils are in the most advantageous position, the leakage is very small, and the machine is practically enclosed. Hence it may be found in the Exhibition in large numbers both as motor and dynamo. The next noticeable fact is the use of the four-pole machine for very small outputs. Doubtless this is partly due to the number of motors now built for 400 volts. Still, in England one is accustomed to find four-pole machines built for an output of over 10 kw. to 15 kw., but in the Paris Exhibition the four-pole type is found in sizes as small as 2 kw., and as a motor even smaller. Indeed, it may be safely said that for almost all sizes the standard field frame is the circular shape, with inwardly projecting radial poles (Fig. 2). Sometimes, as in the case of the Schuckert, this is modified to a polygonal frame. A division, or partial division, of the frame at each pole (Fig. 3) is very common indeed, and no doubt effective in assisting in the best distribution of the flux. Special devices, however, for reducing sparking (such as special pole-tips on one side of a pole) are almost entirely absent, and the only speciality of this kind is the laminated pole-tip with alternate long and short laminations (Fig. 4). As has been already said, the material for the field is almost always cast steel, which gives the machines a very light

Digitized by Google

and neat look when placed beside a cast-iron frame for the same output.

Next, as to the question of armatures. With all the leading firms, both English and foreign, the ring armature is a thing of the past, except for very special uses, such as some tramway generators, where the modified Ayrton-Perry multipolar winding is used. Yet there are two notable exceptions in this way. The Société Gramme and L'Eclairage Electrique have a great number of ring armature machines, and the latter firm build them up to 1,000 kw. The representative of the first-named company at the Exhibition did not express to the writer any conviction that their machines would undergo any alteration in the near future, but the representative of L'Eclairage Electrique said, "We are now beginning to build more drums." It might, therefore, be fairly argued that the majority of

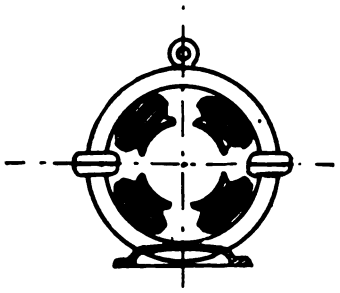


FIG. 2.

FIG. 3.

makers are distinctly against ring armatures. Reasons are fairly obvious. Higher densities, due to shallower stampings, cause greater iron losses, whilst often in bipolars, and always in multipolars, the length of copper required for armature winding is greater, hence greater copper loss in the armature and greater expense. Neither are mechanical reasons wanting for the universal adoption of the drum armature, for the question of shape of spider is more easily and satisfactorily solved in the case of a drum than in that of a ring.

The form of winding that is the favourite abroad is undoubtedly the cylinder winding. This almost follows from the adoption of the multipolar machine, for this method of winding for machines with four or more poles gives a compact and easily arranged set of end connections with economy in copper. It is possible, however, that it makes the over-all length of the machine rather greater than evolute end connectors Still, the contrast between the amount of copper required for ring winding and that required for drum winding becomes all the more pronounced with multipolar machines, and this is another strong reason for the disappearance of the ring armature.

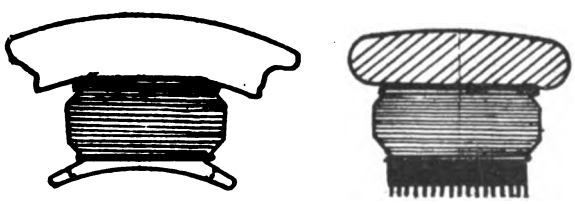


FIG. 4.

Another point which is worthy of remark is the varying length of gap allowed by various makers. The fact that the sparklessness of a machine depends to a large extent on the product of the density in the gap × length of gap seems to induce not a few makers to increase the clearance in their machines, though one would have thought that the advent of cast steel would have made the alternative of increasing the gap-density more natural and quite sufficient. Of the forms of stampings that are being used, the "toothed" and "slotted" are very much to the front—indeed, for all sizes of machines abroad they are the rule, and the smooth core is quite an exception. The shape of tooth is for all larger machines almost invariably like that sketched in Fig. 5, with an insulating strip driven in at the top as shown.

Leaving, now, the direct-current machine and coming to the question of alternators, we find what is generally known as the "iron-type" alternator absolutely universal. There does not seem to be throughout the whole of the Exhibition one single instance of an alternator of the "copper type." By "copper" type, of course, is meant that type of alternator in which the armature contains no iron, such as the disc machines of Siemens, Ferranti, and Mordey. Of course, one must again remember that the English exhibits are comparatively few; still here is a common form of English machine which is regarded with so little favour by foreign firms that not one of its class is to be seen. This may be due to several good reasons: firstly, most of the large alternators shown are three-phase, and the disc machine does not lend itself well to polyphase winding; secondly, it is doubtful whether the copper-type machine is so good mechanically as the iron-type machine; thirdly, machines with a certain amount of iron in their armatures are more easy to parallel than those without iron. The form of these iron machines varies but little. They are

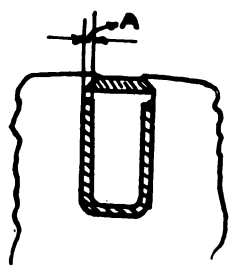


FIG. 5.

all of the flywheel type, and in nearly all cases it is the field that revolves. This, of course, obviates high-tension sliding contacts, and is good from that point of view. A form of machine, however, which is coming apparently fast to the front is the umbrella type—*i.e.*, the machine which has the revolving field magnets outside the armature, but projecting radially inwards from the extended flywheel rim. The advantages of this form of wheel are that the centrifugal force of the field tends to bed the pole down to the rim and to keep the winding well back from the armature, instead of throwing the whole strain on a couple of bolt-heads and tending to throw the field winding towards the armature face. The disadvantage is that the wheel is almost bound to run "cat-necked"—*i.e.*, with a supporting bearing on one side only—for the second bearing is awkward to arrange in the centre of the armature frame.

With regard to alternator details, the shape of pole-face is universally rectangular, but the thickness varies from $\frac{3}{8}$in. up to 3in. (Kolben). The form of the pole itself is usually rectangular, though sometimes round. The winding is almost always a flat copper strip wound on edge, and hence it follows that if the pole is rectangular the strip must stand some distance over the end (as shown in Fig. 6), and this is

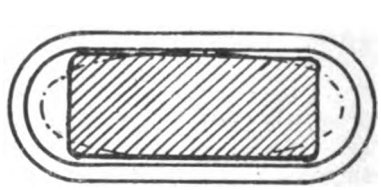


FIG. 6.

frequently seen. The Oerlikon Company, for instance, wind their fields in this way. It seems a most uneconomical arrangement, though possibly it secures rather better magnetic distribution. Surely the better form is the elliptical pole with rectangular face (as shown dotted in Fig. 6), for it is obvious that with the same amount of steel in the pole itself the length of copper will be less and quite as easy to wind.

Laminated pole-faces are fairly usual, though not universal, and in some smaller machines the field magnets are laminated throughout—*i.e.*, the magnet will be built up of a number of star-shaped plates, the points of the star forming the poles of the alternator. The armatures of alternators abroad show signs of standardisation. They are nearly always coil windings, lying in large and deep slots, which are sometimes arranged so that the coil may be wound on a former and slipped into place, and sometimes so that it can only be wound in position. The

Digitized by Google

first of these two methods may be used with a tooth of the shape of that shown in Fig. 5, where it will be seen that the projecting part of the tooth is just equal to the slot insulation, A. Both methods of winding are, however, practised, and not infrequently both are used by the same firm.

There are certain differences in the schemes of winding adopted by different firms. Some prefer windings which may be divided and packed in segments, whilst others arrange their stampings so that they overlap. The latter arrangement seems to have the effect of making the machine run more silently, and it must be said that throughout the Exhibition these large iron alternators do run with very little hum.

Most of the better-known firms are building inductors for special purposes, such as very high speeds, but they do not specially support or recommend them. The fact is that there is a general feeling throughout the Exhibition that plants of 1,000 h.p. or 1,500 h.p. are best running at a speed of about 90 to 100 revolutions per minute, and there are few serious attempts made to construct plants of the combined high-speed order, such as those at Bristol (Ferranti - Willans), Sheffield (Raworth - Mordey), or Plymouth (Ferranti). Whether they are right in this or not time will show, for the battle of the high *v.* low speed engine is not finished yet. Still, it is necessary to keep a sharp look out as to what are the tendencies abroad, for it is not pleasant to recollect that in at least two large central stations in England, where up to the present English machines have been used, a Swiss firm have the order for extensions of plant.

HIGH-SPEED RECIPROCATING ENGINES.*

BY ALLAN COATS, B.SC.

The study of high-speed engines is a fascinating one, and the points of difference between them and their slow-speed brethren are many and interesting. The history of the introduction of high-speed engines is analogous in many points to that of the safety bicycle. In the case of the bicycle the "safety" was introduced because people considered that being flung on the ground several times a year from a height of, say, 5ft. and at the rate of 10 miles an hour was monotonous; the machine itself was regarded as slower, uglier, and inferior in every way. In the case of the high-speed engine it was introduced on account of the necessity in confined spaces of driving dynamos direct, and was, as a rule, only employed where a slow-speed one could not be used. High-speed engines were decried on all sides as steam-eaters, and liable to breakdown, till the genius of one Peter William Willans placed them on their true basis, and proved conclusively that high rotating speed was one of the chief elements of economy. It is not to be wondered at that the early high-speed engines were liable to breakdown; the conditions were so novel, and the effects of inertia and reversal of stress hardly received the amount of attention they require, but there is no reason to doubt that the high-speed engine of to-day is second to none in economy, freedom from wear, and reliability. It is not surprising that this engine is more and more coming into use, not only for electric purposes, but for mill driving as well. To take a common instance from mill practice, we have a slow-running engine with large flywheel sometimes measuring 35ft. in diameter driving smaller pulleys in the rope-race. Would it not be much better to have the driving and driven pulleys about the same size and speed up the engine? Or, to carry the principle still further, we might do away with the large engine-house, make the rope-race the engine-house, and have a separate high-speed engine for each main shaft. In this case it would be impossible for all the engines to break down at once, and even supposing one engine gave way, all that would be required would be to have spare pulleys on each shaft, and connect to the shaft above or below, or possibly both. There are a great many points of difference in the manufacture of the two types. For instance, in lining up, a slow-speed engine might be a good deal out and one never know it, but the same amount would be fatal to the high-speed one; it must be practically dead in line. The reason for this is that any want of alignment sets the reciprocating parts vibrating sideways, and as all these inertia effects increase as the square of the revolutions, the strains are 100 times greater at 10 revolutions per second than those at one revolution per second, and the result is a side knock on the connecting rod that no system of lubrication can prevent. In order to assist the engine to take up its proper aligument when working, it is almost necessary to have floating packing, or very deep packing for the piston rods, especially if the engine is of any considerable size. These causes even affect the shaft journal. If it is not quite round, power is lost in lifting crankshaft flywheel every revolution. In two-crank and single-crank engines it is advisable to balance the whole of the connecting rod and cross-head with, of course, the crank webs. This produces a greater horizontal vibration, but the total vibration is very much reduced.

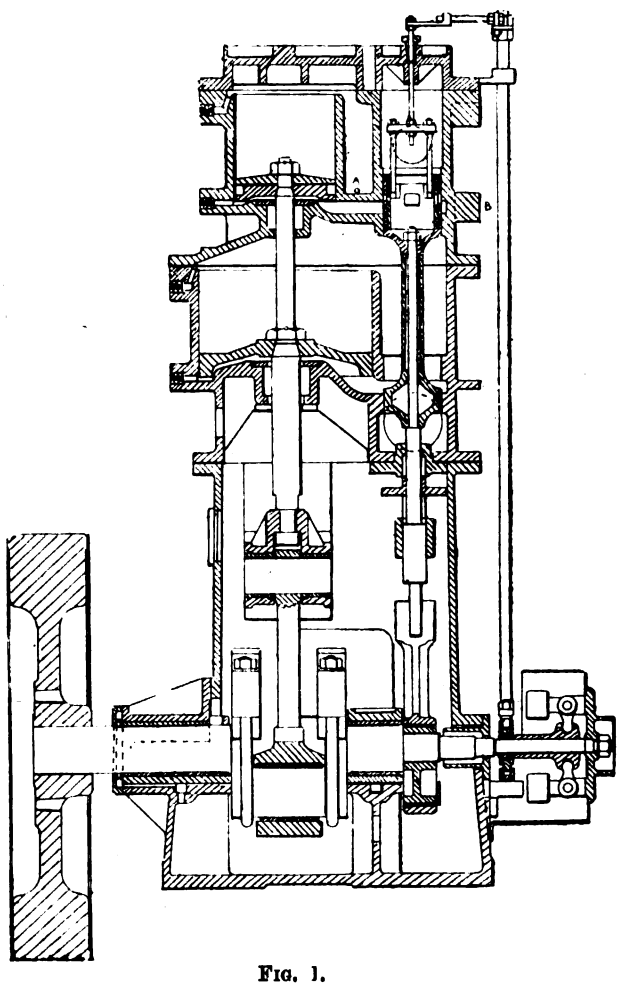


FIG. 1.

I should like now to direct your attention to some matters of detail, and, firstly, I wish to make a few remarks on piston packings. I have recently designed an engine which was extremely favourable for the observing of piston packings (Fig. 1). The space above the high-pressure piston in this case acted as a steam buffer, and was only connected to the live steam by a small non-return valve, which kept up the supply. The engine was sometimes worked with the top cover off, a small cover being temporarily put over the valve chest. In this piston, not only could the exact amount of leakage be observed by means of the indicator card, but as there were holes bored in the junk ring it was possible to see whether the steam was escaping past the vertical face or past the horizontal faces of the rings by putting on the cover on valve chest, and running the engine double-acting without the steam buffer; if the steam escaped up the sides of the piston it was passing the vertical face, if it came through the holes in the junk rings it was passing the horizontal faces. The rings used were Willans type—*i.e.*, an inside spring ring and two outside ones. Now, even at very moderate pressures, say 20lb. to 30lb., steam escaped

* Paper read before Glasgow Technical College Scientific Society.

Digitized by Google

freely through the junk ring holes, even though the rings had been bedded down and were a nice pushing fit in the pistons; these holes were afterwards plugged up. This proved that steam finds its way pretty easily to the back of most piston rings.

Leakage of Piston.—Again, it was observed that the piston, which was fairly tight before the engine started—*i.e.*, with steam on and engine at dead centres—leaked very badly after starting, and that even when stopped and brought to the dead centre and steam turned on again, the leakage of steam was enormous, as could be seen by opening the indicator and lubricator cocks. Suspecting that the rings were being forced from the face of the cylinder by water and oil, I caused a small piece of flat brass to be inserted in the joint of the inner spring ring, and this kept it from collapsing. The result was marvellous, as may be seen from the indicator cards (Figs. 2 and 3) taken immediately before and after. This changed the loss from

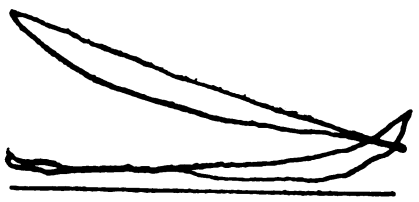


FIG. 2.—Indicator Diagram taken Before Strengthening the Piston Ring Springs

the buffer from about 10 h.p. to rather under 1 h.p. It might be objected that the spring ring was much too weak, but its proportions were based on Willans's practice, and besides, the cylinder and springs assumed a very fine polish after a few days' running. The patentee of a well-known form of piston rings, on being shown the cylinder and rings, expressed surprise that there should be any leakage. Whether or not the spring was too weak, even had it been stronger, through time it would have expanded to the strength it then had. The probable course of events is that the piston rings are first forced from the cylinder face by the film of water; steam then rushes in between the faces and forces the rings in. The piston rod packing rings in this engine were also of the Willans type, consisting of two inner rings of white metal and an outer spring one of phosphor bronze. In order to give the necessary elasticity to the white metal rings, the outer edges were cut half-way through at several points. This packing was steam packed, and gave no trouble from leakage. Solid packing rings are extensively used, and in cases like the Raworth engine, where the cylinder is bound to expand equally in all directions, are almost sure to give satisfaction. The difficulty is to know exactly what diameter to make them, so as not to seize on the one hand and not to let steam pass on the other. Our American cousins make pistol valve rings solid up to at least 12¼in. diameter, and

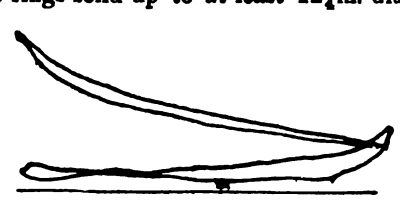


FIG. 3.—Indicator Diagram taken After this Alteration.

it is unlikely that their valve seats remain truly cylindrical. In order to try and get a piston valve which would be tight, and yet not liable to seize, the piston valve in this engine was made with three grooves about ⅛in. wide, and special white metal was run into them and turned down to a nice working fit, the idea being that the white metal would expand more than the iron and wear itself down to the correct diameter. This idea was an afterthought, and, unfortunately, there was not enough metal in the valve to allow of the white metal being sunk more than an eighth part into the cast iron. The result was that, although the rings wore without seizing to their correct diameter, the centre one persistently cracked, although the other two remained all right. The white metal scored more readily than cast iron would have done; but, on the other hand, it left the cylinder faces like mirrors. White metal, however, is very easily chipped in passing over port edges, and it would not be advisable to use it unless there were guide bars across the port.

Port Design.—The correct design of ports becomes more important in high-speed engines, and when we remember that a cylinder is very often filled and emptied in one-tenth a second, it is conceivable that the ports may exercise some influence in the economic result. To secure the best results, it is necessary that the ports should be straight. It is difficult to exactly determine the loss due to bends, but if we take the similar case of the Row tube, used as a condenser, we find that more than twice the amount of steam will be condensed in exactly the same tube after it has been indented. In the same way, in the S ports so common in engines, we have steam at a high temperature and velocity violently thrown against surfaces which immediately before had been as violently swept by comparatively cold steam. Then, again, no attempt is ever made to reduce the velocity of the steam as it enters the cylinder. The result is that steam enters the cylinder at the full velocity of the ports, causing severe currents to be set up and assisting initial condensation. I am sure it would help greatly if ports were belled at the mouth, both vertically and horizontally, and thus reducing the velocity of the incoming steam and assisting the outgoing steam to acquire the necessary velocity. Port losses are nearly always put down to port friction; but this is not so, as the heat generated by the friction is equivalent to the work done on account of the friction and would tend to dry the steam, and thus help the efficiency of the engine, were it not for the second and more serious source of loss caused by the iron storing up this heat and giving it out again to the exhaust. Any increase of clearance caused by widening the port mouth is quite negligible, as large clearances in high-speed engines are fortunately much less harmful than in low-speed ones. This and the striking reduction in initial condensation are both due to the same fact—namely, that the transference of heat from the steam to the cylinder walls is a time function—so that if we run our engine four times as fast we get the same amount of water condensed, but get four times the power—*i.e.*, our condensation per horse-power is a quarter of what it was. Another thing against long and tortuous ports is that the drainage is never so good. This is especially so in high-speed engines, as the time per stroke is so short that there is a tendency for part of the outgoing water meeting the incoming steam and being carried back into the cylinder. The bad effects of water in the cylinder hardly need emphasising, but in high-speed work it is especially important, because, although heat takes an appreciable time to go out and in from iron, on water it acts practically instantaneously, so that high speed does not effect any economy so far as water in the cylinder is concerned. It is, therefore, very important that the drainage should be as perfect as possible. The principal difference in the design of high-speed engines is in the precautions taken to prevent knock and the care bestowed on lubrication.

Single v. Double Acting.—High-speed engines naturally divide themselves into two classes—single and double acting. Double-acting engines are more liable to heat losses than single-acting. In nearly every case one or both of the steam ports has an S bend. The drainage is also very much inferior. Against these disadvantages it had the advantage of getting twice the power out of the same size of engine for the same speed. The turning moment in two-crank engines is not any better than single-acting engines, but in the three crank engines there is an advantage on the side of double-acting.

Lubrication.—The system of lubrication in the two classes is entirely different. The double-acting engine relies on a cushion of oil to keep the parts lubricated, the single-acting on a copious supply of oil and water splashing over all the parts. The forced lubrication is more complicated and liable to break down—in fact, the greatest row I ever heard an engine make in my life was a Belliss in which the forced lubrication had broken down. It was quite impossible to hear oneself speaking anywhere near it. The oil used for forced lubrication after a time gets thick, and it is quite a common thing for the pressure of oil to fall 10lb. in a day; if this were allowed to continue, the lubrication would, of

Digitized by Google

course, fail. On this account oil filters or oil tanks are usually fitted, but, nevertheless, it is well to keep an eye on the pressure gauge occasionally. The oil has also a tendency to heat, both from heat transmitted from the cylinders and on account of the friction of the parts. If we take a 100-h.p. engine, as a rule about 8 h.p. will be lost in friction, of which 60 per cent, according to reliable trials, is lost, apart from piston, piston rod, and valve—*i.e.*, about 4 75 h.p.—and this equals 205 heat units per minute given to the oil. This makes it necessary to have a system of cooling pipes in the bed or oil tank in large engines. Forced lubrication engines have to be made very accurately, or it becomes difficult to keep sufficient oil to prevent knock. On the other hand, if the oil is properly cooled, it is supplied at just the point it is wanted to keep the journals cool. Sea-going engineers have already found out the danger of pouring water on the outside of a hot bearing, as this tends to shrink the outside and cause still worse firing. Splash lubrication has none of the disadvantages mentioned. It is impossible for the system to break down. The oil may be allowed to become very thick without materially affecting the lubrication, especially as the heat soon thins it, and the water prevents the bearings from becoming too warm. If air is allowed free access at top and bottom of the frame, a great amount of heat can be readily taken away. For single-acting engines this system works splendidly, but it is not suitable for double-acting ones. The penetrative power of oil in splash lubrication is remarkable. I have frequently seen it come up past the air buffer and out at the air buffer gland.

Steam v. Air Buffers.—Single-acting engines may be divided into steam buffers and air buffers. Air buffers are designed to absorb the momentum of the reciprocating parts, and keep the connecting rod bush always in contact with the crank pin. Each air buffer is designed for a certain speed, and if that speed be greatly exceeded the buffer is not strong enough and a knock commences. Again, as the lowest pressure cannot be any lower than the atmosphere, and as the pressure rises very rapidly at the end of the stroke if the pressure is carried at all high, it becomes necessary to make the air buffer fairly large in diameter in order to get sufficient pressure at the middle of the curve. Air is also very much more difficult to pack than steam, and any leakage means an absolute loss of power. In an air buffer the piston or cross-head is vibrated from side to side on account of the connecting rod being in constant thrust. This action tends to wear the buffer oval, and there are few single-acting engines which do not suffer considerable loss after some sever or eight years' wear from this cause. Willans made some experiments to determine the effect of water and steam in the buffer of his engine, and found that in each case there was a loss of power as compared with air, but the conditions are very much against the use of steam in the Willans engine, for there we have a large surface splashed by water and oil, so that the loss of heat must have been excessive. Steam buffers removed from the influence of the crank chamber do not show this loss, but on account of Willans's trials the belief is very general that a steam buffer necessarily means loss of power. As this is rather an interesting point, I should like to make it clear that, *apart from radiation*, a steam buffer is as free from loss as an air one. In this connection I would draw attention to the diagrams from Peache's steam buffer. This buffer is between the high and low pressure pistons, and the very slight loss may be easily accounted for by the pistons not being absolutely tight.

The theory put forward to explain the so-called loss in the steam buffer is that heat is absorbed by the buffer walls on the up stroke, and is not given out at the same point on the down stroke—in other words, it lags behind. Now, if you grant what I think are two self-evident statements, I think I can prove my point. These are: (1) that if heat lags behind in coming out of the cylinder walls, it also lags behind in going in; (2) that there is one point in the stroke of the engine at which the steam and buffer walls are at exactly the same temperature. To prove the second statement, it is only necessary to draw approximate curves for the temperatures of the cylinder walls and the steam respectively. Let D B E (Fig. 4) represent the temperatures of the cylinder walls, and A B C those of the enclosed steam—*i.e.*, at the top of the stroke the temperature of the steam is higher than that of the walls, and at the bottom of the stroke lower. As these two curves are perfectly regular, it follows that they cross at some intermediate point, B—*i.e.*, a point at which the steam and cylinder walls are at exactly the same temperature. If now we draw F B G (Fig. 5), a curve to represent the pressures due to compression of an air buffer, and H B K, the pressures due to compression in an *ideal* steam buffer in which at *every point* of the stroke the temperature of the steam and cylinder walls coincided, the point B in the previous figure is the only point on this ideal curve. Starting from this point, then, on the up stroke, and allowing for the lagging behind of the transference of heat, the steam is being compressed and therefore heated; if it did not lose any of its heat to the cylinder walls, it would follow the air curve, F B G; on the other hand, if it immediately parted with enough of its heat to raise the cylinder walls to its own temperature, it would follow the ideal buffer line, H B K. The real action is between these two forming the enclosed loop on account of the steam being at a higher temperature all the time, and, therefore, losing heat. This loop indicates power lost, but on the other side of B the temperature of the cylinder walls is continually higher than that of the steam, and a similar loop is formed, the one loop cancels the other, the net result being the same as the air buffer. In actual engines there is always enough radiation and leakage to

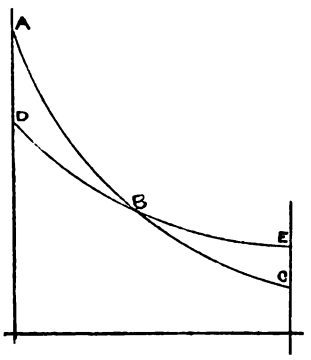


FIG. 4.

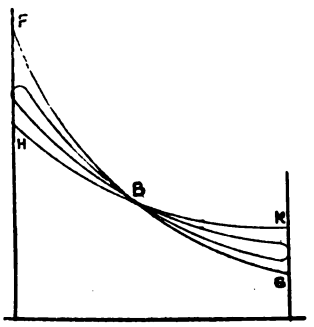


FIG. 5.

prevent the return line of the indicator card from ever crossing the initial line. This radiation in buffers, removed from the influence of the crank chamber, goes either to the atmosphere, in which case it takes the place of the usual radiation from the working steam and tends to keep that steam dry, or it is conducted down the cylinder walls and keeps them dry. In Fig. 1 any steam passing the buffer goes into the high-pressure cylinder, and is not altogether lost. It will always be found, too, that on opening the air-cock of an air buffer that a little steam escapes, showing that the air is very moist. From sheer habit engineers are accustomed to blow through an indicator when indicating an air buffer, thereby filling the buffer with dry air and getting a good card, but a card taken without this unnecessary precaution nearly always shows a loop.

(To be continued.)

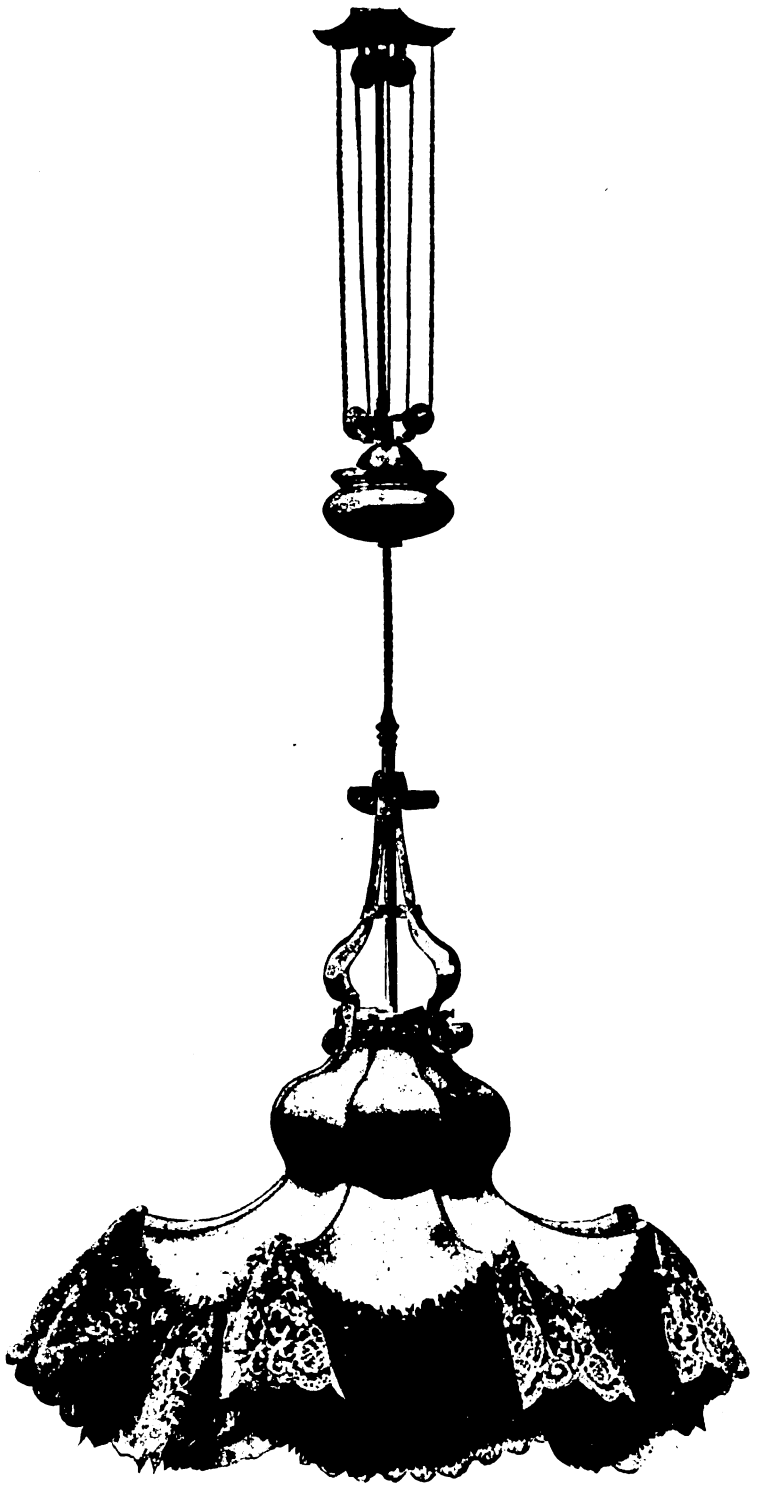
THE ELECTRICAL COMPANY'S NEW SHOWROOMS.

The Electrical Company, Limited, have for many years carried on an extensive business as suppliers of electrical plant and fittings at 122, Charing Cross-road. Owing to the increase in their business in both of the departments—*i.e*, that devoted to arc lamps, incandescent lamps, motors, dynamos, etc., and that which undertakes the supply of electroliers and fittings generally—the company has been obliged to extend their accommodation, and have moved their fittings department to 162, Shaftesbury-avenue. The removal of this department, of course, enables them to devote much more space at Charing Cross-road to heavy goods, and we gather that this space was urgently needed.

The new showrooms at Shaftesbury-avenue have been arranged and equipped by the joint managers of the

Digitized by Google

fittings department. As the building is a new one, and the company agreed to take the ground and the first floor while it was in course of construction, they have had an exceptional advantage in getting the internal arrangements made to their own designs. They are to be highly complimented on the result, and we believe that our congratulations will be accompanied by largely increased returns to the company, owing to the fact that the showrooms as now equipped possess exceptional facilities for the display of electric light fittings. The great idea of their arrangement is that it is not advisable to attempt to display the fittings of various classes in the same room. Neither is it advisable to show electroliers which are to be used in an ordinary-sized room in a large showroom, which dwarfs their general appearance. Another disadvantage of a large showroom is that the wall space is limited, and hence it becomes necessary, in order to show a large number of typical wall brackets, that they should be very much crowded on the same. In this way it is not easy to obtain the lighting effect of an individual fitting. All these objections have been avoided by dividing the space available into a series of moderate-sized rooms, and confining the fittings in each room to distinctive classes. In consequence of the increased wall space the individual fittings are not unduly crowded, and by a series of wall plugs and plug blocks any individual fitting can be lighted alone, so that its effect in a moderate-sized room can be readily seen. The first result is to greatly enhance the appearance of the fittings, while at the same time customers are more easily enabled to make a selection. A long corridor with handsomely draped curtains runs along the full length of the floor, and the small showrooms open out from this. Entering the showroom, the first division is devoted to statuary and to handsome onyx pedestals, on which this statuary can be well displayed. The goods shown here are mostly of large size, as small statuary and groups in brass are displayed in one of the other showrooms. The private office is a large one, and is lighted from one end. Dark blinds for the windows of the room enable the daylight to be excluded, and the room offers every facility for displaying a number of fittings which are designed for use

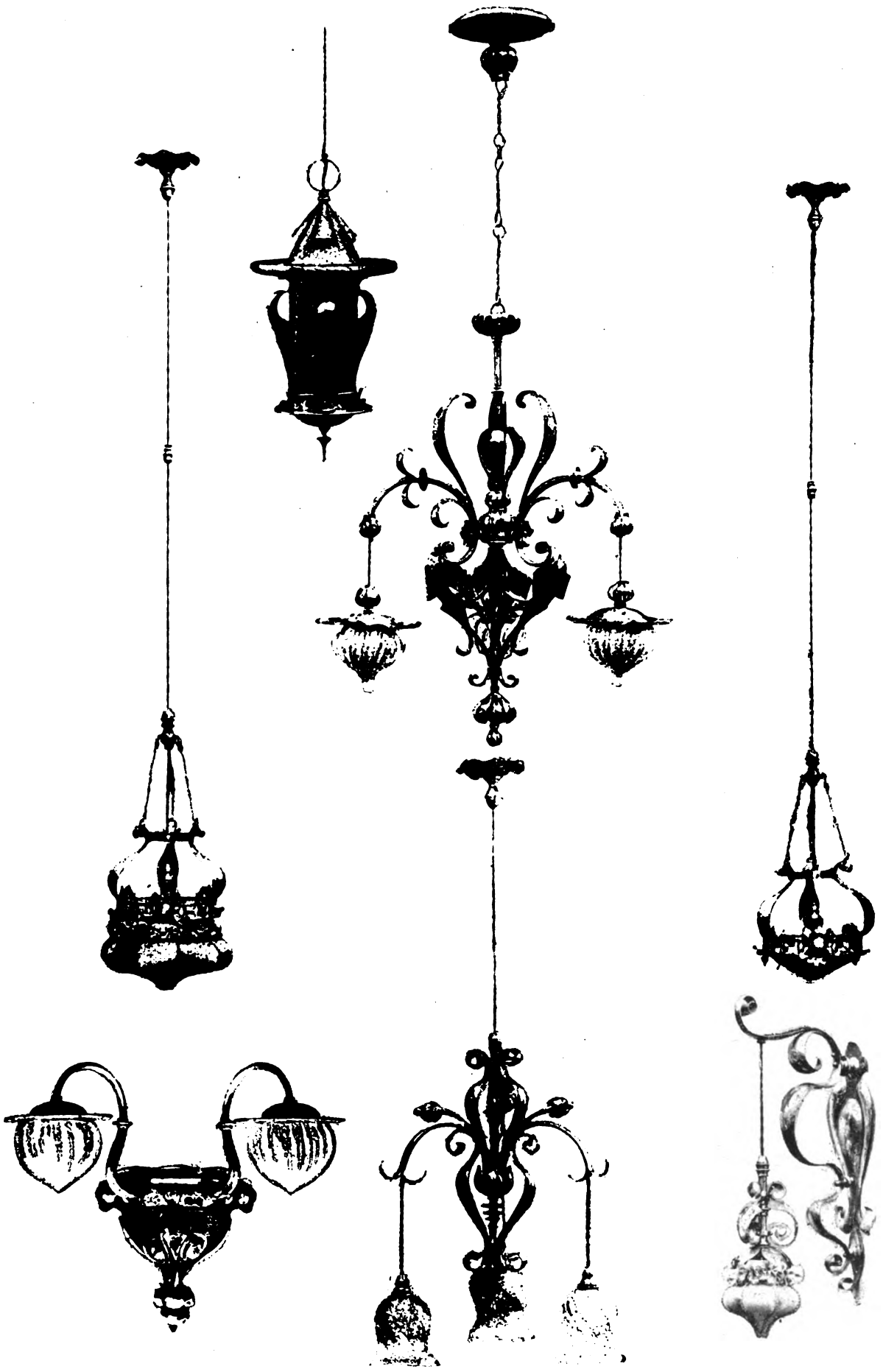


A Dining-Room Pendant.

Digitized by Google

conjointly. Thus, when we inspected it, there was over a large table in the middle of the room a dining-room electrolier of planished steel, while four single-light pendants of similar design were grouped symmetrically round it. On the walls were displayed brackets, also designed to harmonise, and the whole gave a good idea of the adaptability of this planished ironwork for dining-room lighting.

The next department to be inspected is a showroom devoted to oxidised silver fittings, which are especially suitable for use in halls, dining-rooms, libraries, etc.



A Group of Typical Fittings seen in the Electrical Company's Showrooms.

Illustrations of some of these designs are incorporated with this article, but, of course, it is impossible to reproduce the exquisite figuring on some of these oxidised-silver surfaces. A further development of this method of

Digitized by Google

finishing is the reproduction of the surface found on old armour, which can be varied to suit the taste of the purchaser through a range of shades from dark to light. The designs of the wall brackets in this department are novel, and are worthy of a special visit.

The next showroom up the corridor is much longer than its predecessor, and in it are displayed a large series of dining-room pendants and their shades, of all imaginable colours, shapes, and sizes. As they are arranged to be adjustable for height, they can be tried individually by having only the one pendant drawn down lighted, while the rest are raised out of the line of vision. The silk shades on view give a very good idea of the latest in this class of work, while the shapes of the supporting electroliers are extremely graceful. On long benches at the sides of this showroom are displayed bronze and other figures of comparatively small size. Some of the real bronzes on view are exceptionally handsome, and while they are reasonable in price for the work on them, they form a ready means of increasing the cost per lamp of an electric light installation. Just outside in the corridor we noticed some wonderfully handsome onyx pedestals used to support these bronze figures.

The wrought-iron fittings and also the steel fittings of the armour-finished type are displayed in a large room next to the one previously referred to. Here, again, the Electrical Company, Limited, have on view a number of unique designs, and we were particularly struck with some which have been got out for some Freemasons' habitations. They were prepared to meet the views of a well-known architect, who required for the habitation in question an extensive range of wall brackets and many light electroliers. All periods of hammered ironwork are represented in the showroom, and the blackened work is especially suitable in many cases where the oxidised silver would be somewhat too light.

The showroom devoted to French types of electroliers, including the various Louis styles and also fittings of the Empire type, is well filled. Those who are only willing to recognise the orthodox would here find what they required, and would also, we presume, have objections to raise to certain of the goods displayed as being more beautiful than they are correct in style. The ageing effect reproduced on some of these is to the philistine objectionable, and hence the Electrical Company, Limited, have accommodated themselves in certain cases to the public taste. In the last showroom, which is larger than the rest owing to the fact that it runs the full breadth of the building without the breadth of the corridor being taken off, as is the case in the other showrooms, is devoted to the brass fittings of modern types. It is distinctly a commercial room, where the customers who prefer new forms to old can select at will from a great variety of electroliers, wall brackets, and pendants. We were particularly struck in this room with the great variety of glass shades which the company has collected, and which, we were informed, it can supply without delay. The harmonising of the shade and fittings is most essential for the good effect in the lighting of rooms, and in this we think the firm is to be highly congratulated. In all this kind of work it is the individual attention which makes the business successful, and we trust that the attention given to the equipment of these showrooms will be amply repaid by business done. We may add that while the Electrical Company, Limited, only supply to wholesale firms, they are pleased for these firms to bring their clients to these showrooms to make selections.

SPEED ON THE LONDON UNDERGROUNDS.

The opening of the Central London Railway has shown the inhabitants of the Metropolis what can be done by electricity in improving the communication between the suburbs and the City. The first comparison which one naturally makes when using the Central London Railway is on the score of comfort. In this respect it stands far and away beyond the Metropolitan District Railway on account of the purity of the air. Of course, this advantage would not be maintained were the District and Metropolitan Railways to be converted from steam to electric traction, as the open cuttings on these railways would tend to keep the air even more fresh than is the case on the Central London. The fact remains, however, that at the present time a journey on the District Railway is most unpleasant on account of the sulphurous fumes, which, even if they have the healthy properties claimed for them in certain quarters, are by no means agreeable to inhale. A journey on the Central London, on the other hand, is free from any unpleasantness on the score of impure air. There is, of course, the slight smell due to the vitiation of the air by the passengers, but this is hardly noticeable after the first minute. The next ground for comparison between an electric underground railway

BEST RECORD OBTAINED ON THE CENTRAL LONDON RAILWAY.

Station.	Time. H. M. S.	Stopping time.	Running time.	Distance, yards.	Speed, miles per hour
Shepherd's Bush	dep. 3 33 4	secs.	m. sec.		
Holland-park	arr. 3 36 9	7	3 5	1,012	11·2
	dep. 36 16				
Notting Hill gate	arr. 38 3	9	1 47	683	13 0
	dep. 38 12				
Queen's-road	arr. 40 7	12	1 55	768	13·8
	dep. 40 19				
Lancaster-gate	arr. 42 27	10	2 8	986	15 7
	dep 42 37				
Marble Arch	arr. 45 16	13	2 39	1,288	16·5
	dep. 45 29				
Bond-street	arr. 46 58	11	1 29	642	14·7
	dep. 47 9				
Oxford-circus	arr. 48 41	18	1 32	699	15·5
	dep. 48 59				
Tottenham Court-road	arr. 50 31	10	1 32	666	14·7
	dep. 50 41				
British Museum	arr. 52 20	12	1 39	682	14·0
	dep. 52 32				
Chancery-lane	arr. 54 22	11	1 50	746	13·8
	dep. 54 33				
Post Office	arr. 56 54	16	2 21	1,163	16·8
	dep. 57 10				
Bank	arr. 59 10	—	2 0	828	14 1
Totals		2 9	23 57	10,163	—

Speed on journey, 13·2 miles per hour; average running speed, 14·4 miles per hour; average stop in station, 11·7 seconds; time spent in stations, 8·25 per cent. of time on journey and 9 per cent. of running time.

RECORD FROM THE CENTRAL LONDON RAILWAY TAKEN DURING THE TRAFFIC RUSH AT NIGHT.

Station.	Time. H. M. S.	Stopping time.	Running time.	Distance, yards.	Speed, miles per hour
Bank	dep. 6 3 30	secs.	m. sec.		
Post Office	arr. 5 45	20	2 15	825	12·5
	dep. 6 5				
Chancery-lane	arr. 8 33	15	2 28	1,163	16·0
	dep. 8 48				
British Museum	arr. 10 45	15	1 57	746	13
	dep. 11 0				
Tottenham Court-road	arr. 12 43	25	1 43	682	13·5
	dep. 13 8				
Oxford-circus	arr. 14 50	28	1 42	666	13 3
	dep. 15 18				
Bond-street	arr. 17 0	18	1 42	699	14 0
	dep. 17 18				
Marble Arch	arr. 18 45	33	1 27	642	15 0
	dep. 19 18				
Lancaster-gate	arr. 21 38	10	2 20	1,288	18 7
	dep. 21 48				
Queen's-road	arr. 24 20	15	2 32	986	13·2
	dep. 24 35				
Notting Hill-gate	arr. 26 25	22	1 50	768	14·2
	dep. 26 47				
Holland-park	arr. 28 20	20	1 33	683	14 9
	dep.* 28 40				
Shepherd's Bush	arr. 31 20	—	2 40	1,012	12 9
Totals		3 41	24 9	10,163	—

Speed on journey, 12·4 miles per hour; average running speed, 14·3 miles per hour; average stop in station, 20 seconds; time spent in station, 13·25 per cent. of time on journey; time spent in station, 14·9 per cent. of running time. * Signal delayed train.

Digitized by Google

constructed on the tube principle and a steam railway running in tunnels, should be made on the score of cost and of upkeep of permanent way. Such comparisons can only fairly be made after a year or two's running, as a certain amount of time is required for items of upkeep to assume their normal proportions. There is, however, one means of comparison which is at once available, and which we have taken the interest to investigate. We refer to the speed obtained on the various London lines, whether driven by electricity or steam. To this end we have had records taken of actual runs on the Central London Railway, the District Railway, and also a few records from the City and South London Railway. We cannot, of course, claim that these figures are absolutely correct, or that they give a fair average of what can be done on any of the lines, but we have discarded any sets of readings which show abnormal length of time on the journey due to the signals being against the trains. We have also compared the running times when the trains are light, such as in the middle of the afternoon, and when they are heavy, as when the people are returning to the suburbs. The accompanying tables give the figures obtained on five separate trials. Underneath each table we have stated the speed of the journey, which is obtained from the total time taken and the total distance covered. The next interesting figure from an engineer's point of view is the average running speed, and it will be seen that, while there is a considerable difference in the first item, in the running speeds the record is borne by a steam locomotive. The following comparisons of the conclusions from the trial in this respect will be of interest, but it must be remembered that the average distance between stations is lowest with the Central London Railway. This distance has a great influence on the average speed.

TIMES TAKEN ON THE DISTRICT RAILWAY.

Station.		Time. H. M. S	Stopping time.	Running time.	Distance, yards	Speed, miles per hour
Blackfriars	dep.	4 23 55	secs.	m. sec.		
Temple	arr.	25 55	26	2 0	836	14 2
	dep.	26 21				
Charing Cross	arr.	28 17	28	1 56	792	13 9
	dep.	28 45				
Westminster Bridge	arr.	30 34	25	1 49	748	14 0
	dep.	30 59				
St. James's Park	arr.	32 51	40	1 52	814	14 8
	dep.	33 31				
Victoria	arr.	35 18	48	1 47	814	15·5
	dep.	36 6				
Sloane-square	arr.	38 32	36	2 26	1,122	15·7
	dep.	39 8				
South Kensington	arr.	41 53	27	2 45	1,256	15·5
	dep.	42 20				
Gloucester-road	arr.	43 55	32	1 35	792	17
	dep.	44 27				
Earl's Court	arr.	46 38	—	2 11	770	11 9
Totals			4 22	18 21	7,944	—

Speed on journey, 11·9 miles per hour; average running speed, 14·7 miles per hour; average stop in station, 33 seconds; time spent in stations, 19·1 per cent. of time on journey and 23·8 per cent. of running time.

RECORD OF TIMES TAKEN ON THE DISTRICT RAILWAY DURING THE RUSH AT NIGHT.

Station.		Time. H. M. S	Stopping time.	Running time.	Distance, yards	Speed, miles per hour
Mansion House	dep.	6 9 37	secs.	m. sec.		
Blackfriars	arr.	11 28	31	1 51	672	12·35
	dep.	11 59				
Temple	arr.	14 3	26	2 4	836	13·8
	dep.	14 29				
Charing Cross	arr.	16 30	27	2 1	836	14·1
	dep.	16 57				
Westminster Bridge	arr.	18 53	47	1 56	747	13 1
	dep.	19 40				
St. James's Park	arr.	21 43	41	2 3	814	13·5
	dep.	22 24				
Victoria	arr.	24 27	1 4	2 3	814	13·5
	dep.	25 31				
Sloane-square	arr.	28 9	24	2 38	1 122	14·45
	dep.	28 33				
South Kensington	arr.	31 36	26	3 3	1,256	14 0
	dep.	32 2				
Gloucester-road	arr.	33 58	32	1 56	792	13 9
	dep.	34 30				
Earl's Court	arr.	36 48	46	2 18	770	11·4
	dep.	37 34				
Addison-road	arr.	40 56	40	3 22	1,650	16·7
	dep.	41 36				
Uxbridge-road	arr.	44 21	—	2 45	1,032	12·75
Totals			6 44	28 0	11,341	—

Speed of journey, 10·85 miles per hour; average running speed, 13 3 miles per hour; average stop, 36·8 seconds; time spent in stations, 18·8 per cent. of time on journey and 24 per cent. of running time.

Line.	Average distance between station, yards.	Running speeds.		Speeds on journey.	
		Ordinary.	Busy times.	Ordinary.	Busy times.
Central London	847	14·4	14 3	13 2	12 4
District	945	14 7	13 3	11·9	10·85
City and South London	920	14 2	—	12·3	—

The next point of interest is the time spent in the stations themselves; and, while this is not an electrical problem, it will be seen that the electrical engineers who had charge of the equipment of both the City and South London Railway and of the more recent Central London Railway have grasped the problem of getting the passengers in and out of the trains more thoroughly than have the steam engineers. Thus it will be seen that when the Central London is running in the afternoon with only about half of its full complement of passengers, the average stop per station is only 11·7 seconds. This time is, however, increased to 20 seconds at times of heavy load, owing to the larger number of passengers which have to get into and out of the trains. The District Railway, on the other hand, stops on the average 33 seconds in each station when running light and 36·8 seconds when running with a large number of passengers. It will be seen from this that on the journey from Uxbridge-road to Mansion House with the same number of stopping points, the District Railway requires three more minutes for stopping at stations. With regular passengers this is equivalent to six minutes per day and to 36 minutes per week of six working days. The value of the time to each of the individual passengers may not at first sight seem to be much, but the waste could be prevented by a better design of rolling-stock. On the City and South London Railway we see the first attempt to

RECORD TAKEN ON THE CITY AND SOUTH LONDON RAILWAY.

Station.		Time. H M S.	Stopping time.	Running time.	Distance yards.	Speed, miles per hour
Moorgate	dep.	4 21 22	secs	m. sec.		
Bank	arr.	23 23	53	2 1	820	13·8
	dep.	24 16				
London Bridge	arr.	26 1	28	1 45	880	17·1
	dep	26 29				
Borough	arr.	28 25	12	1 56	675	13 9
	dep.	28 37				
Elephant and Castle	arr.	30 42	21	2 5	1 030	16·8
	dep.	31 3				
Kennington	arr.	33 10	16	2 7	800	12 8
	dep.	33 26				
Oval	arr.	35 41	13	2 15	950	14·3
	dep.	35 54				
Stockwell	arr.	39 1	18	3 7	1,430	15 6
	dep.	39 19				
Clapham-road	arr.	41 53	25	2 34	1,100	14 6
	dep.	42 18				
Clapham Common	arr.	44 18	—	2 0	600	10·2
Totals			3 6	19.50	8 285	—

Speed on journey, 12 3 miles per hour; average running speed, 14 2 miles per hour; average stop in station, 23·3; time spent in station, 13 5 per cent. of time on journey; time spent in station, 15 6 per cent. of running time.

Digitized by Google

reduce the time taken in the stations by means of reducing the number of points of ingress or egress in the train, and of placing one conductor at each point. In consequence of this their average stop is only 23·3 seconds. In this connection a few particulars as to the actual arrangements on the Central London Railway will be of interest. In Fig. 1 we reproduce a photograph of the entrances to two of the carriages on the Central London Railway. The gates are shown open, but the gates on the other side are, of course, closed.

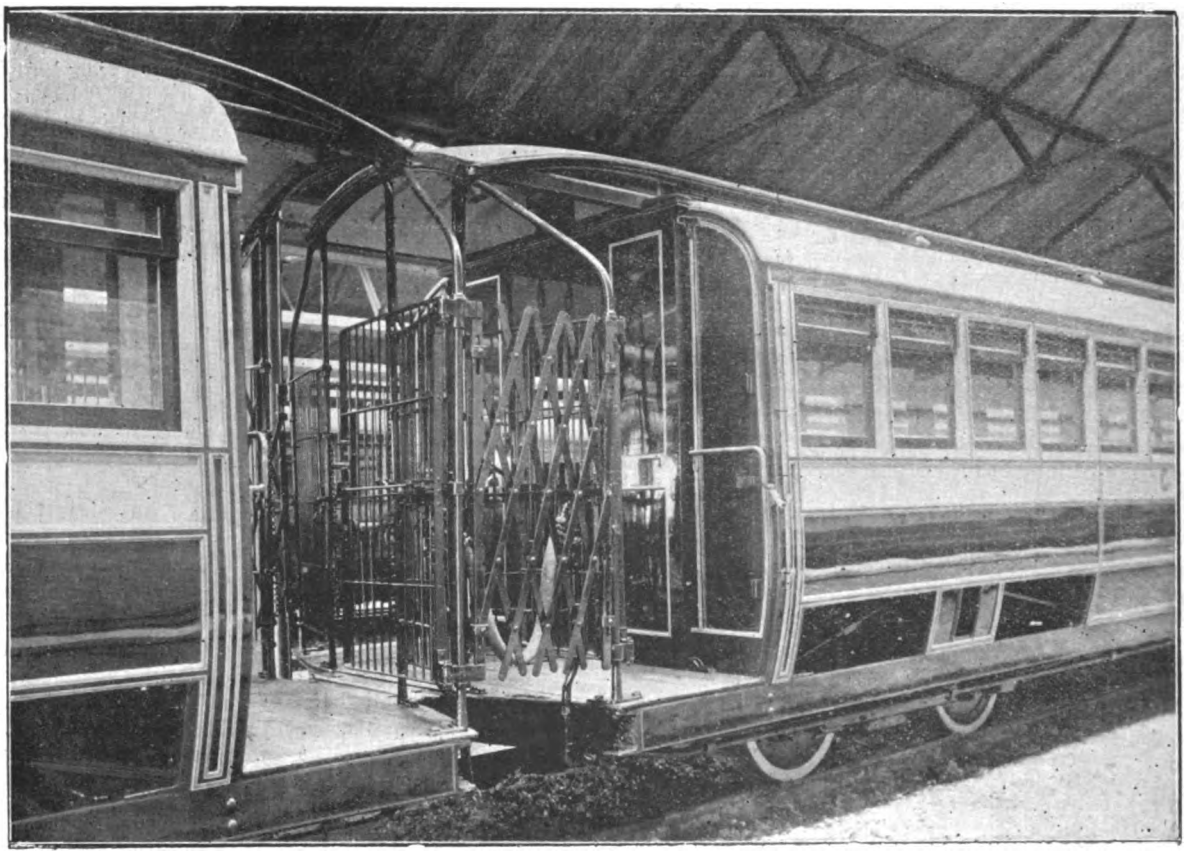


FIG. 1.

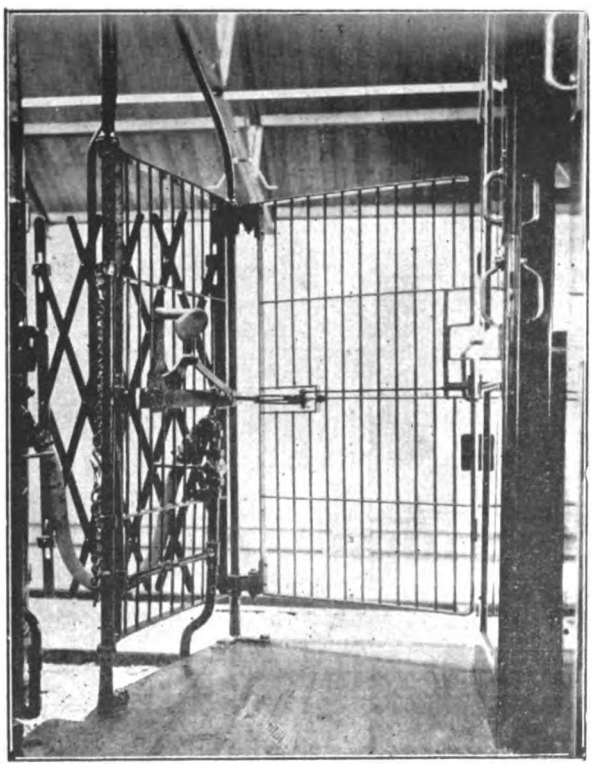


FIG. 2

It will be seen from this and the next illustration (Fig. 2) that these gates are opened and closed by means of levers, which are so placed that the conductor can operate the one gate with his left hand and one with his right. The hinged gates closing outwards have also an advantage from a safety point of view, as passengers trying to board the train while in motion cannot do so. The first element, then, in the shortness of stop is that the gates can be quickly opened and closed. The second element, and in our opinion much more important, is the design of the

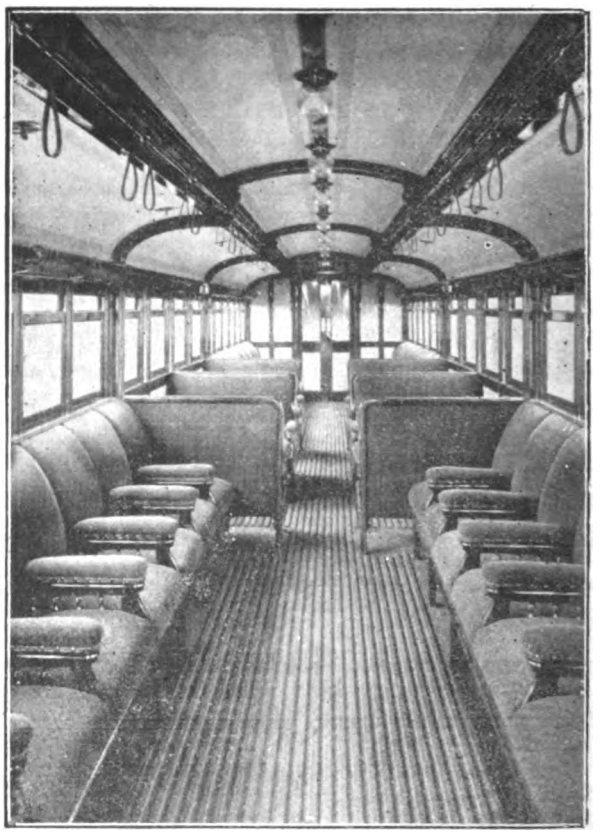


FIG. 3.

seating accommodation in the carriages themselves. Fig. 3 shows a view of this, and we may add that the general arrangements are taken from rolling-stock

Digitized by Google

which has been proved to work successfully on the elevated railways in New York. It will be seen that near the door the seats are placed on either side along the carriage, leaving a broad corridor, in which the passengers collect as the train is being brought to a standstill. In the middle of the carriage the seats are transverse, and hold four passengers in a line across the carriage. Although there is only room for one passenger to pass at a time between these seats, there need be no congestion, as comparatively few people have to use it. A third item in the reduction of the stopping time is the discipline amongst the staff, and the arrangement of calling the name of the next station as the train leaves one station, while as the train is slowing up the conductors also call out the name of the station, which induces the passengers to rise from their seats and collect in the broad gangway. The organisation of the staff is largely due to Mr. C. Aldington, the traffic manager of the line, and he is to be congratulated on the success attained. It must be remembered that there are six conductors on any one train, and that delay on the part of one would keep the whole train back. Perhaps reference should be made to another feature in this saving of time, due to the fact that there is no class distinction on the Central London. It is this hunting for the right class and the closing of the many doors which causes the delay which occurs at the many stations of the District Railway. In conclusion, we have to thank the traffic manager for the permission to take the photographs which we reproduce herewith, and also the British Thomson-Houston Company for the facilities which they have placed at our disposal.

THE "MARY GORDON" ELECTRIC LAUNCH.

This week there was launched from the yard of the Thames Electric and Steam Launch Company, at Strand-on-the-Green, Chiswick, a new electric launch, called the "Mary Gordon," which is designed to accommodate from 65 to 70 people. This launch, which was both designed and built by the company, is to the order of the Leeds Corporation, and will run on the Waterloo Lake, Roundhay Park, Leeds. The dimensions of the boat are: length, 55ft.; beam, 8ft. 6in.; draught, 2ft. 6in; and displacement about 10 tons with full load. The whole of the hull is built of teak, the planking being in narrow widths to allow for expansion and contraction. The cabin is 14ft. long, and the fittings are teak throughout. The cabin is specially designed for this kind of launch, and gives a clear run from stem to stern on a level floor. The accumulators are placed underneath the seats in the fore part of the boat, and are connected up in parallel and series to port and starboard armature and port and starboard field. The motor is designed for marine work, the speed being considerably less than that generally employed on electric launches, but an advantage is gained by the absence of vibration. The motor is in a watertight lead-lined compartment under the floor in the after part of the boat, and connected up direct with the propeller shaft, which drives a gunmetal propeller 24in. in diameter. Incandescent lamps are fixed up in the cabins, and awnings are fitted to the fore and after part of the cabin. The gunmetal steering wheel and the controlling switch are placed forward with two speeds ahead and two astern, and worked with one lever, which can easily be removed, so that the current cannot be switched on by anyone not in charge of the vessel. The whole of the electrical work has been manufactured and completed at the Strand-on-the-Green Works, Chiswick. The "Mary Gordon" is a similar vessel to the "Viscountess Bury," the first electric passenger boat on the Thames with a Board of Trade certificate for 72 people. This latter boat was designed and built by W. S. Sargeant for Messrs. Immisch and Co. in 1888, and which is now running on the Thames at Hampton. The illustrations which we give herewith (Figs. 1 and 2) show the general design of the launch. Fig. 1 is a plan of the same one-half in section, which shows the arrangement of the batteries and also the seating accommodation. Fig. 2 is a sectional elevation of the same boat, from which it will be seen that a very considerable portion of the passengers can be carried under cover. In fact, the cabin is sufficiently large to accommodate them nearly all if some are standing.

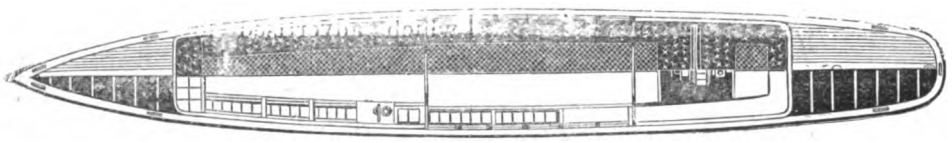


FIG. 1.

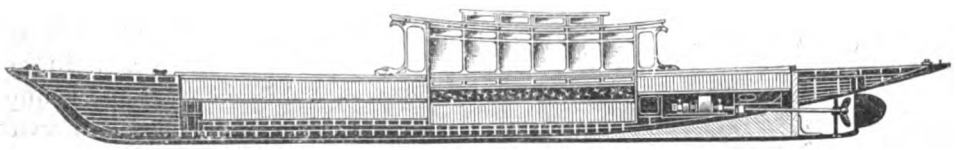


FIG. 2.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—I am disappointed to find Mr. Dunton making such a plausible attempt to cloak the real point of difference between us by drawing the discussion into side issues. His opening remark in your last week's publication is rather beneath contempt, while the remarks which immediately follow it I admit being quite unable to follow in the light of our previous correspondence.

With regard to his further reference to what he erroneously took to be a *non sequitur*, I have already already pointed out that this sentence lends itself, unfortunately, to the misconstruction which Mr. Dunton puts upon it, and were it not for the fact that it is entirely beside the point which is under discussion, he would be justified, perhaps, in making this digression.

In the last paragraph of his letter, Mr. Dunton professes to refer to the real point at issue. All that he does, however, is to link arms with Faraday and others to bolster up his contention. The question is not, however, whether the authority of Faraday is right or wrong on the question of induced currents, but whether or not the statement condemned by Mr. Dunton in Messrs. Slingo and Brooker's text-book is correct. This latter statement in no way whatever contradicts either the laws of Faraday or the remarks quoted by Mr. Dunton from "Dynamo-Electric Machinery." I can only assume that Mr. Dunton's remarks are based on his inability to appreciate the difference between a closed coil moving entirely in a magnetic field and a straight conductor moving in a magnetic field having its ends connected electrically together *outside that field*.

It would be interesting to know, for instance, how Mr. Dunton would explain the action of a simple unipolar dynamo in which an E.M.F. is generated in radial conductors cutting through a continuously uniform field.—

Yours, etc.,
F. JOHNSTON.

Belfast, Oct. 3, 1900.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	469	The Evolution of Switch Gears for High-Pressure Alternating Currents	488
The Electric Lighting of the City of Glasgow	474	Light Railways	492
The Tendency of Modern Dynamo Design	475	A.E.G. Standard-Gauge Electric Locomotive	492
High-Speed Reciprocating Engines	477	Questions and Answers	493
The Electrical Company's New Showrooms	479	Electric Lighting Orders	495
Speed on the London Undergrounds	482	Contracts for Electrical Supplies	498
The "Mary Gordon" Electric Launch	485	Lighting Notes	499
Correspondence	485	Traction Notes	502
Specifications	486	Companies' Meetings and Reports	503
Forthcoming Events	487	Provisional Patents	503
Recent Advances in Wireless Telegraphy	487	Traffic Returns	504
		Companies' Stock and Share List	504

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

SPECIFICATIONS.

The drafting of specifications is a fine art, and, as a rule, the progress made in the art by various engineers can be roughly determined by the variation in prices of the tenders received to the specifications. It must be remembered that the interests of the two parties dealing with specifications for electrical engineering plant are in the main the same. The engineer, with whom we must associate his clients, wishes to obtain the best possible plant at its market value as determined by competition. The contractor who tenders on the specification also wishes, for his reputation's sake, to supply the best article in the market, for only by so doing can he hope to establish a business which shall bring in regular returns and good profits. The competition between contracting firms, however, introduces a third element which is the cause of much trouble—that is, that the contractor not only has to conform to the specification with respect to the quality of his work, but also has to do so at a lower price than his competitors. As an engineer who has gone over from the contracting to the consulting side stated, "Contractors are not in business for the good of their health, and have to consider not only that L which signifies self-induction, but also the L which is crossed by two horizontal strokes." Coming now to the question of the effect of the draughtsmanship of a specification on this last quantity, nothing can be more unfair to the contractor than a loosely-drawn specification which has afterwards to be interpreted at the will of the engineer drawing it up. In such a case the contractor has to estimate for risks which he cannot foresee. As a case in point, we know of one corporation which advertised for tenders for the overhead construction for their electric tramways without drawing up any plans for the same. It was left to the individual contractor to supply what he thought was requisite, and on this basis a contract was entered into without any definite position being fixed for the trolley wire. In carrying out the work we believe that the instructions were equally lax; the result was that the position of the rails having been altered, the trolley wire did not come sufficiently near the centre of the rails to meet the engineer's views. The contractor was finally obliged to carry out extensive alterations in the overhead work, which made his contract most unprofitable. The other extreme from a loosely-drawn specification is one in which the details are given to an unnecessary extent, and insisted on being carried out without any valid reason. It should always be open to a contractor to supply goods in conformity to the general requirements of the specification, but with slight variations in detail as can be proved by him to be advantageous in practice. We do not here refer to such large departures from the specifications as necessitate the sending in of alternative tenders, as there can be no objection whatever to this latter course. Passing on from the specification stage to the time when the goods are being delivered, we have to consider how far the interests of the two parties are alike when serious disconformities from the specifi-

Digitized by Google

cation are disclosed by the prescribed tests. Of course, if the goods are better than called for in the specification, the contractor gains in repute, the consulting engineer claims a fair proportion of the kudos, and they remain the best of friends. In certain cases even a bonus passes from the one side to the other, which still further increases the mutual appreciation. The reverse picture is not so pleasant. The dynamo, for instance, discloses a tendency to act as assistant to the heating plant provided in the station, or it may even be that its commutator renders considerable assistance in the lighting of the same. It is then that one hears complaints of the absurdly low limits fixed for the temperature rises, or of the impossibility of designing machines to run with fixed brushes at all loads. Evidence is also brought forward of machines which have for years run without breakdown in spite of the wretched designs to which they were made. In such a case the consulting engineer can either refuse the machine, or can, if so arranged in the specification, take delivery at a reduced price. This latter course is as a rule strongly resisted by the contractor, but we would point out that it is greatly to the ultimate interest of the manufacturers as a whole that such a reduction in price should be insisted upon. The reduction should be such as to represent the value of the machine when judged according to the specification. For instance, if a thousand horse-power dynamo fails to conform with the specification if more than eight hundred horse-power is taken from it, the price should be reduced by 20 per cent. If this course, which is fair both for the buyer and seller, is not insisted on, it becomes quite impossible for manufacturers to tender to specification. The only successful contractor in that case would be one who possessed an intimate knowledge of the extreme variation from the specification which each consulting engineer would allow. He might then for a few years succeed in passing off his geese as swans, but ultimately his workshops would not be distinguishable from scrap heaps on account of the plant returned to him as condemned after a year or two's running; in short, in competitive tendering the rigid enforcement of essentials is to the ultimate advantage of all concerned.

FORTHCOMING EVENTS.

SATURDAY, OCT. 6.

Association of Municipal and County Engineers.—District meeting at East Molesey and Hampton.

MONDAY, OCT. 8.

Poplar Board of Works.—At 4 for 5.30 p.m., opening of new electricity works at Glaucus-street, E.

FRIDAY, OCT. 12.

Electro-Harmonic Society.—At St. James's Hall Restaurant, first smoking concert of season.

RECENT ADVANCES IN WIRELESS TELEGRAPHY.

The following letter from Prof. Fleming appeared in the issue of the *Times* for yesterday:

Sir,—As the subject of wireless telegraphy has not yet apparently lost interest for the general reader, I venture to ask a little space to make known for the first time some recent achievements by Mr. Marconi which have astonished those who have been allowed to examine them. Everyone is aware that in his system of electric wave telegraphy an important feature is the employment of an elevated conductor, which generally takes the form of a wire suspended from a mast. When Mr. Marconi attracted attention by his feat of establishing communication across the Channel without wires, critics raised a not altogether valid argument against its commercial utility, that a wave or signal sent out from one transmitter would affect equally all receivers within its sphere of influence, and hence the privacy of the communication would be destroyed. No one felt the force of this objection more strongly than the distinguished inventor himself, whose original work has caused so many others to attempt to follow in his steps. For the last two years he has not ceased to grapple with the problem of isolating the lines of communication, and success has now rewarded his skill and industry. Technical details must be left to be described by him later on, but meanwhile I may say that he has modified his receiving and transmitting appliances so that they will only respond to each other when properly tuned to sympathy. I am well aware that other inventors have claimed to be able to do the same thing, but I do not fear refutation in saying that no one has given practical proof of possessing a solution of this problem which for a moment can compare with that Mr. Marconi is now in a position to furnish.

These experiments have been conducted between two stations 30 miles apart, one near Poole in Dorset and the other near St. Catherine's in the Isle of Wight. At the present moment there are established at these places Mr. Marconi's latest appliances, so adjusted that each receiver at one station responds only to its corresponding transmitter at the other. During a three days' visit to Poole, Mr. Marconi invited me to apply any test I pleased to satisfy myself of the complete independence of the circuits, and the following are two out of many such tests: two operators at St. Catherine's were instructed to send simultaneously two different wireless messages to Poole, and without delay or mistake the two were correctly recorded and printed down at the same time in Morse signals on the tapes of the two corresponding receivers at Poole.

In this first demonstration each receiver was connected to its own independent aerial wire hung from the same mast. But greater wonders followed. Mr. Marconi placed the receivers at Poole one on the top of the other, and connected them both to one and the same wire about 40ft. in length, attached to a mast. I then asked to have two messages sent at the same moment by the operators at St. Catherine's—one in English and the other in French. Without failure, each receiver at Poole rolled out its paper tape, the message in English perfect on one and that in French on the other. When it is realised that these visible dots and dashes are the results of trains of intermingled electric waves rushing with the speed of light across the intervening 30 miles, caught on one and the same short aerial wire and disentangled and sorted out automatically by the two machines into intelligible messages in different languages, the wonder of it all cannot but strike the mind.

Your space is too valuable to be encroached upon by further details, or else I might mention some marvellous results, exhibited by Mr. Marconi during the same demonstrations, of messages received from a transmitter 30 miles away and recorded by an instrument in a closed room merely by the aid of a zinc cylinder, 4ft. high, placed on a chair. More surprising it is to learn that, whilst these experiments have been proceeding between Poole and St. Catherine's, others have been taking place for the Admiralty between Portsmouth and Portland, these lines of communication intersecting each other; yet so perfect is the independence that nothing done on one circuit now affects the other, unless desired. A corollary of these latest improvements is that the necessity for very high masts is abolished. Mr. Marconi now has established perfect independent wireless telegraphic communication between Poole and St. Catherine's, a distance of 30 miles, by means of a pair of metal cylinders elevated 25ft. or 30ft. above the ground at each place.

I need not enlarge on the possibilities thus opened out

Digitized by Google

for naval and military purposes. The importance of this practical solution of the problem of independent electric wave telegraphy, in which each wireless circuit is as private as one with a wire, is obvious without comment. My desire is solely to mention the above facts for the benefit of general readers, whose minds will thus perhaps be eased of any doubts lest this brilliant application of electrical discoveries should, like some others, fall short in satisfying the requirements of practical use and be relegated to the region of imperfect inventions or unfulfilled hopes.—I am, Sir, yours obediently,

J. A. FLEMING.

University College, London, Sept. 28.

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

(Continued from page 419.)

The standard high-pressure panel now adopted by Messrs. Ferranti is shown in Fig. 45, where the following modifications will be noticed. The high-tension instruments are supplied with current through a small oil-break fuse, and the spring link of the older boards is replaced by a solid link, bolted on to the 'bus bar fitting and 'bus bar. The bolt holes in the bar fittings and the slots in the links are of such a pitch that the link which will connect the 'bus bar with the panel fitting will also couple two fittings together. An insulated spanner and lifting handle allow of the alteration of the links under current. The synchronising contact is also an improvement on the old solid type. It consists of a brass swing piece pivoted to a small shank, which is sulphured into a recess in a brass casting. This same casting is provided with a curved projection cast on it, around which is wound a spring. A hole in the swing piece is made of the same diameter as the projection on the fitting, so that when the switch is raised to "synchronise," the blades press the swing piece against the spring, thus connecting the incoming machine through a small 'bus bar and oil-break fuse to the synchroniser and its high-tension voltmeter.

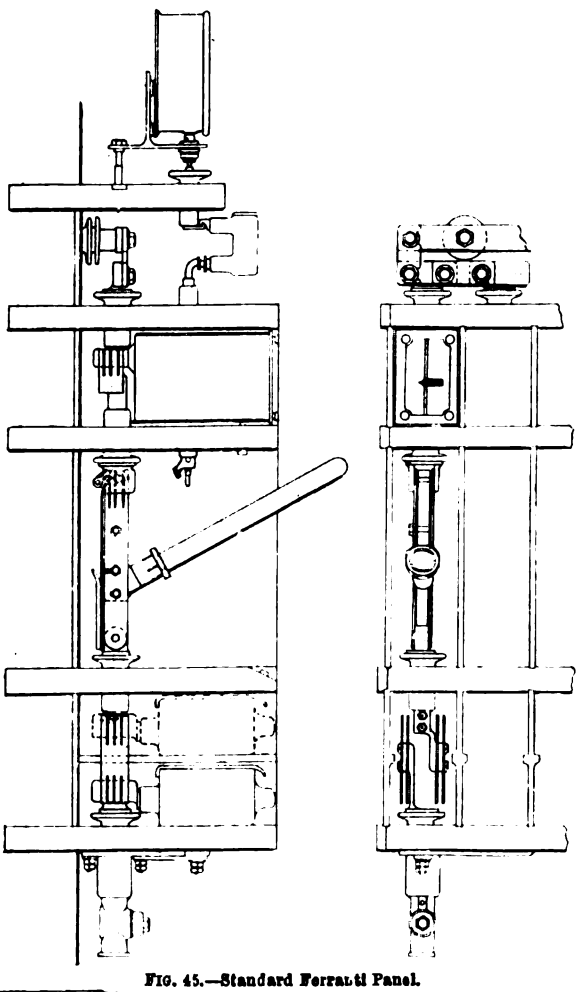


FIG. 45.—Standard Ferranti Panel.

A board, with two inner 'bus bars, erected to the above standard design, is shown by Fig. 46. Below the high-pressure gear will be seen the regulating table, with its handwheels, ammeters, and switches. Beneath the latter four sockets are discernible, and these allow the changing over of the machine field, from an exciter on the alternator shaft to a battery, or *vice versâ*, through a plug switch. The slate on which the field switch is mounted, carries all terminals for the exciter currents, and a bracket to which the field ammeter is fixed in such a way that its scale may be observed through an opening in the upper slate, close to the rheostat handwheel. The rheostat is also an improvement on the older form, it being of the open type, and fixed in the most convenient position procurable, below the regulating table, whence it is operated by the handwheel.

Fig. 47 illustrates two open-type rheostats joined together to form one complete resistance. The single rheostat is, however, generally used, except where the energy to be dissipated exceeds 1,750 watts, when two frames are geared together, as shown. It will be seen that the rheostat is complete in itself, there being no cable connections to separate resistance frames, or sweating sockets, save at the only two terminals needed. The wires are wound on frames provided with stoneware insulating bridges, one set of these being fitted with the stops and terminals. Two such frames are bolted together on one base, the wires of each frame being prevented from touching by spacing pieces at the top and bottom of the rheostat. A slider bridges the stop of the two frames, so that the wires are connected in series. The slider is constructed to bear on the upper and under sides of the stops, which are provided with projections, these tending to keep the connecting bridge firmly in contact with the stops. A screw with coarse pitch operates the slider, so that very little rotation of the handwheel is needed for adjustment of the resistance, and a spring at the upper end of the spindle acts as a damper to the slider when it is brought violently

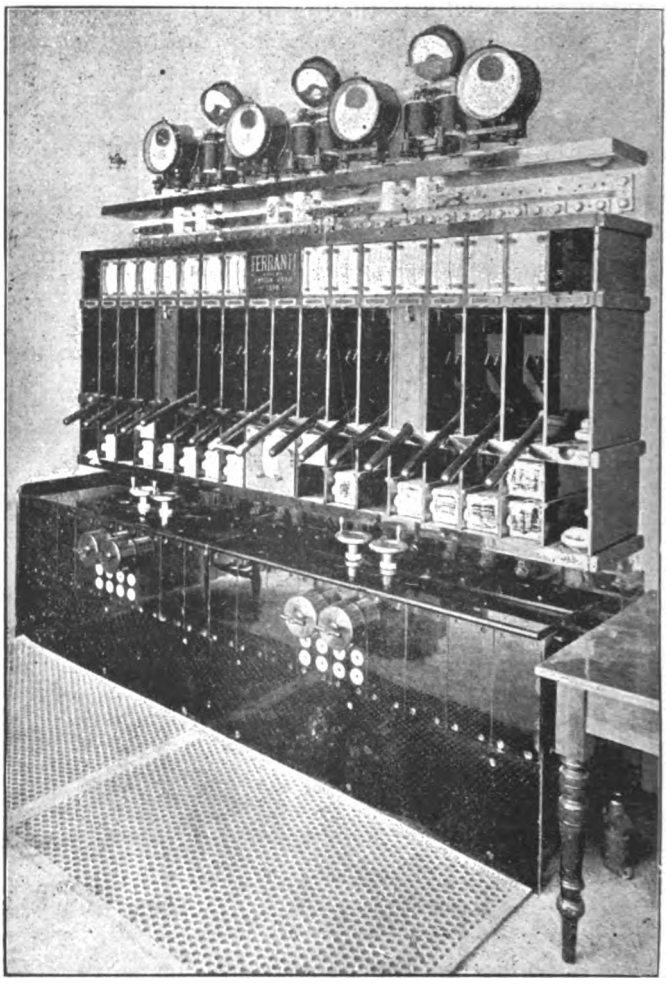


FIG. 46.

Digitized by Google

to either end of its travel. No current passes through the spindle, the slider only acting as part of the circuit. The panels for dealing with currents above 300 amperes are constructed on the same principle in the slate framework as the smaller gears save that the cells are 9in. wide, the

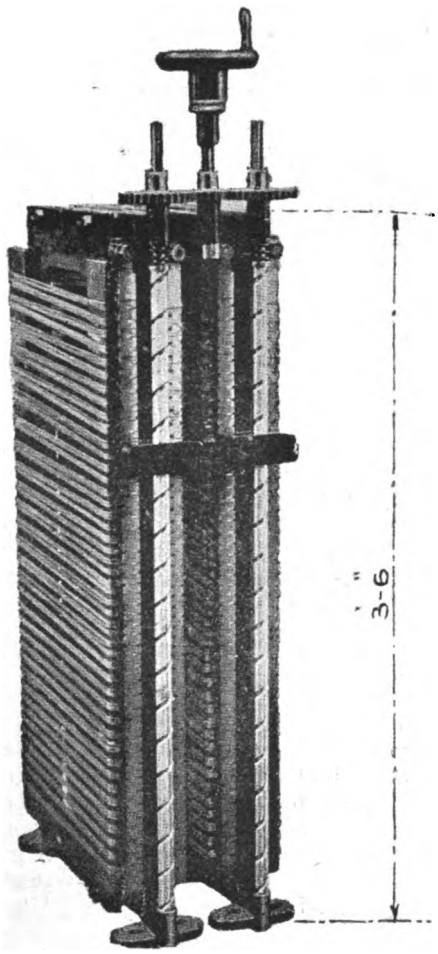


FIG. 47.—Ferranti Rheostat—Open Type.

fittings generally are of large section, and the spring-break switch is replaced by one having an oil break. The principle of this switch will be gathered from Fig. 48, where front and side (sectional) elevations are shown. The moving parts are fastened to a casting, which is bolted to a fitting sulphured into a porcelain insulator on the lower slate. This casting carries an oilpot, O, fitted with gland, G, and a gauge glass, G^1. Through the gland passes a steel rod, R, fitted at one end with a plunger working in a dashpot (to be seen at the base of the switch); a collar, C, is fixed on the rod in the centre, and a final contact piece is screwed in at the upper end. A long polished teak handle operates the blades, B B, which also carry a spindle, P, fitted with a link, L. This link moves, through the medium of an arm A, pivoted to the body of the switch, two other links, L^1 L^1, joined at their upper extremities by a cross-piece, D. The rod, R, passes with clearance through this cross-piece, between which and the end of the plunger on the rod will be seen a powerful spring, S. The switch is shown in the "on" position, when the blades complete the circuit from the casting at the points :a—a: to the fitting fixed in the insulator on the upper slate. A final contact-piece, F, is held in this fitting by a screw, and in this contact the steel rod passes when the switch is closed. In opening the switch the action is as follows: The handle is pulled down, and the blades will leave the upper contact altogether. The rod, R, however, still completes the circuit, it being of sufficient sectional area to carry the full capacity of the switch. In its downward motion the handle causes the blades to move the links, L, A, L^1, L^1, and thus puts the spring, S, in tension by means of the cross-piece, D. The energy thus stored in the spring is applied to the rod through the medium of the plunger, but a catch, C^1, has kept the rod in the upper contact by holding up the collar, C. This catch takes the form of a crank lever pivoted to the switch body, but its horizontal arm carries a spindle passing through a block, M, fixed to the arm, A, and provided with two adjusting nuts, N N. A further descent of the blades compresses the spring, S, until the small block above mentioned bears on the surface of the nuts. At this moment the catch, C^1, is hit off, when the rod, by reason of the spring, S, flies quickly from the upper contact into the oil contained in the pot. The dashpot damps the blow of the rod, which has thus broken the circuit. A small spring, S^1, takes the catch, C^1, back to its place again. It will be noticed that the spring, S, is never in tension until the switch is opened, so that it is not in any way losing its power, even though the circuit be closed for long periods. The final contacts of switch and fitting may be renewed in case of their becoming burned. The synchronising contact differs from the smaller types in that the incoming machine is put on to the synchronising bar through an oil-break fuse of similar make to that used for the instruments. The capacity of panels so fitted is 1,000 kw., there being fuse, switch ammeter, and 'bus bar fittings as in the smaller gears.

Messrs. Ferranti have equipped many stations with standard switch gears of both sizes, but in some cases where replacing old boards some special requirements have been called for by the engineer. The fact that these needs have been met in a most satisfactory manner speaks well for the general flexibility of the design. A switchboard which has been recently erected for the Huddersfield Corporation illustrates this last statement very well. The gear was arranged to meet the requirements of Mr. A. B. Mountain, M.I.E.E., the borough electrical engineer, who originally laid down the station in 1883. The system employed is a single-phase alternating-current one, and the

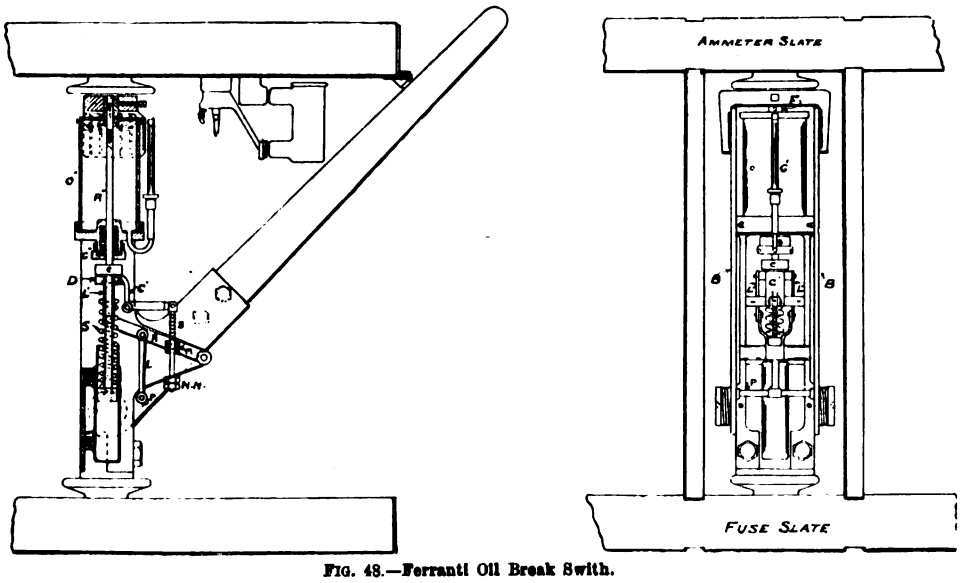


FIG. 48.—Ferranti Oil Break Swith.

Digitized by Google

alternators have been run on separate circuits since the supply was started. The board erected by Messrs. Ferranti differs from their standard design only in the arrangement of the inner 'bus bars, there being three of these instead of one. Fig. 49 is a photograph of the complete board, which comprises a dynamo board (Fig. 50) in the centre and two circuit boards, one on either side of the dynamo gear

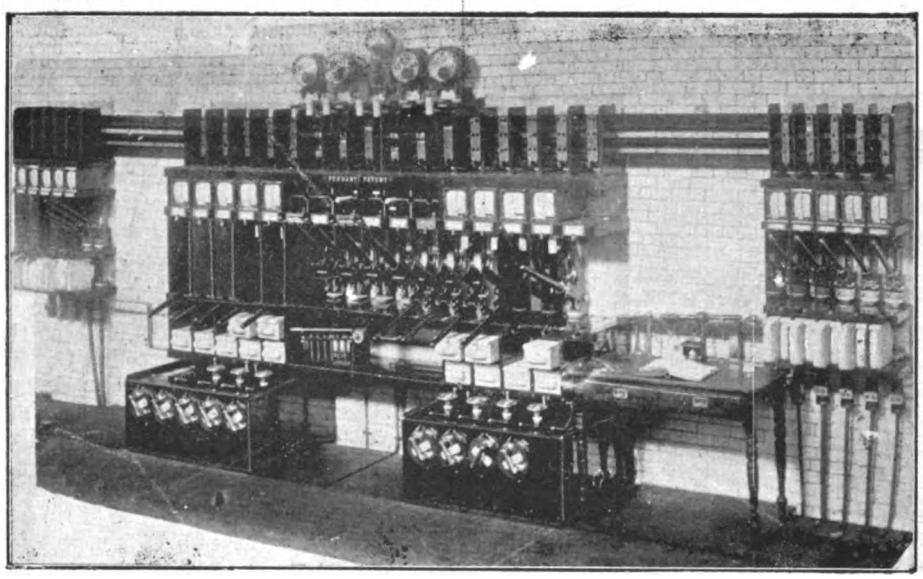


FIG. 49.—Huddersfield Complete Board.

(Fig. 51). These photographs will give an idea of the general arrangement of the board, and the diagram in Fig. 52 will explain the connections of the high-pressure portion. Each dynamo and circuit is provided with a fitting having three holes in it, at centres corresponding to the centres of the three 'bus bars, so that any dynamo can be connected to any one or number of circuits by means of a special expansion plug.

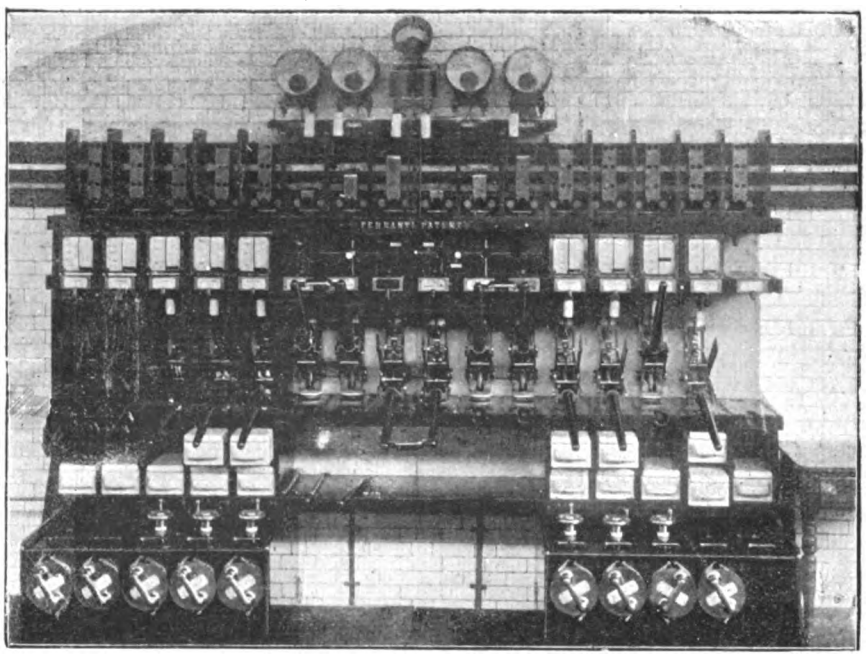


FIG. 50.—Dynamo Board, Huddersfield.

A sectional elevation through the three 'bus bars and fitting shows this plugging device (Fig. 53). The 'bus bars, made up of 2in. by ¼in. copper strip, are mounted on insulators cemented at suitable intervals into the wall. A bar of smaller section is fixed in front of the main bars, and carries sockets for the insertion of the plugs. These sockets are bolted to the bar by small screws, and the bar is fixed to the main laminations by small bolts with spacing washers, over the centres of each vertical slate. A gunmetal casting is bolted to the 'bus bar fitting of each panel, and this casting has three bosses on it corresponding with the sockets on the 'bus bars. Holes 1in. diameter are drilled through these bosses, and the sockets are also bored for a similar diameter. The expanding plug consists of a copper tube tapered from each end towards the centre, and provided with a number of sawcuts in each tapered portion to render the tube flexible at its ends. A brass spindle having a cone (with similar taper to that of tube) turned on it at one end, and being screwed at the other end to receive a travelling cone, is passed through the tube. After the insertion of the spindle in the tube the travelling cone is screwed on, and it is fitted with two pins which travel along the sawcuts and prevent its rotation in the tube. A stop fixed to the spindle behind the moving cone keeps the latter from leaving the tube. After the plug is pushed into its socket, through the boss in the front fitting, it is expanded in place by turning the brass spindle with an insulated handle having a bayonet socket at one end. The rotation of the spindle causes the moving cone to travel inwards by reason of the pins which prevent it turning in the tube. The cone on the spindle also moves towards the centre, and when the handle can no longer be moved the plug has been properly expanded, nor will any efforts to withdraw it be availing until it is contracted by the opposite rotation of the handle. A stop on the

Digitized by Google

copper tube engages with a pin in the face of the 'bus bar fitting, so that when the tube is being expanded it will not rotate in the hole. The handle can be removed when the plug is inserted, so that there are no unsightly projections above the board. Vertical and horizontal guard slates serve to insulate the bars and fitting from one another, besides preserving the panel arrangement in a vertical line

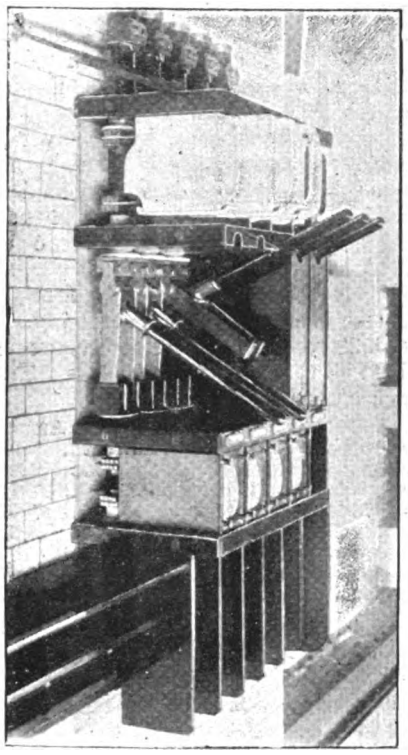


FIG. 51.—One of the Circuit Boards, Huddersfield.

down the board. The slates fit into one another and are thus self-supporting, but several vertical slates may be removed at once for purposes of cleaning and inspection without the horizontal slates altering their position.

Referring again to the diagram (Fig. 52), it will be seen that the board is capable of dealing with 10 dynamos (1,000 kw. each) and 10 circuits (400 kw. each at present, but can be fitted to take 600 kw. each). The dynamo and

plugging to do while the alternators are in parallel. Each machine that has to run during an evening is plugged up on a certain bar with circuits loaded to the capacity of the particular dynamo, and when the time arrives for it to be put in, it is paralleled with the machine already supplying the whole board. The circuits to be fed from the new machine are already plugged up on the correct bar, and when their ammeter readings are obtained on the dynamo ammeter the bar is separated from the rest of the board by opening the interconnector switch. Should this now isolated machine meet with a mishap or breakdown, the circuits which it is feeding may be supplied by another machine without affecting the rest of the board. The bars are paralleled when it is necessary to take off the extra

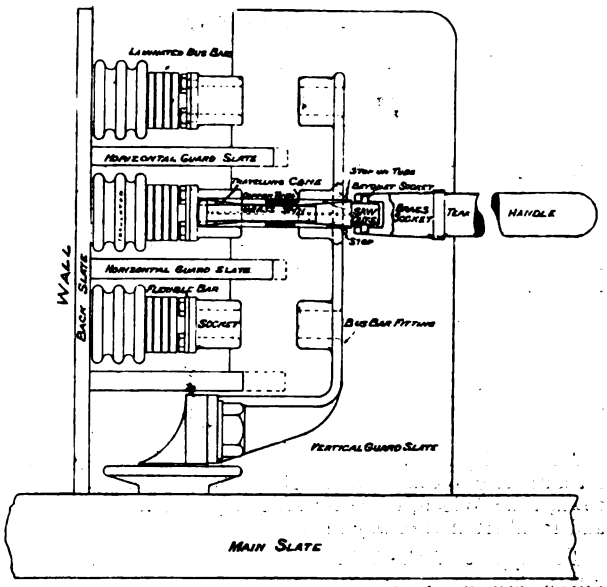


FIG. 53.—Ferranti Expansion Plug and Fittings.

machine, the interconnector switch then remaining closed. It will be noticed that the instruments at the top of the board are very few in number when compared with the machines and bars supplied. The voltmeters, four in number, indicate the pressures on each bar and the incoming machines respectively, and one synchroniser only fills the purpose for paralleling bars together or any machine on to any bar. This is effected by means of a

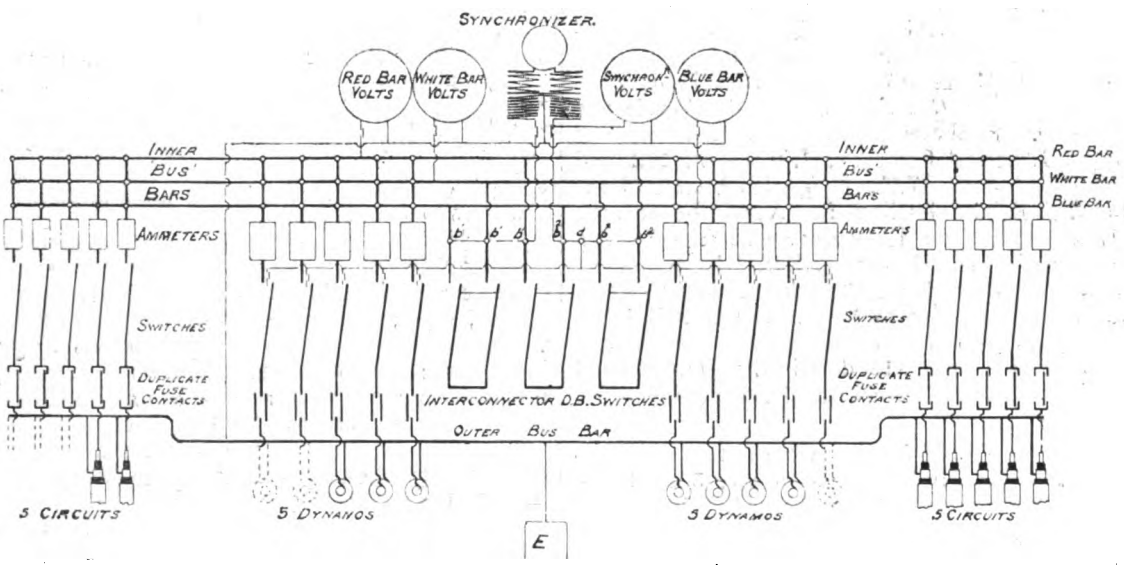


FIG. 52.—Diagram of Connections, Huddersfield Board.

circuit gears are separated from one another by a space of 3ft. 9in., and the arrangement allows of both boards being extended independently up to a certain point. The three inner 'bus bars are coloured, for distinction, red, white, and blue, and they may be all connected together by three interconnector switches in the centre of the dynamo gear. This allows of machines being run separately on one or a number of circuits, and the compactness of the switches renders the operation a very simple one, there being no

plugging arrangement, to be seen in the photograph above the interconnector switches. In the diagram at b^1 b^2 will be seen six sockets, three on either side of the centre of the board, and a seventh at d. These are on two bars, each connected to either limb of the synchroniser by means of a plug. The socket d is coupled to the synchronising bar recessed in the ammeter slate, so that when a machine is run up from rest and paralleled with the board, this socket must be connected through the plug to one limb of

Digitized by Google

the synchroniser, and other limb being supplied through a plug connected to any of the 'bus bars. A guard slate is fixed before each of these synchroniser bars, and it is coloured by a line over each plug hole corresponding to the 'bus bar connected. A locking device prevents the insertion of two plugs on one side, so that the 'bus bars cannot at any time be connected when they have a difference of phase and potential through either synchroniser bar. The connections to the synchroniser and voltmeters are effected by means of bare braided flexible in ebonite tubes, thus avoiding the use of all rubber-covered couplings. The name plates of the interconnectors are coloured to represent the bars which each switch connects, so that mistakes are reduced to a minimum.

(To be continued.)

LIGHT RAILWAYS.

The Light Railway Commissioners will hold an enquiry at the town hall, Kidderminster, on Oct. 17 at 1.45 p.m. into the application which has been made to them by the Kidderminster and District Electric Lighting and Traction Company, Limited, for an order to authorise the Kidderminster and Bewdley light railway.

The Light Railway Commissioners held a public enquiry at Blackburn on Tuesday morning, and decided to recommend the application which had been made to them by the Auxiliary and Light Railways and Tramways Company, Limited, for an order to authorise the construction of the Blackburn, Whalley, and Burnley district light railway.

An enquiry has been opened at Wigan into an application for authority to construct a light railway from Ashton to Newtown, near Wigan, there forming a junction with the Wigan and Pemberton tramway line.

In support of the Witney, Burford, and Andoversford light railway scheme, a public meeting of the inhabitants of Northleach and neighbourhood was held at the institute on Tuesday evening.

A E G. STANDARD-GAUGE ELECTRIC LOCOMOTIVE.

In our issue of Sept. 28 we described the standard-gauge electric locomotive exhibited by the Allgemeine Elektricitäts-Gesellschaft at the Paris Exhibition. This week we are enabled to publish the translation of a report by Inspector Loch, of the Prussian State Railways, on the working costs of an A.E.G. standard-gauge electric locomotive employed for shunting operations in the railway yard at Gleiwitz (Germany). The report in question appeared originally in *Glaser's Annales für Gewerbe und Bauwesen*, and the translation herewith was kindly supplied to us by the Electrical Company, Limited, of 122 and 124, Charing Cross-road, W.C., the British branch of the Allgemeine Elektricitäts-Gesellschaft. As will be seen, the figures given by Inspector Loch prove conclusively that a handsome saving is effected by the electric locomotive as compared with steam working. The locomotive to which the figures refer is of what is known as the A.E.G. 166 type, and the principal differences in construction compared with the locomotive type 115, described in our issue of last week, will be gathered from the following report by Inspector Loch :

The locomotive was built for the overhead trolley system of working, and is of full—that is to say, 3ft. 11in.—gauge, with two axles coupled together, the diameter of wheels being 3ft. 7½in. The distance between the axles is 4ft. 11in., the over-all length between the buffers 17ft. 4½in., width 7ft. 5¾in., and height to the roof 10ft. 6½in. The total weight of the locomotive is 9 tons. The driver cab is roofed in, and is symmetrically arranged in the centre of the locomotive. The free space in front and rear is sheathed, and may serve to store accumulators. The motor is of the V.N.B. 125 type, coupled to the driving axle by means of a double reduction gear of 1 : 5 and 1 : 4·5 ratios respectively, the spindle of the latter gear being mounted direct upon the frame on a level with the driving axles. The motor rests on this spindle by means of two bearings, the other end being suspended on springs from the frame. The motor starters and regulators are mounted inside the cab. The locomotive is provided with a hand brake and compressed-air siren, and is illuminated by electric incandescent lamps. The overhead wire is suspended about 16ft. or 17ft. above the rails, and the current is collected by means of a contact bow, which automatically alters its relative position to the wire when the direction of travel is reversed. The part which comes in contact with the wire was originally made of aluminium in order to subject the wire to as little wear as possible. Experience, however, showed that the aluminium wore away too rapidly, and this was eventually replaced by steel wire, which has proved eminently satisfactory. The locomotive was specified to be fully capable of drawing a load of 100 tons at the rate of 3ft. 3in. per second on a level track, and also to be capable of varying the speed from 2ft. 6in. to 6ft. 6in. per second. A larger variation of speed was, according to the tenders received from the competing firms, not possible unless more than one motor were employed. The supply pressure was 220 volts. The locomotive supplied by the A.E.G. fulfilled all the specified conditions. The results of various tests are tabulated below :

	Amperes.		Volts.
1. Locomotive without load—Starting current...	20	at	210
When running at highest speed	22 24	,,	210
2. Locomotive when pushing or pulling 12 trucks = 78·76 tons—Starting current	70-60	,,	200
At highest speed	40 33	,,	200
3. Locomotive when pulling 16 trucks = 106 56 tons—Starting current	75·70		—
At highest speed	43 50		—

	Feet per sec.
The highest speed attained was—Without load..... ...	7 02
When fully loaded	5 41

It was decided, however, that the speed attained, especially for long distances, was insufficient. The existing gear did, however, not allow an increase in speed without altering the ratio of reduction, and it was therefore decided to increase the pressure in the mains. This was effected by means of a booster, which increased the pressure from 220 to 230 volts. This arrangement has proved very effective, and has been in operation since last October. The results of various tests under the modified conditions are tabulated below :

	Amperes.		Volts.
1. Locomotive without load—Starting current...	55·50	at	310
At highest speed	20 19	,,	310 315
2. Locomotive pulling eight trucks (46·8 tons)—Starting current	60·50	,,	300
At highest speed	30 25	,,	310
3. Locomotive pulling 12 trucks—Starting	60-40	,,	310
At highest speed	26-28	,,	310
4. Locomotive pulling or pushing 18 trucks (106 tons)—Starting	80 60	,,	300
At highest speed	28 35	,,	300·294

	Feet per sec.
Speeds—At no load	11·1
With 25·30 tons	9·2
With 46·8 tons.....	8·37
With 105 tons	6·25

The cost of installation was as follows: for electric locomotive, £400; for overhead line, £700—together, £1,100. In the tender six tons was stated as the weight of the locomotive: the complete locomotive, however, weighs 9 1 tons, so that the correct cost of locomotive may be taken as £500. The overhead line, when extended to all the lines in the yard, will cost an additional £375, so that the total capital outlay will amount to £500 + £700 + £375 = £1,575.

The working expenses of the electric locomotive are as follows: salary for the driver per annum = £77, or per day, 5·13s.; further wages for a shunter, 2·4s.—total per day, 7 53s.

The locomotive works about eight hours a day. Considering the very intermittent service when shunting, the average current consumption is about 16 amperes. Or per day $= \frac{8 \times 16 \times 330}{1{,}000} = 42{\cdot}24$ kilowatt-hours at 1·38d. = 4·65s.; for repairs per quarter (December to February), about 7·5s.; for oil and waste, 11s.—total, 18·5s. If, however, the repairs are taken at 4 per cent. of the capital expenditure

Digitized by Google

$= 0{\cdot}04$, 31,500 = 1,260s.; and for oil and waste, 100s.—total, 1,360s. Then the amount per day is $\frac{1,360}{300} = 4\ 53$s.

The total cost of running the electric locomotive per day is, therefore, 7·53 + 4·65 + 4·53 = 16·71s.—say 16s. 9d. Five per cent. interest on capital $\frac{0\ 05 \times 31,500}{300} = 5\ 25$s., say 5s. 3d. A steam locomotive weighing 31 tons would cost about £1,750.

Running Expenses.—Wages for the driver, 1,580s.; wages for the stoker, 1,280s.—total, 2,860s.; or per day, $\frac{2,860}{300} = 9\ 53$s.

Further shunting allowance and bonus for driver per day, 8 × 0·125 = 1s.; for the stoker, 8 × 0·08 = 0·7s.—total, 1·7s. Wages for shunter per day, 2·4s. Cost of coal per day of eight hours = 150 + 8 × 40 = 470 kg. (1,040lb.), at 9s. 3d. per ton = 4·23s.; for oil and waste, about 13½lb., at 2·2d. = 2 4s.—total, 6·63s.

For repairs and maintenance allow about 0·066 (6·6 per cent.) of the capital expenditure per annum, as found by actual experience during 1898-90—*i.e.*, 0·066 × 35,000 = 2,310s., or $\frac{2,310}{300}$ per day = 7 7s. The total cost per day for a steam locomotive for shunting operations is, therefore, 9 53 + 1·7 + 2·4 + 6·63 + 7·7 = 27 96s.—say 28s.

For depreciation 7 per cent. has to be allowed in the case of a steam locomotive per annum. Or per day $\frac{0{\cdot}07 \times 35,000}{300} = 8{\cdot}17$s.—say 8s. 2d.

To do the work by manual labour would require at least 12 men and a foreman. This would require wages per day 12 × 2·2 + 2 6 = 29s. It will, therefore, be seen that the electric service is by far the cheapest, and that a saving of over 40 per cent. in favour of the electric service has been effected.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

313. When testing an electric locomotive, both in the shop with a brake on the wheels and when pulling a train on the line, what are the quantities which have to be measured? In the latter case, does the draw-bar pull multiplied by the space moved over represent work comparable to the energy supplied to the motors?—P. T.

314. In working shunt-wound motors from a 110-volt circuit nominal, the voltage sometimes drops to 100. If the supply of current is practically unlimited, as from a large generating station, how will this voltage drop affect the working of the motors, electrically and mechanically?—W. G.

ANSWERS.

Question No. 307.—To what extent would the capacity of a compound or shunt machine be affected when working in extremes of temperature, such as are experienced on some ocean liners? Give the ratio.

Best Answer to No. 307 (*awarded* 10s.).—The high temperature of the surrounding air affects a dynamo in two ways: it reduces the terminal voltage by increasing the resistance of the shunt, and thus reducing its exciting power, and it reduces the maximum safe current which the armature can give without damaging its insulation. The latter effect may be dismissed in most cases as of no great importance, for suppose the armature rises 70deg. F. above the surrounding air after a long run at full load, and that the temperature of the room is as much as 120deg. F. (which may occur on board ship), the actual temperature of the winding will be 190deg. F. (or a little more, due to the increased C^2R loss at the higher temperature), and this is insufficient to materially damage ordinary insulation unless kept up for a very prolonged period. Still, the overload safely obtainable from a machine is certainly somewhat reduced when working in the high temperature. On the other hand, the drop in voltage is a serious matter. In the case of a shunt machine wound to only just give its correct voltage of full load in a normal room temperature of, say, 70deg. F., the result of running the machine in a temperature of 120deg. F. would be to increase the resistance of the shunt winding by about ·3 × (120deg. − 70deg.) = 15 per cent. (·3 being approximately the correct percentage increase of resistance per 1deg. F. for copper, allowing for the fact that the temperature rise of the inner layers is considerably higher than that measured by a thermometer on the outer layer of the shunt). This 15 per cent. increase of resistance, and consequent reduction of exciting ampere-turns, will produce a voltage drop of about 8 to 12 per cent., according to the state of saturation of the magnet iron, and this again will reduce the shunt current, which in turn reduces the voltage once more, and so on, until a steady state is again reached with an actual drop in voltage of easily 15 per cent. or more.

In the case of a compound dynamo the effect on the shunt winding is exactly the same as in a simple shunt dynamo, so that the no-load voltage of the machine will be reduced about 15 per cent., as shown above. At full load, however, the drop will be much less than 15 per cent. (probably not more than 5 to 10 per cent.), because the shunt winding only forms a certain proportion of the whole excitation at full load, the rest being series winding, the exciting power of which is not in the least affected by temperature. The effect of the higher temperature on a compound dynamo is therefore not only to lower the voltage at all loads to a greater or less extent, but also to spoil the compounding. Thus, a machine which compounds level in a 70deg. F. room temperature, will compound up 5 to 10 per cent. in a 120deg. F. room temperature.

More exact figures for the different drops cannot be given, because they depend so decidedly both on the point on the saturation curve of the magnet iron at which the machine is working, and also on the shape of this curve. Some of the remedies for these excessive drops due to heating are: (1) the machine should be worked with nearly saturated iron; (2) the magnet winding should be made particularly cool; and (3) a regulating resistance should be kept in the shunt winding of even a compound dynamo, so that as the machine heats up resistance may be cut out by hand, thus keeping the shunt current constant.—Q.

Answer to No. 307 (*awarded* 5s.).—When any dynamo is set to work, the temperature of their masses gradually rises above that of the surrounding air, until, finally, the rate at which the heat is generated is equal to the rate at which it is carried off by radiation, convection, and conduction, when no further rise in temperature will take place. Therefore, the rise in temperature depends essentially upon the amount of cooling surface provided and its actual effectiveness in dissipating heat. So that by the extent of the cooling surface being so proportioned to the watts expended in supplying energy to the field coils and armature, extreme rise in temperature is prevented. In the first place, the higher the temperature the greater will be the loss of energy due to the passage of a given current, for the electrical resistance of copper increases ·21 per cent. per degree F. If, therefore, the temperature be raised from 60deg. to 120deg. F., the increase in the resistance will be 12·6 per cent. of the resistance at 60deg. F. The limits of temperature within which dynamos are worked under average conditions may be taken between 60deg. and 120deg. F., the latter being the ultimate temperature to which the coils attain when continuously worked for many hours together at normal output. Therefore, if the copper on armature rises 60deg. F., its resistance will be increased 12·6 per cent., or R_a hot = R_a cold multiplied by 1·126; so that

Digitized by Google

when a given current is passed through the armature, the loss in volts over its resistance when hot is, of course, increased by the same percentage. In the same way will the heating of the field coils increase the loss of power in them for the same output at the terminals.

But in measuring the temperature it must be remembered that the temperature of the inner layers of the winding is considerably higher than that of those of the surface, and in calculating the resistance of any such coils the average temperature has to be taken as higher than that of the outer layers as measured by a thermometer. The allowance to be made will, of course, vary with the depth of the winding and the closeness with which the coils fit the magnet limbs. For the field-magnet coils of ordinary machines the ratio of the actual increase of resistance to the increase as calculated from the temperature of the surface varies from 1·25 for a depth of winding of ¾in. to 1·5 for a depth of 2½in. to 3in. Thus, if the depth of winding be 2½in. at the temperature at the surface = 55deg. F., the actual increase in the resistance will be ·21 × 55deg. × 1·5 = 17·3 per cent., so that the resistance hot will be increased by an amount equal to 17·3 per cent. of the resistance cold. But now in the case in question the extreme heat is not the consequence of the current passing through the coils beyond certain limits, but due to the temperature of the surrounding air, consequently the average temperature must not always be calculated as explained above. But after the maximum temperature generally allowed for ordinary dynamos has been reached—that is, 120deg. F.—the increase in resistance due to any further rise in temperature should be calculated direct from the temperature of the surface, for the coils will then be almost at the same temperature in every part in consequence of there being no radiation. Then, knowing the increase in resistance per degree F., and, therefore, the lost energy, the ratio of the efficiency at any temperature can be calculated.—J. C. B.

Answer to No. 307 (*awarded* 5*s.*).—The effect of external temperature on the capacity of a dynamo is not above normal, provided the machine has been designed to work in an atmosphere of the given temperature. Provided also that the driving engine is not working to full capacity at normal temperature, and that the field magnets are not saturated at normal speed, a rise in temperature of the surrounding atmosphere to a certain limit will not affect the capacity of the dynamo. The direct electrical effect of temperature on a dynamo is to increase the resistance of the armature and also of the field coils. On the field coils this has the effect of decreasing the ampere-turns and the magnetic flux. If the machine were designed to work in a high temperature, makers would make an allowance in the field coils, such that the resistance of the coils at the maximum temperature and normal voltage would provide normal ampere-turns. If the machine is run in a temperature above its normal, without providing it with increased driving power, its capacity will be affected approximately, as shown by the following example. Take the case of a 30-kw. direct-current shunt-wound machine showing the following tests at full load and normal temperature (temperature of design): output, 100 volts × 300 amperes; external resistance, 0·3333 ohm; resistance of armature, 0·01 ohm; resistance of field coils (in series), 10 ohms; normal temperature, 70deg. F. If such a machine be worked in an atmosphere of 100deg. F., the resistances of the field coils and of the armature, taking the coefficient of copper at 0·38 per cent. per degree Centigrade, or 0·21 per cent. per degree Fahrenheit, will be approximately:

$$\text{Field coils } 10 + \frac{10 \times 0{\cdot}21 \times (100 - 70)}{100} = 10{\cdot}63 \text{ ohms.}$$

$$\text{Armature } 0{\cdot}01 + \frac{0{\cdot}01 \times 0{\cdot}21 \times (100 - 70)}{100} = 0{\cdot}0106 \text{ ohms.}$$

Now if the speed of the dynamo be constant, the voltage will drop approximately in proportion to the ampere-turns of the field coils, which now become diminished, roughly, in the proportion 10·63 : 10, and the voltage of the machine will be 10·63 : 10 : : 100 : 95 (nearly). The new resistance of the total circuit outside 0·3333 + 0·0106 = 0·3439 compared with 0·01 + 0·3333 = 0·3433. This is so small an increase of resistance in the total circuit as to be negligible.

The capacity of the machine may, therefore, be considered to have been affected to the extent of the voltage drop: in this case 5 volts in 100, or 5 per cent. The influence of temperature is really more complex than this, but for practical purposes the effect is nearly as shown. Of course, there would also be certain mechanical losses by working in abnormal air temperature; but this point is not involved in the question.—W. G.

Question No. 308.—In providing condensing plant for a central station, what should be the governing factor in deciding the size of the plant? What is the mistake so often made?

Best Answer to No. 308 (*awarded* 10*s.*).—The wording of this question is somewhat vague, for there are several items which might be termed governing factors, which then can be the governing factor referred to. The aim in all well-conducted stations is to combine efficiency of supply with economy, and these are considered the principal items in attaining the success of the supply. Referring this principle to our question, we have that the governing factor is economy in working consistent with efficiency of supply. In this, the selection of size of condensing plant, as in many other things, no hard-and-fast rule can be laid down which will apply to all cases, and each case must be considered on its own merits; we can, however, select one or two cases to illustrate a principle which may be applied to all.

First, let us consider a station where the maximum load is 1,000 kw. and the average load, or say an all-night load, is 200 kw. In this case it would obviously be unwise to have a condenser or duplicate condensers each capable of dealing with the total of 1,000 kw., or even three condensers that would each deal with 500 kw. of plant, as for a greater portion of the time the 1,000-kw. or 500-kw. condensing plant would have to run for 200 kw., which would result in a loss of economy. In this case the best arrangement would be to have a condenser capable of dealing with the 200 kw. of plant; thus this plant could be run economically for a great number of hours. The selection of the size of the remaining condensing plant required, would depend on the system of condensing employed. The various systems are: (1) surface condensing with air-pump and circulating pump; (1A) surface condensing with air-pump only; (2) jet condensing with air-pump; (3) ejector condensers; (4) evaporative condensers.

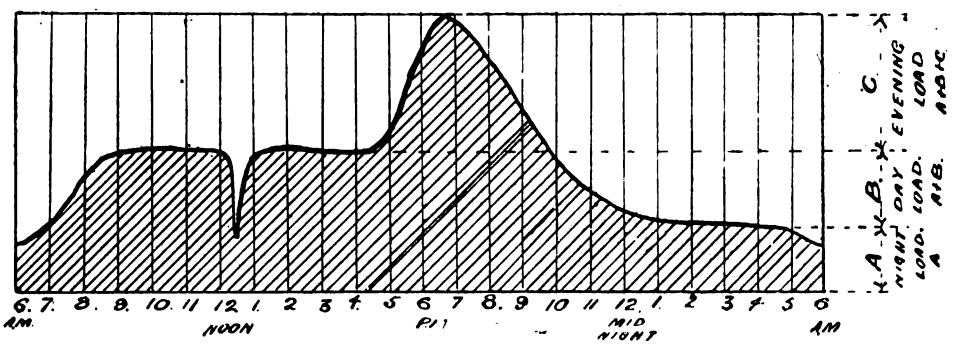
The system to be selected depends on local conditions and the amount of condensing water available. Thus, in the case under consideration, if surface condensers were used, probably two sets of plant, each capable of dealing with 400 kw., would be the best arrangement; with jet condensing apparatus, if a large number of units were used in the station, probably a condenser to deal with every two sets would be best; and with ejector condensers, a condenser for each unit would be advisable.

Let us consider another case, in which the estimated or existing load curve would show three distinct average loads, such as, say, a manufacturing town in which a large number of motors are connected to the mains, also extensive street-lighting which runs throughout the night, besides which there would be the ordinary lighting load, such a load curve would take as an average somewhat of the form shown in the accompanying diagram. It will be seen in this case there are three distinct periods of time in which the plant could be run at its most economical load. The best practice, then, would be to have three condensers, or sets of condensers, which would deal with their respective loads as A, B, and C. From the above cases, and expanding our first definition of the governing factor in selecting the size of condensing plant, we may say it is "the economic ratio of the sizes of condensers to the various average loads"—that is, sizes must be selected whose most economical working load will equal the loads prevailing over certain periods of time. It must not be forgotten to select these sizes with a view to uniformity as far as possible in case of extensions, also in dealing with all possible requirements. With ejector condensers it is considered best to use one condenser with each unit. The mistake most often made is that of selecting condensing plant to deal with a maximum load rather than an average load; thus, though it works economically

Digitized by Google

at the time of such load, yet in most cases that load only exists a short period of the whole time, and at other times an excessively large condenser is being used for a small load—thus loss of economy. It may be pointed out that where air and circulating pumps are used, these pumps, being large enough to cope with the full load of the condenser, will, when the condenser is much too large for its work, be only working at a small percentage of their load, resulting in a further loss, which will make a greater total loss, or, in other words, a lower efficiency. It may be further noted that electrically-driven pumps are far more convenient and economical than steam-driven pumps, on account of their cleanliness, not being so liable to get out of order, and of taking their energy from the switchboard direct from the large economical units.

Another governing factor in this false step lies in the fact that station engineers frequently neglect to consider fuel economy until the lean years of the station's existence have been passed. Condensing plant of suitable size should be provided during those lean years, and the benefit will be felt much more than at a later period. For the purposes of this argument, let us assume typical conditions, taking the load factor of our theoretical station (this load factor being the ratio of average to the maximum rate of production) as 10 per cent., and the maximum load at 400 kw., and the coal consumption during the early years of the station's life at 10lb. of Welsh steam coal per unit. The load factor will, of course, improve as time goes on, and the coal per kilowatt decrease, but in the first years of a lighting station these figures will be found approximately



correct, especially as the coal consumption is a larger proportion of the total costs of production during these first years than it will ever be again. Then it follows that:

1. When condensing plant capable of dealing with the average load over the 24 hours is provided, and granting a 20 per cent. saving due to condensing, the annual amount of saving in our coal bill will be:

$$\frac{400 \times 10 \times 24 \times 365 \times 10 \times 20}{100 \times 2{,}240 \times 100} = 313 \text{ tons per annum.}$$

2. When condensing plant capable of dealing with the full load over two hours per day is provided, and granting, as before, a 20 per cent. saving due to condensing, and allowing only 5lb. of coal per kilowatt generated owing to the rate of production being high and the fuel per unit consequently lower than in the preceding case, the annual amount of saving in our coal bill will be:

$$\frac{400 \times 2 \times 365 \times 5 \times 20}{2{,}240 \times 100} = 130 \text{ tons.}$$

It will thus be clearly seen that the governing factor in the provision of condensing plant should be the average load. The condenser should be provided as early as possible in the station's existence, and should be of such a size that it will deal with the probable average load for the next three years.—F. H. READ.

Other factors in finally deciding the size of plant are: (1) Amount of steam required to be condensed per hour and its pressure. Particulars of the engine or engines, together with the indicator diagrams, to be studied to ascertain these quantities. (2) The average and maximum temperature of the condensing water available. (3) The position of the injection or circulating water supply in relation to the position of the condensers.

In conclusion, it is most important that the full details are gone into most carefully, as a condenser of unsuitable size will not operate so well, and will probably be more costly than one suited to meet the special demands of the case. Makers will often only guarantee results when these particulars are most carefully stated. The advantages of condensing are well known, but these advantages are often minimised by the unsuitable selection of sizes of plant.—E. T. W.

Answer to No. 308 (*awarded* 5s.).—In the provision of condensing plant for central stations, the mistake is often made in providing plant that is capable of dealing with the maximum load instead of only providing sufficient capacity in the condenser to deal with the average load. The capital expenditure on condensing plant for a central station is a considerable item, no matter what system be adopted. The policy of electric lighting stations in this country has almost always been to delay the adoption of condensing plant until the load is large. Then a large amount of capital is expended in providing condensing plant capable of dealing with the top load. This, of course, means that the plant will be run most economically during the two hours of maximum load, but after that will have to be dispensed with owing to the expenditure in running of the condensing plant more than counterbalancing the economy of running the main engines condensing. At the most the condensing plant under these conditions can only be run for three or four hours daily, but in the majority of cases only two hours' economical use can be obtained from it. The result of such a policy is that the capital expenditure on condensing plant remains unproductive during the larger portion of the day. Theoretically, it might be argued that the introduction of such a condensing plant would save the erection of an engine and dynamo, but in practice this has never been carried out. In one case, however, the introduction of such a condensing plant led to the corporation putting in larger dynamos and delaying the installation of a new steam dynamo, but even in this case the difference between the capital expenditure on the condensing plant and new dynamos was not very much less than that on a new steam-driven plant.

ELECTRIC LIGHTING ORDERS.

The report by the Board of Trade respecting the applications to and proceedings of the Board of Trade under the Electric Lighting Acts, 1882 to 1890, during the past year, states that the following applications for provisional orders have been received by the Board of Trade since the date of the last report. The title of order and description of area, name of promoters, and how the application has been dealt with are given in their respective order:

Allerton, Much Woolton, Little Woolton, Childwall, and Garston Electric Lighting Order (amending the Allerton, Woolton, Childwall, and Garston Electric Lighting Order, 1896).—Liverpool District Lighting Company, Limited.—Order granted except in so far as it related to the urban district of Garston.

Banbury Electric Lighting Order (the municipal borough of Banbury).—Electrical Power Distribution Company, Limited.—Order granted.

Barmouth Electric Lighting Order (the urban district of Barmouth).—Urban District Council.—Order granted.

Barnard Castle Electric Lighting Order (the urban district of Barnard Castle).—Northern Counties Electricity Supply Company.—Order granted.

Digitized by Google

Barnet Urban District Council Electric Lighting Order (portion of the urban district of Barnet).—Urban District Council.—Order granted.

Barnstaple Corporation Electric Lighting Order (the borough of Barnstaple).—Corporation.—Order granted.

Basingstoke Electric Lighting Order (the borough of Basingstoke).—Corporation.—Order granted.

Berwick-upon-Tweed Electric Lighting Order (the borough of Berwick-upon-Tweed).—Urban Electric Supply Company, Limited.—Order granted.

Birkenhead Corporation Electric Lighting (Extension) Order. (the townships of Bidston-cum-Ford and Noctorum in the rural district of Wirral).—Corporation.—Order granted.

Bishop Auckland Electric Lighting Order (the urban district of Bishop Auckland).—Urban Electric Supply Company, Limited.—Order granted.

Bonchurch Electric Lighting Order (the parish of Bonchurch, Isle of Wight).—Ventnor Electric Light and Power Company, Limited.—Order granted.

Boston Electric Lighting Order (the municipal borough of Boston).—Corporation.—Order granted.

Brecon Electric Lighting Order (the borough of Brecon).—Corporation.—Order granted.

Bredbury and Romiley Electric Lighting Order (the urban district of Bredbury and Romiley).—Urban District Council.—Order granted.

Bridge of Allan and Dunblane Electric Lighting Order (the burghs of Bridge of Allan and Dunblane).—Urban Electric Supply Company, Limited.—Order granted for the burgh of Dunblane. The two districts applied for do not adjoin, and the Board of Trade refuse to include non-contiguous areas in one order. As the promoters were unable to obtain the consent of the local authority for Bridge of Allan, they elected to proceed with the application in respect of Dunblane only.

Bridlington Electric Lighting Order (the borough of Bridlington).—Corporation.—Order granted.

Brierfield Electric Lighting Order (the urban district of Brierfield).—Urban District Council.—Order granted.

Brierley Hill Electric Lighting Order (the urban district of Brierley Hill).—Urban District Council.—Order granted.

Broughty Ferry Electric Lighting Order (the burgh of Broughty Ferry).—Commissioners of the Burgh.—Order granted.

Caterham Electric Lighting Order (the urban district of Caterham and the parish of Warlingham, in the Godstone rural district).—Urban Electric Supply Company, Limited.—Order granted.

Cheadle and Gatley Electric Lighting Order (the urban district of Cheadle and Gatley).—Urban District Council.—Order granted.

Cheltenham (Extension) Electric Lighting Order (the urban district of Charlton Kings and portions of the rural districts of Cheltenham and Winchcombe).—Corporation of Cheltenham.—Order granted for the urban district of Charlton Kings. As regards the other districts included in the application, the promoters failed to produce the consent of the Cheltenham Rural District Council, or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order for that district. The promoters obtained the consent of the Winchcombe Rural District Council, but the part of the Winchcombe rural district which was applied for is separated from the remainder of promoters' area of supply by the Cheltenham rural district, and the Board refused, therefore, to include it in the order.

Chester-le-Street Electric Lighting Order (the rural district of Chester-le-Street).—County of Durham Electrical Power Distribution Company, Limited.—The promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that it should be dispensed with, and the Board refused to grant the order.

Clacton Electric Lighting Order (the urban district of Clacton).—Urban District Council.—Order granted.

Cleckheaton Electric Lighting Order (the urban district of Cleckheaton).—Urban District Council.—Order granted.

Cleethorpes Electric Lighting Order (the urban district of Cleethorpes-with-Thrunscoe).—Urban District Council.—Order granted.

Cobham Electric Lighting Order (the parishes of Cobham and Stoke d'Abernon, in the Epsom rural district, and part of the parish of Byfleet, in the Chertsey rural district).—Cobham Gas Company.—The promoters failed to prove compliance with the requirements of the Electric Lighting Acts and of the rules of the Board of Trade within the time prescribed by the rules, and the Board refused to proceed with the application.

Cowpen Electric Lighting Order (urban district of Cowpen).—Northern Counties Electricity Supply Company.—Order granted.

Dartmouth Electric Lighting Order (the borough of Dartmouth).—Urban Electric Supply Company, Limited.—Order granted.

Egremont Electric Lighting Order (the urban district of Egremont).—Urban District Council.—Order granted.

Elland Electric Lighting Order (the urban district of Elland).—Urban District Council.—Order granted.

Enfield Electric Lighting Order (the urban district of Enfield).—Urban Electric Supply Company, Limited.—The promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that it should be dispensed with, and the Board refused to grant the order.

Erdington Electric Lighting Order (the urban district of Erdington).—Urban District Council.—Order granted.

Exmouth Electric Lighting Order (the urban district of Exmouth).—Urban District Council.—Order granted.

Farnham Electric Lighting Order (the urban district of Farnham).—Urban District Council.—Order granted.

Felixstowe and Walton Electric Lighting Order (the urban district of Felixstowe and Walton).—Urban District Council.—Order granted.

Freshwater and Totland (I.W.) Electricity Supply Company, Limited, Electric Lighting Order (portion of the rural district of the Isle of Wight).—Freshwater and Totland (I.W.) Electricity Supply Company, Limited.—The local authority refused to consent to the application except on certain conditions. The Board of Trade, for the reasons stated in the special report made by them and presented to Parliament decided to dispense with the consent of the local authority, and granted the order.

Gosforth Electric Lighting Order (the urban district of Gosforth).—Newcastle-upon-Tyne Electric Supply Company, Limited.—Order granted.

Gosport and Alverstoke Electric Lighting Order (portion of the urban district of Gosport and Alverstoke).—Urban District Council.—Order granted.

Grantham Electric Lighting Order (the borough of Grantham).—Urban Electric Supply Company, Limited.—Order granted.

Harrow-on-the-Hill Electric Lighting Order (portion of the urban district of Harrow-on-the-Hill).—Urban District Council.—Order granted.

Hebburn Electric Lighting Order (the urban district of Hebburn).—Urban District Council.—Order granted.

Heston and Isleworth Electric Lighting Order (the urban district of Heston and Isleworth).—Urban District Council.—Order granted.

Hyde Electric Lighting Order (the borough of Hyde).—Corporation.—Order granted.

Hythe Corporation Electric Lighting Order (the borough of Hythe).—Corporation.—Order granted.

Jarrow, Hebburn, and Felling Electric Lighting Order (the municipal borough of Jarrow and the urban districts of Hebburn and Felling).—County of Durham Electrical Power Distribution Company, Limited.—Order granted for Jarrow only. As regards Hebburn, an application was also received from the local authority, to which preference was given by the Board of Trade in accordance with their usual practice. As regards Felling, the promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board refused to proceed with the application in respect of that district.

Kendal Electric Supply Order (the borough of Kendal).—Corporation.—Order granted.

Leek Electric Lighting Order (the urban district of Leek).—Urban District Council.—Order granted.

Littleborough Electric Lighting Order (the urban district of Littleborough).—Urban District Council.—Order granted.

Liversedge Electric Lighting Order (the urban district of Liversedge).—Urban District Council.—Order granted.

Llandilo Electric Lighting Order (the urban district of Llandilo).—Urban District Council.—Order granted.

Llanrwst Electric Lighting Order (the urban district of Llanrwst and portion of the rural district of Geirionydd).—Llanrwst Electricity Supply Company, Limited.—Order granted for the urban district of Llanrwst. The promoters were unable to obtain the consent of the local authority for the Geirionydd rural district, and withdrew the application in so far as it related to any part of that district.

The County of London.

Battersea Electric Lighting Order (portions of the parish of St. Mary, Battersea).—County of London and Brush Provincial Electric Lighting Company, Limited.—The local authority refused to consent to the application, but the Board of Trade, for the reasons stated in the special report made by them and presented to Parliament, decided to dispense with the consent of the local authority, and granted the order.

Lambeth (part of) Electric Supply Order (portion of the parish of Lambeth).—South London Electric Supply Corporation, Limited.—The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board refused to grant the order.

Limehouse District Electric Lighting Order (the Limehouse district).—Board of Works.—Order granted.

Marylebone Electric Lighting Order (the parish of Mary

Digitized by Google

lebone).—Marylebone Electric Supply Company, Limited.—The local authority refused to consent to the application, and the Board of Trade held an enquiry in the matter. After consideration of the representations made to them, the Board of Trade, for the reasons stated in the special report made by them and presented to Parliament, decided to dispense with the consent of the local authority, and granted the order.

Mile End Old Town Electric Lighting Order (the hamlet of Mile End Old Town).—Vestry.—Order granted.

St. George-in-the-East Electric Lighting Order (the parish of St. George-in-the-East).—Vestry.—Order granted.

Long Eaton Electric Supply Order (the urban district of Long Eaton).—Urban District Council.—Order granted.

Lytham Urban District Council Electric Lighting Order (the urban district of Lytham).—Urban District Council.—Order granted.

Malton Electric Lighting Order (the urban district of Malton).—Northern Counties Electricity Supply Company.—Order granted.

Maryport Electric Lighting Order (the urban district of Marport).—Urban District Council.—Order granted.

Midland Electric Power Distribution and Lighting (Extension) Order (the borough of Smethwick, the urban districts of Oldbury, Perry Bar, and Stourbridge, the township of Upper Penn in the Seisdon rural district, and the parish of Bushbury, in the Cannock rural district).—Midland Electric Corporation for Power Distribution, Limited.—Order granted in respect of the township of Upper Penn in the Seisdon rural district and the parish of Bushbury in the Cannock rural district. Application refused as regards other districts.

Nantwich Electric Lighting Order (the urban district of Nantwich).—Urban District Council.—Order granted.

Neath, Briton Ferry, and Aberavon Electric Lighting Order (the municipal boroughs of Neath and Aberavon, and the urban district of Briton Ferry).—Electrical Power Distribution Company, Limited).—The promoters failed to produce the consents of the local authorities or to satisfy the Board of Trade that they should be dispensed with, and the Board refused to grant the order.

Newark Electric Lighting Order (the borough of Newark).—Corporation.—Order granted.

Newhaven Electric Lighting Order (the urban district of Newhaven). — Rev. H. G. Bonnewell and others. — Order granted.

Nuneaton and Chilvers Coton Electric Lighting Order (the urban district of Nuneaton and Chilvers Coton).—Urban District Council.—Order granted.

Ogmore Valley Electric Lighting Order (portion of the urban district of Ogmore and Garw.)—Ogmore Valley Electric Light and Power Supply Company, Limited.—Order granted.

Ormesby Electric Lighting Order (the urban district of Ormesby).—Urban District Council.—Order granted.

Ormskirk Electric Lighting Order (the urban district of Ormskirk).—Urban District Council.—Order granted.

Penrith Electric Lighting Order (the urban district of Penrith).—Urban District Council.—Order granted.

Penzance Electric Lighting Order (the borough of Penzance).—Corporation.—Order granted.

Prestwich Electric Lighting Order (the urban district of Prestwich).—Urban District Council.—Order granted.

Pwllheli Electric Supply Order (the borough of Pwllheli).—Corporation.—Order granted.

Ramsgate (Corporation) Electric Lighting Order (the borough of Ramsgate).—Corporation.— Order granted.

Ramsgate Electric Lighting Order (the borough of Ramsgate). Isle of Thanet Electric Tramways and Lighting Company, Limited. An application was also received from the local authority, to which preference was given by the Board of Trade in accordance with their usual practice, and the company's application was not proceeded with.

Redcar Electric Lighting Order (the urban district of Redcar).—Urban District Council.—Order granted.

Redruth Electric Lighting Order (the urban district of Redruth).—Urban Electric Supply Company, Limited.—Order granted.

Romford Electric Lighting Order (the urban district of Romford and the parish of Romford Rural in the rural district of Romford).—Urban District Council.—Order granted.

Royal Leamington Spa Electric Lighting Order (the borough of Royal Leamington Spa).—Midland Electric Light and Power Company, Limited.—The local authority refused to consent to the application, but the Board of Trade, for the reasons stated in the special report made by them and presented to Parliament, decided to dispense with the consent of the local authority, and granted the order, subject, however, to a provision that the order shall not come into force unless the local authority make default in putting into operation the order obtained by them in 1899 as provided by Section 3 of that order.

St. Helens (Isle of Wight) Electric Lighting Order (the urban district of St. Helens, Isle of Wight).—Edmund Ironside Bax, Esq.—Order granted.

Sandgate Electric Supply Order (the urban district of Sandgate).—Urban District Council.—Order granted.

Seaford Electric Lighting Order (the urban district of Seaford).—Rev. H. G. Bonnewell and others.—Order granted.

Seaham Harbour Electric Lighting Order (the urban district of Seaham Harbour).—County of Durham Electrical Power Distribution Company, Limited.—The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board refused to grant the order.

Sevenoaks Electric Lighting Order (the urban district of Sevenoaks).—Electrical Power Distribution Company, Limited. Order granted.

Sheerness Electric Lighting Order (the urban district of Sheerness).—Electrical Power Distribution Company, Limited. Order granted.

Sleaford Electric Lighting Order (the urban district of Sleaford).—Urban District Council.—Order granted.

South Blyth Electric Lighting Order (the urban district of South Blyth).—Northern Counties Electricity Supply Company. Order granted.

Southwold Electric Lighting Order (the borough of Southwold).—Corporation.—The Board of Trade declined to grant the order, as the promoters failed to satisfy them that they were in a position financially to give effect to the order if granted.

Sowerby Bridge Electric Lighting Order (the urban district of Sowerby Bridge).—Urban District Council.—Order granted.

Spennymoor Electric Lighting Order (the urban district of Spennymoor).—Northern Counties Electricity Supply Company.—Order granted.

Staines, Egham, and Chertsey Electric Lighting Order (the urban districts of Staines and Chertsey and the rural district of Egham).—Electrical Power Distribution Company, Limited.—The local authorities for Staines and Chertsey consented to the application, but the local authority for Egham refused their consent. After consideration of the circumstances the Board of Trade, for the reasons stated in the special report made by them and presented to Parliament, decided to dispense with the consent of the Egham local authority, and granted the order for the three districts.

Stamford Electric Lighting Order (the borough of Stamford). Urban Electric Supply Company, Limited.—Order granted.

Sudbury Electric Lighting Order (the borough of Sudbury).—Corporation.—Order granted.

Teddington and Twickenham Electric Lighting Order (the urban districts of Teddington and Twickenham).—Richmond (Surrey) Electric Light and Power Company, Limited.—The promoters decided not to proceed with the application.

Thirsk Electric Lighting Order (the parishes of Thirsk and Sowerby in the Thirsk rural district).—Northern Counties Electricity Supply Company.—Order granted.

Totnes Electric Lighting Order (the borough of Totnes).—Totnes Electricity Supply Company, Limited.—Order granted.

Tunstall Electric Lighting Order (the urban district of Tunstall and the parishes of Goldenhill and Chell in the rural district of Wolstanton).—Urban District Council.—Order granted.

Twickenham and Teddington Electric Lighting Order (the urban districts of Twickenham and Teddington).—Twickenham and Teddington Electric Supply Company, Limited.—Order granted for the urban district of Twickenham. The promoters failed to produce the consent of the local authority for Teddington, or to satisfy the Board of Trade that it should be dispensed with, and the Board decided to exclude that district from the order.

Uxbridge and District Electricity Supply Order (the urban district of Uxbridge, the rural district of Uxbridge (except the parish of Northolt), and the parishes of Iver, Denham, and Gerrard's Cross in the Eton rural district).—Uxbridge and District Development Syndicate, Limited.—Order granted in respect of the Uxbridge urban district, the parishes of Hillingdon East, Ickenham, Cowley, and Hayes, in the Uxbridge rural district, and the parish of Denham, in the Eton rural district. Application refused in respect of the remainder of the area applied for.

Wallington Electric Lighting Order (the parish of Wallington, in the rural district of Croydon).—County of Surrey Electrical Power Distribution Company, Limited.—Order granted.

Wellingborough Electric Lighting Order (the urban district of Wellingborough).—Electrical Power Distribution Company, Limited.—Order granted.

Weybridge Electric Lighting Order (the urban district of Weybridge).—Urban Electric Supply Company, Limited.—Order granted.

Whitefield Electric Supply Order (the urban district of Whitefield).—Urban District Council.—Order granted.

Witney Electric Lighting Order (the urban district of Witney).—Witney Electric Supply Company, Limited.—Order granted.

Woking Electric Supply Company Electric Lighting Order (the parishes of Woking and Horsell, and portions of the

Digitized by Google

parish of Chertsey).—Woking Electric Supply Company, Limited.—Order granted.

Wormit and Woodhaven Electric Lighting Order (portions of the districts of Wormit and Woodhaven, in the parish of Forgan).—Tayside Electric and Gaslight Company, Limited.—Order granted.

Of these applications (108 in number), 59 were made by local authorities and 49 by companies or persons. Of these latter only 39 were passed by the Board of Trade, and one of these—*i e*, the Marylebone electric lighting order—was thrown out by the House of Commons. All the applications by local authorities were successful. The Board of Trade also report that during the year ending in June the following electric lighting orders have been transferred from the first mentioned to the last-mentioned:

Audenshaw Electric Lighting Order, 1899.—Corporation of Manchester.

Barnet Local Board Electric Lighting Order, 1893.—North Metropolitan Electrical Power Distribution Company, Limited.

Carshalton Electric Lighting Order, 1898.—County of Surrey Electrical Power Distribution Company, Limited.

Droylsden Electric Lighting Order, 1897.—Corporation of Manchester.

Gateshead Electric Lighting Order, 1899.—County of Durham Electrical Power Distribution Company, Limited.

Godalming Electric Lighting Order, 1896.—Urban Electric Supply Company, Limited.

Heaton Norris Electric Lighting Order, 1899.—Corporation of Manchester.

Hertford Electric Lighting Order, 1891.—North Metropolitan Electrical Power Distribution Company, Limited.

Lewes Electric Lighting Order, 1898.—County of Sussex Electrical Power Distribution Company, Limited.

Margate Electric Lighting Order, 1896.—Isle of Thanet Electric Tramways and Lighting Company, Limited.

Sutton Electric Lighting Order, 1892.—County of Surrey Electrical Power Distribution Company, Limited.

Weston-super-Mare Electric Lighting Order, 1891.—Weston-super-Mare and District Electric Supply Company, Limited.

Whiston Rural District Electric Lighting Order, 1898.—British Insulated Wire Company, Limited.

It is curious to note that electric lighting licenses have been granted during the year in question. Thus a license was granted on July 28 to the Corporation of Birkenhead and to the Ingleton Electric Light and Power Company on July 31, 1899. The report gives a full list of all the provisional orders which have ever been granted, with remarks as to those which have been revoked, and also some useful information as to the working of the new Electric Light Clauses Act.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Varna.—The Municipality invite tenders for the lighting of the town by electricity for 40 years by Oct. 15 (concession).

Beetle.—The Corporation invite tenders for a steam dynamo. Tenders by Oct. 13. Details in our advertisement columns.

Bermondsey.—The Vestry invite tenders for the erection of steam dynamos, etc. Tenders by Oct. 15. Details in our advertisement columns.

Paris.—The Postal and Telegraph Department, rue de Grenelle, No. 103, invite tenders for a number of telephone apparatus. Tenders by Oct. 16.

Swansea.—The Corporation invite tenders for the supply and erection of arc lamps, etc. Tenders by Oct. 10. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for 24 car bodies and electrical equipment. Tenders by Oct. 15. Details in our advertisement columns.

Maidstone.—The Corporation invite tenders for a surface condenser and feed pumps. Tenders by Oct. 16. Details in our advertisement columns.

Santiago.—Offers are invited for the laying down and working of a telephone system in Santiago de Compostela, in the province of Coruna, Spain. Tenders by Oct. 19.

Palma.—The Municipality of this town, in the province of Baleares, Spain, invite tenders for the installation and maintenance of 60 arc lamps. Tenders by Oct. 30.

Glasgow.—The Corporation invite tenders for cables for connecting up plant and transformer connecting bars. Tenders by Oct. 5. Details in our advertisement columns.

Wolverhampton.—Tenders are about to be advertised for for the material required in the making of the tramway section which runs from the Bilston-road terminus to Newbridge.

Cortegana.—Offers are invited for the installation of electric lighting and the working of same for five years in this town, in the province of Huelva, Spain. Tenders by Oct. 19.

Azuaga.—Offers are requested by the Municipality of this town, in the province of Badajoz, Spain, for the installation and working of the electric light for 20 years. Tenders by Oct. 11.

Callosa de Ensarria.—Offers are requested by the Municipality of this town, in the province of Alicante, Spain, for the installation and working of the electric light for 15 years. Tenders by Oct. 12.

Fuenteovejuna.—Offers are requested by the Municipality of this town, in the province of Cordoba, Spain, for the installation and working of the electric light for 20 years. Tenders by Oct. 9.

Manchester.—The Directors of the Lancashire and Yorkshire Railway Company invite tenders for the supply of various stores. Tenders by 10 a.m. on Oct. 8. Particulars in our advertisement columns.

Ilford.—The Urban District Council invite tenders for meters (direct-current) and cut-outs. Specification may be obtained from Mr. J. W. Benton, clerk, Council Offices, Cranbrook-road, Ilford. Tenders by Oct. 8.

Whitechapel.—The Electrical Committee invite tenders for the supply of a hand-driven overhead travelling crane for their new electricity supply station. Tenders by Oct. 23. Details in our advertisement columns.

Whitehaven.—The Water and Lighting Committee of the Corporation invite tenders for the supply and erection of a switchboard at their electric lighting station. Tenders by Oct. 13. Details in our advertisement columns.

Aberdeen.—The Tramways Committee invite tenders for the manufacture and supply of 25 electrical tramcars, and equipments for six horse cars, about to be converted. Tenders by Oct. 17. Details in our advertisement columns.

Grimsby.—The Corporation invite tenders for the wiring of the free library for electric lighting. Specifications and forms of tender can be obtained from Mr. W. A. Vignoles, borough electrical engineer, Grimsby. Tenders by Oct. 6.

Cardiff.—Tenders are invited for slow-speed vertical engines, slow-speed generators, boilers, and economisers. Specifications, etc., may be obtained from Mr. A. Ellis, M.I.E.E, Old Post Office-buildings, Cardiff. Tenders by Oct. 23.

Middleton (Lancs.).—The Corporation invite tenders for buildings required for electricity station. Specifications, etc., may be obtained at the offices of Messrs. Lacey, Clirehugh, and Sillar, 78, King-street, Manchester. Tenders by Oct. 11.

Nottingham.—The City Council invite tenders for 1,500 tons of steel girder tramrails and 76 tons of fishplates. Specifications, etc., may be obtained from Mr. Arthur Brown, M.I.C.E., city engineer, Guildhall, Nottingham. Tenders by Oct. 8.

Bradford.—The Corporation invite tenders for the construction and delivery of an engine and dynamo, also switchboard apparatus, etc., for their destructor works Southfield-lane, Bradford. Tenders by Oct. 9. Particulars in our advertisement columns.

Brighton.—The Town Council invite tenders for rewiring the abattoir premises, Hollingdean-road, for electricity installation. Specifications may be obtained from the borough engineer and surveyor, Mr. Francis J. C. May, M.I.C.E., Town Hall, Brighton. Tenders by Oct. 11.

Ayr.—The Council invite tenders for the supply and delivery of steel tramway rails and fishplates for the work required in connection with the proposed tramways. Specification, etc., may be obtained from Mr. J. Young, C.E., town surveyor, Town Buildings, Ayr. Tenders by Oct. 12.

Dartford.—The Urban District Council invite tenders for the erection of an electric light station at Dartford, in accordance with drawings and specifications prepared by their architects. Specifications may be seen at the office of Messrs. Hesketh and Stokes, 110, Cheapside, E.C. Tenders by Oct. 20.

Dundee.—The Gas Commissioners invite tenders for the supply and erection of three steel water-tanks at the electric lighting station, Dudhope-crescent-road, Dundee. Specification, etc., may be obtained from Mr. Walter H. Tittensor, city electrical engineer, Dudhope-crescent-road, Dundee. Tenders by Oct. 12.

Glasgow.—The Corporation invite tenders for the supply of 1,000, 2,000, or 3,000 tons steel straight track rails; 100 200, or 300 tons steel curved rails; 50, 100, or 150 tons steel fishplates. Specifications, etc., can be obtained from Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Oct. 23.

Sheffield.—The Corporation invite tenders for specification No. 3 (a) two two-phase steam alternators and exciters, 600 kw. each; (b) alteration of present single-phase plant to two-phase. Specifications can be obtained from Mr. S. E. Fedden, chief engineer and manager, Commercial-street, Sheffield. Tenders by Oct. 6.

Brussels.—The Government Railways require a number of insulators, 150 tons of galvanised iron wire, and a large amount of various telephone and telegraph material. Particulars (special specification No. 59) may be obtained from that authority. The adjudication takes place at the Brussels Exchange on Oct. 10 at 11 a.m.

Whitechapel.—The Board of Works invite tenders for erection of a chimney shaft and the construction of economiser chambers, flues, and cableways at the new electrical supply station yard, Osborne-street, Whitechapel, E. Drawings may be seen at the office of Mr. M. W. Jameson, engineer and surveyor to the Board. Tenders by Oct. 16.

Digitized by Google

London (City).—The Streets Committee of the Corporation invite tenders for the hiring of a mechanically-driven dust-cart for collecting and removing the dust, trade refuse, and street sweepings from the City to the Corporation's depôt at Lett's Wharf, Commercial-road, Lambeth, S.E. Tenders by Nov. 10. Details in our advertisement columns.

Medomsley (Durham).—The Parish Council invite tenders for the supply and erection of electric lamps, posts, cables, etc., necessary for the lighting of the road leading from Black Hall Mill to Medomsley Village, via Westwood Colliery. Particulars may be obtained from Mr. M. T. Milburn, Medomsley, R.S.O., clerk to the Council, and the ground may be viewed on making an appointment by letter.

India.—The Secretary of State for India in Council is prepared to receive tenders for the supply of a complete electrical installation for supplying power to a factory from a waterfall about three miles distant from factory. The generator will be required to develop about 500 kw., and the installation is to include complete plant of generators, line, transformers, cables, motors, etc. Conditions, etc., may be obtained from the Director, General Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office by 2 p.m. on Oct. 16.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

RESULTS OF TENDERS.

Ayr.—The Corporation have placed the contract for two 200-kw. P.P.P. traction and lighting generators, coupled to Belliss engines, with Messrs. D. Bruce Peebles and Co.

Barrow-in Furness.—The Corporation have placed the contract for a year's supply of motors for hiring-out purposes from 1 h.p. to 10 h.p. with Messrs. D. Bruce Peebles and Co.

Cotswold Sanatorium.—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, have secured the order for the supply of storage battery required for the electric lighting of this institution.

Leeds.—The Tramways Committee have accepted the tenders of W. Irwin and Co., Leeds, general trades, £7,595; Clayton, Son, and Co., Leeds, ironwork, £2,973. 16s., with reference to the erection of a new boiler-house at the generating station, Crown Point, Leeds.

Southampton.—The Guardians have accepted the tender of Messrs. Lankester and Son, High-street, Southampton, at £3,499. 10s., for the erection and completion of electrical plant and installation for the lighting of the new workhouse infirmary, Shirley Warren.

Wigan.—The Tramways Committee have accepted the following tenders for the Wigan-lane section of the tramways: Esther and Co., poles and section pillars; Blackwell and Co., bonds and castings; Bergtheil and Young, overhead material; Naylor Bros., brackets; Macartney, McElroy, and Co., trolley wire.

Worthing.—The Electric Lighting Committee have accepted the following tenders: Scott and Mountain, dynamos, £2,850; Danks and Co., boilers, etc., £1,130; Callender's Cable and Construction Company, manhole covers, £501. 3s.; Mackenzie Bros., arc lamp-posts, £1,353. 5s.; Albion Clay Company, stoneware casings, £2,102. 3s. 6d.; Callender's Cable and Construction Company, cable work, £5,967. 15s. 3d.; Eclipse Brass and Copper Company, York, storage batteries, £984. 4s.; Laurence, Scott, and Co., boosters, etc., £710; Lowcock, Limited, economiser, £372. 10s.; Carrick and Ritchie, travelling crane, £165.

Croydon.—The tender of Askham Bros. and Wilson, Limited, for the supply of points and crossings, has been accepted. The British Electric Traction Company have agreed to the Corporation accepting the following contracts—viz.: (Contract No. 2) British Thomson-Houston Company, car bodies; (3) British Thomson-Houston Company, motorcar equipment; (4) British Thomson-Houston Company, feeders; (5) British Thomson-Houston Company, overhead construction; (6) British Thomson-Houston Company, excavating and ground wires; Thornton Heath depôt car-shed—J. Smith and Son, builders' work; G. Sands and Son, smith and founders' work; Brighton road car-shed—E. J. Saunders, builders' work; G. Sands and Son, smith and ironfounders' work. The prices, etc., were discussed by the Council at a private sitting last week.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Eastbourne.—The Town Council have decided to establish a municipal telephone exchange.

Guildford.—The Council are still considering the question of the provisional order for electric lighting.

Luton.—Mr. Snell has forwarded designs of arc lamp columns, and the positions of the 10 columns have been fixed.

Tynemouth.—It is reported that the system of electricity for the lighting of the borough is fast nearing completion.

Russia.—An experimental telephone line is shortly to be laid between St. Petersburg and Moscow, a distance of about 650 miles.

Pontypridd.—The Urban District Council are applying for an electric lighting order. A refuse destructor plant is to be included in the scheme.

Edinburgh.—The Town Council have placed the balance of £3,674. 9s. 4d. from the electric lighting account to the credit of the reserve fund.

Removal.—The Lilleshall Company, Limited, have removed from Lime-street to 71, Finsbury-pavement (Electric Railway Station Buildings).

Poplar.—The ceremony of opening the electricity works of the District Board of Works at Glaucus-street, Bromley, E., has been fixed at 4 for 5.30 on Monday, Oct. 8.

Hampstead.—The Lighting Committee are considering the necessity of extending the electric arc lamps from Fortune green to the corner of Platt's-lane, Finchley-road (south side).

Carmarthen.—The Electric Light Committee of the Town Council have decided to engage Messrs. Medhurst and Lloyd, of London, to report upon a system of public electric lighting.

Lymington.—Mr. H. Preston is proceeding rapidly with the erection of the necessary premises at Bath-road which are to form the works of the Lymington Electric Light and Power Company.

Norton (Malton).—The District Council have consented to an application by the Northern Counties Electric Supply Association for a provisional order for the supply of electricity in the district under certain conditions.

Aberdeen.—A plan of the proposed new electricity works at Dee Village, showing Millburn street to be widened from 20ft. to 45ft., has been adopted, also the erection of a chimney stalk 200ft. high, at an estimated cost of £2,900.

Colne.—The Town Council have received the sanction of the Board of Trade to the scheme to be adopted by the Corporation for the supply of electrical energy as per their electric light order, the work to be undertaken forthwith.

African Telegraph.—The African Trans-Continental telegraph line is completed to Kituta on the south end of Lake Tanganyika, and is expected to be carried by the end of July across the Anglo-German frontier to Kassanga, the German station north of Kituta.

Anglo-American Telegraph Co.—The directors, after placing £6,000 to the credit of the renewal fund, announce an interim dividend for the quarter ending 30th ult. of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock, payable Nov. 1.

Warrington.—The promoters of the Manchester and Liverpool Electric Express Railway having intimated their intention to reintroduce a Bill in the next session of Parliament, the Town Council on Wednesday resolved to accept the agreed clauses for insertion in the Bill.

Wigan.—The electrical engineer's report on the extension of the area of supply of electric current has been adopted, and application is to be made to the Local Government Board to borrow the amount required in such instalments as may be necessary for the extension from time to time.

Sussmann Electric Miners' Lamp Co.—This Company has been registered with a capital of £30,000 in £1 shares, the object being to acquire the business of the Sussmann Electric Miners' Lamp Company, Limited, to adopt an agreement with the said old company and its liquidator, etc.

Nelson.—Mr. M. R. North has held an enquiry into the Corporation's application for sanction to borrow £2,500 for electric lighting purposes for the borough. The Town Clerk explained that the present application was to provide an extension of the present storage battery by the addition of 72 cells.

Eastern Telegraph Co.—The directors announce payment on 15th inst. of a dividend at the rate of 3½ per cent. per annum on the preference stock of the Company for the quarter ending 30th ult., and the usual interim dividend of 1¼ per cent. on the ordinary stock in respect of profits for the quarter ended June 30.

Friern Barnet.—At the last meeting of the Urban District Council the Clerk reported that the work in connection with the initial stages of the electric lighting scheme was being proceeded with, and that he was at present in communication with the Board of Trade getting information on questions affecting the local scheme.

York.—At the last monthly meeting of the City Council, it was stated that the Electric Lighting Committee had during the past six months made a trading profit on the lighting of upwards of £200. After the interest and sinking fund were paid about £100 would be left. This is very satisfactory, and it is anticipated that in the next six months a very good profit will be shown.

Barnsley.—The borough electrical engineer is preparing specifications for an additional engine and dynamo for the electricity works. A special meeting of the Electricity Committee was held on Tuesday for the purpose of inspecting the public lamps in the borough, and of deciding what existing lamps shall be moved to other positions, and where additional lamps shall be placed.

Worcester.—In consequence of the continued increase in the price of coal the Electricity Committee propose to increase the prices of the current to consumers, as follows: to private customers, 6½d. and 3d. per unit; for waterworks motors, 1¾d. per

Digitized by Google

unit; for the public arc lamps, an additional two guineas for each all-night lamp, and one guinea for a half-night lamp; and for the public incandescent lamps, 5s. each per annum.

Hereford.—It was reported at Tuesday's meeting of the Town Council that the cost of the town's electric light works was £20,470. 16s. 2d. The demand for the current has exceeded the expectations. The present installation represents the equivalent of 6 822 8-c.p. lights, and altogether there are over 7,500 lights. Applications have been made for current which it is estimated will represent a supply of considerably more than 500 additional lights.

Macclesfield.—On Thursday week a special meeting of the General Purposes Committee of the Corporation—which consists of the whole of the members of the Council—was held for the purpose of considering the proposal of the Electrical Power Distribution Company to apply for a provisional order enabling them to establish an electrical installation in Macclesfield. An amendment that a provisional order be applied for on behalf of the Council was carried.

Sutton Coldfield. — The Highways Committee reported at Wednesday's meeting of the Town Council that, with a view to facilitating the establishment of telephonic communication in Sutton Coldfield, they had granted to the National Telephone Company permission to erect five poles in Green-lane and 38 poles in Penn's-lane, and it was stated that telephonic communication would be established between the borough and the adjoining towns within the next six months.

Berkhampstead.—At a recent meeting of the District Council a letter was received from the Herts County Council, explaining the relation of district councils to the North Metropolitan Electric Supply Company, who had recently got a Bill passed through Parliament, and stating that the County Council would be willing to assist any district council that was desirous of obtaining powers for themselves. The Council decided to take the necessary steps to obtain themselves the position of distributors.

New Firms.—We are informed that Prof. Alex. B. W. Kennedy's business will henceforth be carried on under the style of Kennedy and Jenkin, the partner being Mr. Bernard M. Jenkin, and the address 17, Victoria-street, Westminster.—Mr. J. Wemyss Anderson, A.M.I.C.E., M.I.Mech.E., has arranged a partnership in connection with electrical work with Mr. Alfred Hay, B.Sc., M.I.E.E., and the business of consulting electrical engineers will be carried on at Pearl Assurance-buildings, Liverpool.

London Gazette.—A receiving order has been made out *re* T. W. Greaves and W. G. Randall (lately trading as T. W. Greaves and Co., at 230, East India Dock-road, and 6, Nelson-street, Greenwich), on debtors' petition. An adjudication order has also been made out *re* the above. A first and final dividend of 2s 8½d. per pound has been declared *re* B. Symons (trading as B. Symons and Co.), 2, North-street Quadrant, Brighton, Sussex, payable at the offices of Ward and Wilding from Oct. 5.

Carnoustie.—At the last meeting of the Burgh Commission the Clerk reported receipt of a letter from the Board of Trade anent the transference of an electric lighting order from a local authority to a contracting firm. The Department stated that unless any special reasons could be urged, they had decided not to insert such powers in the future. The Clerk also stated that the Electrical Supply Company had promised a reply within a few days to his communication as to whether they would withdraw their application for an order for Carnoustie.

Belfast —The Corporation have resolved that motor consumers be allowed to take not more than one 16-c.p. lamp off the motor circuit, this lamp to be only for use in connection with the motor, the current for same being charged at motor rate. Six prepayment meters will be installed as an experiment. The charge has been fixed at 5½ d. per unit for all current consumed; 4½d. of this sum will go to the credit of the Corporation, and the remainder—viz., ¾d.—to the credit of the National Free Wiring Company, as rent on the wiring and fittings in premises installed by them.

Appointments Vacant.—The West Bromwich Corporation invite applications for the appointment of borough electrical engineer.—The West Hartlepool Corporation are prepared to appoint two assistant engineers, at a commencing salary of £120 per annum, rising by yearly increments of £10 to £150.—The services of a mains superintendent are required by the Corporation of Southampton.—The borough of Blackburn have a vacancy for a shift engineer.—The Ashton under Lyne Corporation invite applications for the post of switchboard assistant at their electricity works. Full particulars of these vacancies appear in our advertisement columns.

Cardiff.—A report upon the recent accident was submitted by Mr. W. H. Illingworth, mains superintendent, at the last meeting of the Electric Lighting Committee containing some suggestions for the improvement of the low-tension system. After considerable discussion on the propriety of receiving the report it was eventually decided that it be referred to Mr. Appelbee, and that the latter be asked to report upon the suggestions contained therein to a meeting of the Electric Lighting Committee to be held to-morrow. It was stated at the last meeting, and there appears to be a good deal of truth in it, that a good many of these difficulties were due to the unwarrantable interference of the committee in matters of petty detail.

Stirling.—At a recent special meeting of the Police Commission, Town Council, and Local Authority it was explained, in connection with the electric lighting account, that the expenditure included £834 as instalment of principal of £25,000 loan, and £665 of interest, the station costs being: management, £265; wages, £435; coal, £500; and stores, £180—the total estimated outlay being £2 879. The income from consumers was calculated at £1,750, being 5,000 lamps at 7s. per lamp, with £510 from arc lamps, and £619 from assessments. There was £2,479 of the £25,000 loan unexpended, but there were a few accounts still unpaid. The sum of the credit of the Council for new municipal buildings was £2,326.

Inefficient Telephone Service.—The National Telephone Company in the City of London Court, on Tuesday, sought to recover £50 from Messrs. Daniel de Pass and Co., Fenchurch-buildings, E.C., for the use of a private telephone wire from their City office to their branch establishment at Barking. Messrs. de Pass and Co. declined to pay because the wire had never been efficiently fixed. The plaintiffs, on the other hand, declared that the wire had been fixed as well as possible. For four miles the wires had to stretch alongside the sewer bank, and on several occasions whole lengths of wire had been cut off and taken away. The company did not guarantee that the telephones should work always. The jury gave judgment for the defendants.

Leeds.—The City Council on Wednesday agreed to apply to the Local Government Board for permission to borrow £510,500 for electric lighting purposes. This sum includes the sum of £177,573 already sanctioned by the Council, for which the Local Government Board enquiry had not yet been held. This proposed loan further includes £100,000 for general extensions, and £80,000 for extensions on the main line of road to Wortley, New Wortley, Armley, and Bramley, and on to Stanningley. It also covers a scheme of crossing the river again and extending up with the West Hunslet direction, through Globe-street, that would require at least £80,000. A sum of £140,000 is provided for development and extension and the provision of new buildings and of machinery on the site already occupied.

St. Albans.—The Guardians recently received the following report from Mr. Miskin: "As requested by the Electric Lighting Sub-Committee of the Board of Guardians, I give below a summary of the probable cost of installing the electric light at the workhouse. From information obtained of the master, there will be required about 85 16 c.p. lamps and 38 8 c.p. The cost would be approximately as follows: wiring generally to all points including fittings, £200; dynamo with necessary mountings, £75; switchboards, belting, steam connections, beds for dynamo and engine, £68; accumulators, complete with stands, fixing, and connecting, £285; 9 b.h.p. vertical steam engine, fixed £85; allow for contingencies, £50—total, £763. Owing to the fact that a man will have to be employed to attend to laundry and boiler, the extra wages involved by the lighting plant would be very small, as the same man could attend to both. I consider £50 would cover the annual expenditure involved, including coal, water, extra wages paid, and maintenance." No definite resolution has been passed.

Enfield.—At a recent meeting of the Electric Lighting Committee of the Urban District Council the Clerk stated that, in reply to certain queries put to the North Metropolitan Electric Power Distribution Company, Limited, Mr. Offor, representing the company, had submitted a draft agreement embodying the proposals of his company. Mr. Offor attended the meeting, and, after a discussion lasting nearly two hours, it was agreed that he should take back the agreement for the purpose of embodying such of the proposals made by the committee as were acceptable to his company, and return the amended draft. Mr. Trenchard said the clerk and he attended a conference of local authorities at the Tottenham School Board offices the previous night with reference to the proposed promotion of a Bill in Parliament to confer powers on district councils for supplying electric lighting powers. The proposals submitted from Enfield that the joint authority should distribute, as well as generate, the light was accepted, and a draft agreement was decided upon subject to the Council's opinion on one point.

West Bromwich.—The Electric Lighting Committee's report recommends that the charge for electricity for lighting purposes be fixed at the rate of 6d. per unit until an equivalent of 100 hours' maximum demand has been reached in each quarter, and thereafter during the same term at the rate of 2d. per unit; that the charge for electricity for power purposes be at the rate of 3d. per unit until an equivalent of 78 hours' use of the maximum demand has been reached in each quarter, and thereafter during the same term at the rate of 1d. per unit. They also recommend that the system known as the "free-wiring system" be adopted. They further recommend that application be made to the Local Government Board for sanction to borrow £10,000 for providing materials and labour for wiring houses, and also for the purchase and fixing of motors. A further demand for power purposes has been made upon them, and to meet this the engine house must be enlarged, and they have agreed to carry out the extension at once. They have decided to advertise for a borough electrical engineer at a commencing salary of £250 per annum.

Sunderland —Various tenders for dynamos and boilers have been referred to Mr. Snell to report upon. The Finance Committee have been authorised to borrow the requisite money for the erection of the new lighting station, purchase of plant, and making connections, and the cost of laying the mains to Roker. The Electric Light Committee have recommended the Council to give customers the option of being supplied on the maximum demand system or to take off a discount upon the number of units used, on a scale which had been in force before the maximum demand system was adopted. Under this scale customers using 200 units per quarter will receive 2½ per cent. discount; those consuming 600, 5 per cent.; 1,000 units, 7½ per cent; 1,500 units, 10 per cent.; 2,500 units, 15 per cent.; and 5,000 units, 20 per cent. In

Digitized by Google

regard to meter rents it was decided to recommend that they be reduced about an average of 3s. per meter per year. These changes will represent a difference of £70 per annum in regard to meter rents and £111 per annum in regard to the discount, but the committee hope to increase the number of their customers and the amount of light used.

Newcastle Electric Supply Co.—A circular has been issued to the shareholders calling attention to the extended powers of the company under an Act of Parliament, which had recently received the Royal assent and become law, and announcing an extraordinary general meeting for yesterday. Under the powers now possessed by the company, the area of supply of electricity in bulk and in detail has been greatly extended, the districts of Gosforth and Longbenton being included; and it is also pointed out that by arrangement with the Council of the urban district of Walker that district will be supplied, as will the Walker and Wallsend Union Gas Company, with the whole of the electric energy in bulk required by them. It is pointed out that the organisation of the company requires to be at once extended and strengthened; and the directors will ask the meeting to vary the articles of association so as to allow of an increase in the number of directors by the addition of several gentlemen, who will assist in the maturing and carrying out of the extended plans and operations necessary in the erection of a new large power station. The names of Sir Lindsay Wood, Bart., and Mr. H. B Noble are mentioned in this connection.

Glasgow.—At the last meeting of the City Council the Statute Labour Committee reported recommending that the application for permission to lay cables by the Corporation telephone department be granted. The master of works stated that the plan showed that the cables were intended to be laid in nearly every street within the district bounded by the River Clyde, Hope-street, George-street, High-street, and Salt-market. He saw no objection from the statute labour point of view, except that there would be an enormous interference with the public use of the streets for a considerable time to come. None of the streets to be opened up could be put into a satisfactory condition for more than 12 months from the time the first opening is made. The committee, having considered the matter, agreed to recommend that, so far as the streets in question were public streets, the permission of the Corporation (Police Department) be granted on the understanding that, with the view of minimising inconvenience to the public, the Telephone Department carry out, as required by the master of works, the work in streets that may be for other purposes opened up, and that the pavements of streets be, as far as possible, utilised instead of the roadway.

Stock Exchange. — The Stock Exchange Committee have appointed Oct. 11 as a special settling day for Eastern Extension, Australasia, and China Telegraph Company's further issue of 50,000 shares of £10 each (issued at £3 per share premium), £6 paid (of which £3 is capital and £3 is premium), Nos. 250,001 to 300,000. The committee have also ordered the undermentioned securities to be quoted in the official list: British Columbia Electric Railway Company's further issue of 1,600 5 per cent. non-cumulative preference shares of £10 each, fully paid, Nos. 37,001 to 38,600; Eastern Extension, Australasia, and China Telegraph Company's further issue of 50,000 shares of £10 each (issued at £3 per share premium), £6 paid (of which £3 is capital and £3 is premium). Nos. 250,001 to 300,060. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the United River Plate Telephone Company's further issue of 23,361 5 per cent. cumulative preference shares of £5 each; and Vickers, Sons, and Maxim's further issue of 500,000 ordinary shares of £1 each, fully paid, Nos. 1 500,001 to 2,000,000. The committee have further been asked to allow the National Telephone Company's £500,000 4 per cent. debenture stock to be quoted in the official list.

Rickmansworth.—At the last meeting of the Urban District Council, Mr. Offor, of the North Metropolitan Electric Power Distribution Company, attended the meeting to explain the company's proposal to light the district with electricity. He said the company had given formal notice of application for a provisional order. The special terms the company would make would not be included in the provisional order, but would be embodied in a supplemental agreement, because the Board of Trade objected to such contracts with local authorities. The company were prepared to undertake the supply of electricity for the street lamps at 3d. per unit. According to Sir William Preece six units were equivalent to 1,000 cubic feet of gas. On that basis 3d. a unit was equal to 1s. 6d. per 1,000ft. of gas. With regard to private supplies, the charge would be at the rate of 7d. per unit for the first hour and 3d. per unit for every hour afterwards. The ordinary consumer would, on the average, use the light for about three hours in the 24, and in such a case the average cost would be 4d. a unit. If anyone used electricity for only one hour a day, his custom would be a loss to the works. The company were also prepared to give the Council the option of purchasing the business as a going concern on the expiration of two years' notice, which could not, however, be given until the lapse of 12 years, or at a subsequent period of seven years, the value to be fixed by independent valuers. Of course, the company would make these arrangements in consideration of the Council consenting to the provisional order. The offer is to be considered by the Council.

Derby.—During the year ended March 31, 1900, a net profit of £113 has been made by the electric lighting undertaking. The increase in the price of coal is estimated to have reduced the profit by £700. The following estimate of expenditure on capital account during the next two years has been submitted by the electrical engineer—viz.: one new 1,000-h.p. engine and alternator with foundations, £8,650; one new 600-h.p. boiler, with superheater and economiser and brickwork, £2,000; one ejector condenser, £650; new chimney, £1,500; motors, £2,000; transformer, £750; meters, £750; extensions to switchboard, £450; piping to connect engine and boilers, £400; extension of mains, £7,500; sundries, £139; amount overspent, £7,190; retentions on existing contracts, £3,021—total, £35,000. With reference to the two last items in the above estimate—viz, £7,190 and £3,021—the committee beg to report that the sum of £850 had been expended on a stock of motors for hire, and £1,000 on a stock of cable. The greater portion of the amount overspent has been used on mains extensions rendered necessary by the rapid increase of demand for electricity in excess of the estimate made when the Council on Jan. 4, 1899, granted the sum of £25,000. The following figures show how rapidly the demand for current has increased during the past few years: 1895, lamps connected 13,554; 1896 18,000 (increase, 4,446); 1897, 20.783 (2,783); 1898, 28,043 (7,260); 1899, 35 909 (7,866); 1900 (to September), 44,959 (9,050). The Council propose to apply for sanction to borrow £35,000. Orders have been given for steam jets to be placed on two boilers at the electric lighting works to make a forced draught. Extensions of the mains have been ordered to the new Methodist Chapel, Dairy House-road, at a cost of £140, and to Abell's Foundry, Brook-street, at a cost of £100. The following is the new scale of charges for electricity, as an alternative mode of charging—viz: for all quantities up to 500 units per quarter, 5½d. per unit; for all quantities over 500 and not exceeding 1,000 units per quarter, 5d. per unit; for all quantities over 1,000 and not exceeding 2 000 units per quarter, 4½d. per unit; for all quantities over 2,000 and not exceeding 3,000 units per quarter, 4½d. per unit; for all quantities over 3,000 and not exceeding 4,000 units per quarter, 4½d. per unit; for all quantities over 4,000 units per quarter, 4d. per unit.

Wrexham.—The engineer's monthly report on the electric lighting work submitted to the Council last week stated: "There are still some details before the buildings are finally completed, but they are ready to receive engines, dynamos, and condenser. All the boilers have been delivered, and foundations completed ready to receive them. The men are now at work getting them into position, and there is nothing now to delay their completion. The water-tube boilers will probably be ready for steaming by the middle of October, but the Lancashire boiler will, of course, not be steamed until the destructor is complete. Two sets of machinery will be delivered at the depôt towards the end of this month, and the condenser is promised at the same time. We are urging the manufacturers of the steam and exhaust piping to push forward the delivery of same, and understand from them that there will be no delay. The makers of the switchboard assure us that they will be in a position to complete by the time this is required. A certain amount of progress has been made with the mains, lamps, etc, but we cannot regard it yet as satisfactory. The contractors have at length, however, got a large amount of material to proceed with, and we think that at the end of this month a large proportion of the cable should be laid. It will be as well to finally decide positions of arc lamps so that the contractors may have no excuse for further delay on that ground. The accumulators will be to hand when required. As mentioned in our last report, there has been great delay on the part of the rolling mills in manufacturing the rails. We understand that these have now been received and the contractors have promised to dispatch. The excavations for the foundations of the destructor have been got out, and there should now be nothing to delay rapid progress with this work." Mr. Trentham further stated that 31 arc lamps had been decided upon to date, and, as it was more convenient to switch nine lamps on and off by one switch, it was suggested that five extra arc lamps be obtained. The estimate of the extra cost, including additional length of cable, was £180, and the length of cable required in Egerton-street would be 180 yards, which, at 8s. 8d. per yard (the schedule price for a ·125 cable), would amount to £78, plus £10 for connecting-box in Regent-street. These works are to be carried out. The estimate of the cost of wiring the depôt premises for electric lighting was £85, and tenders are to be invited for the work. Messrs. Meldrum reported that repeated alterations had been made since their tender was accepted, necessitating new drawings, and generally delaying the work; and they mentioned that so late as the previous week an alteration was made in the position of the boiler. This will necessitate about a month's delay.

Royal Photographic Society.—The forty-fifth annual exhibition of the Royal Photographic Society opened on Oct. 1, and has been removed from its old quarters at the Society of Painters in Water Colours to the New Gallery in Regent-street. The exhibition, which will remain open until Nov. 3, was inaugurated last Saturday by a conversazione, at which Mr. Dallmeyer (the president) and Mrs. Dallmeyer received a very large number of ladies and gentlemen, who greatly enjoyed the many very fine specimens of the photographic art which have been collected together, and which cover the walls of four large rooms as well as those of the upper gallery. The absence of the crush hitherto unavoidable in the one room at Pall-mall East was not the least welcome feature of the evening. The exhibits, remarkable as most of them are both for composition and for technical execution, lie somewhat without the scope of this journal, and the various processes of photography in colours, of which very advanced specimens are shown, have already been described in our columns. The newest of this kind consist in transparencies on glass in colours, produced by the McDonough-Joly process, which is an improved and practical working out of an early method suggested

Digitized by Google

and demonstrated by Louis Ducos du Hauron. It is based, like most of the modern processes of colour photography, on the researches of Clerk-Maxwell and on the Young-Helmholtz theory of the nature and properties of light. It proceeds on lines of analysis and synthesis, breaking up the effect of light upon the photographic plate into three separate colour-sensation effects, the impressions of which are produced simultaneously by one exposure upon a single photographic plate, through the intervention of a screen ruled with the three fundamental colours—red, green, and violet, in very fine parallel lines. By viewing the resulting print or transparency through a second similar screen, properly adjusted, the three-colour effects are again combined, and produce a coloured representation of the original subject. The process can also be applied to the production of photo-mechanical prints in colours on paper, suitable for book illustration or other purposes. The best specimen shown is a stereoscopic photograph of a basket of fruit, by the Sanger Shepherd process of natural colour photography, negative and print by E. Sanger Shepherd and R. Lincoln Cocke. The present exhibition does not present anything new with regard to scientific instruments, no new inventions having been made during the last 12 months which come within its range. Dallmeyers exhibit a new telephotocamera with which some very remarkable results have been obtained. The Eastman Company's "Panoram" camera is also exhibited for the first time. The London Stereoscopic and Photographic Company, Limited, show some wonderfully clear photographs of electric machinery (15 by 12 direct pictures). Among the scientific, technical, and photo-mechanical prints exhibited upstairs we noticed several illustrating the radio-active properties of the metals, radium and polonium, and the action of uranium salts on photographic plates, by Dr. W. J. Russell, F.R.S.; some magnetograms, both by the bromide and the old wax-paper process, by the Rev. Walter Sidgreaves; a number of very interesting photomicrographs of diatoms, by E. M. Nelson; and of curious insects, by T. E. Freshwater; and three platinum prints of brain cells and of ganglia taken by the Zettnow filter at an exposure of 10 minutes, and by the Zettnow-Tavel filter at an exposure of from 12 to 17 hours, by Doctor G. Mann. There is also a curious series of pictures of snow crystals by Dr. R. Neuhauss, and a large number of enlarged astronomical photographs from the Royal Observatory, Greenwich.

TRACTION.

Strike.—A strike of tramway employés has begun at Marseilles.

British Electric Traction Company. — Warrants for the debenture interest have been posted.

Erdington.—A proposal in favour of the construction of tramways will come before the Council next month.

London United Tramways.—We refer elsewhere to the still postponed opening of these lines and its cause.

Newcastle.—It is not expected that any of the new lines of electric tramways will be ready for opening this year.

Nottingham.—The first section of the new electric tramways will be ready for opening in the first week of November.

Darlington.—The Light Railway Commissioners have provisionally approved the order for the scheme originally propounded for the Darlington tramways.

Little Lever.—Deputations from the Farnworth and Radcliffe Urban District Councils are to meet the Little Lever Committee on the matter of the proposed tramways.

Manchester.—We learn that the first section of the electric tramways will be ready in about four months, and the whole system will then be taken over gradually as fast as the new lines can be constructed.

Paisley.—Mr. W. M. Murphy, Dublin, is taking steps to promote another Bill for the forming of a new tramway scheme for the town and district. The new scheme is to be called the Paisley district tramways.

Paris.—The frequent collisions of tramcars are ascribed in the local Press to the inexperience of the drivers, and to the false economy of the companies, who employ only one engineer when two are absolutely necessary.

King's Norton.—The City of Birmingham Tramway Company have agreed to carry their existing line from the terminus at Bournbrook to Chapel-lane, Selly Oak, and to contribute £1,500 towards the lowering of the canal bridge.

Nelson.—The Board of Trade have authorised the service of notice by the Corporation on the Burnley Tramways Company, under the enabling powers of the Tramways Act, 1870 requiring the company to sell to the Corporation so much of their tramway undertaking as is within the borough.

Brisbane Tramways Co.—On and after April 1, 1900, the debentures forming an issue of £250,000 5 per cent. debentures of £100 each, Nos. 1 to 2 500, will be paid off in accordance with the sixth condition endorsed thereon at the National Bank on delivery of the debentures and all unmatured coupons.

Aberdeen.—The Tramway Sub-Committee have approved of the plans showing the connection of the proposed new electric tramway line to the Links to the line at the junction of George-street and Union-street. Part is to be a single line, as an agreement with the proprietor of certain property appears to be difficult to arrive at.

East Ham.—The probable date of the opening to traffic of the first section of the District Council's tramways, consisting of 5¾ miles of single track, is April next. The permanent way is complete, and the erection of the overhead trolley line will be finished in about a month from now, while the generating station and car depôt is also well advanced.

Lifeguards.—We learn that the Dudley, Stourbridge, and District Electric Traction Company have recently fitted one of their new electric tramcars with Messrs. Wilson and Bennett's lifeguard, which was exhibited at the recent tramway exhibition, when it was awarded the first prize. The appliance is manufactured by Messrs. Gabriel and Co., of Birmingham.

Bolton.—At a meeting of the Electrical Tramways Committee of the Corporation on Monday evening, the following information was submitted: as to tramways cost per car mile, exclusive of interest and sinking fund—Bolton, 6·05d.; Hull, 4·47d.; Dover, 5·51d.; Leeds, 5·97d.; Bradford, 6·22d.; Glasgow, 6·26d.; Liverpool, 6·6d.; Blackburn, 6·82d.; Halifax, 8·70d.; Sheffield, 10·9d.; and Blackpool, 11·4d.

Hyde.—The Hyde and Dukinfield Town Councils propose to borrow £75,000 each for the construction of the electric tramway between these boroughs and Stalybridge, which was referred to at length in a previous issue. At the enquiry last week the Light Railway Commissioners granted the order with the exception of the Commercial Brow route, the alternate route along the proposed new road being selected.

Dudley.—Last Friday Colonel Dunlop inspected the new tramway from Dudley to Cradley *vid* Netherton and the reconstructed line from Dudley to the tramway depôt at Sedgley, both of which, within the borough, will be supplied with electricity from the Corporation generating station. The electrical equipment of the lines was inspected by Mr. Trotter six weeks ago, and it is expected that the cars will commence running without further delay.

Cardiff.—Plans have been submitted by Mr. Harpur, the borough engineer, and Mr. Ellis, the electrical tramway engineer, to the Cardiff Tramways Committee for the erection of a power station for tramway purposes, and specifications for the machinery and boilers which Mr. Ellis had prepared have been agreed to. The specifications are for four engines of 500 h.p. each, four 300-kw. generators, and four Lancashire boilers. Tenders are to be advertised for.

Edinburgh.—At a meeting of the Town Council on Wednesday it was proposed that, in view of the electric tramway to be run from Musselburgh to Joppa, and the importance and convenience to the public of a through service to Edinburgh, that it be remitted to the Lord Provost's Committee to consider the whole question of traction between Edinburgh and Joppa, with powers to employ skilled experts and report. The motion, on a show of hands, was defeated by a large majority.

St. Helens.—At the last meeting of the Electric Supply and Tramways Committee the town clerk was instructed to include in the application to the Board of Trade permission to borrow money for the construction of tramways in Corporation-street and Parr-street, the sums required for the construction of the extensions to the borough boundary in Newton-road, and to the boundary in Bold-road from Station-road. The borough electrical engineer was instructed to prepare estimates of the cost of the works indicated.

Kingston.—The Corporation have resolved to oppose a Bill proposed to be promoted by the London United Tramway Company for powers to construct and work electric trams in the borough and in other parts of Surrey. By this scheme the London United Tramway Company propose to lay down trams over about 60 miles of roadway, commencing at Hammersmith and going as far as Esher. There are to be six lines: (1) from Hammersmith, through Fulham, Putney, and Kingston, to Hampton Wick; (2) from New Malden to Kingston; (3) from the Kingston gate of Richmond Park to Tolworth; (4) from Surbiton to Esher; (5) from Thames Ditton to Hampton Court; and (6) from Surbiton to Hook.

Wigan.—At Wednesday's meeting of the Town Council a communication was read from the Pemberton District Council giving notice, under the Tramways Act, 1870, that they required the Wigan Corporation to sell to them so much of the tramways undertaking as was authorised by the Tramways Order, 1879. The matter was referred to the Electric Lighting and Tramways Committee. It was also resolved to ask sanction to the borrowing of £16,500 for electric lighting and power. It was stated, in connection with the construction of the electric tramways, that the work on the section running to Martland Mill Bridge had proceeded fairly rapidly. Difficulties had, however, presented themselves relating to other people. They had not yet been overcome, but it was hoped they would soon disappear, and there would be no difficulty in completing the section within a few days.

New South Wales.—Since the present Government came into office, the construction of the following tramways has been authorised: Spit-road tramway, £15,940; Kensington and Rifle Range tramway, £13,000; Rose Bay to Dover-road tramway, £7,345; St. Peters to Cook's River tramway, £16,850; George-street North to Dawes Point tramway, £18,000; Balmain to Drummoyne tramway, £12,000; Enfield to Mortlake tramway, £17,000; Newcastle-Adamstown tramway, £6,000: Newcastle-Waratah tramway, £5,700; Broken Hill tramways, £18,000. There is considerable stir in Broken Hill as to the character of the tramways which the Minister for Public Works promised them. The suggestion to utilise steam motors from Sydney after the conversion of the trams here does not at all commend itself to a section of the inhabitants, who demand nothing short of an up-to date electrical system.—*New South Wales Railway Budget.*

Digitized by Google

Bradford.—Returns showing the working of the Bradford electric tramways for the week ended Sept. 30 has been submitted as follows: On the Bolton section 3,099 miles had been run, and the receipts amounted to £143. 7s. 10d., equal to 11 1d. per car mile. The workmen's checks issued numbered 1,501, and 1,476 had been returned. The total receipts since April 1 amount to £4,044. 4s. 10d., or 11 57d. per car mile. On the Horton section during the past week 6,352 miles were run, and the receipts were £296. 13s. 4d., which is equal to 11·2d. per car mile. The workmen's checks issued numbered 1,735, and 1,733 were returned. The total receipts since April 1 amount to £8,813. 5s. 10d., which is equal to 12·4d. per car mile. On the Lidget Green section 2,700 miles had been run, and £131. 16s. 10d. taken in receipts, which is equal to 11·34d. per mile. The total receipts since the commencement amount to £632. 7s. 2d., which is equal to 12·31d. per mile.

Wandsworth.—The District Board of Works have adopted the General Purposes Committee's report on the notice of intention of the London United Tramways Company, Limited, to apply for powers to construct tramways through Putney High-street and Upper Richmond-road, Putney. The committee state that they had also considered a letter from the town clerk of Kingston-on-Thames, with reference to the foregoing proposal, stating that the Corporation's Tramways Committee had recommended the Council to offer a determined and unqualified opposition to the company's application, the Corporation having themselves decided to apply in the next session of Parliament for tramway powers, and enquiring whether the Board would also oppose the application of the company. The committee recommended that the company be informed that the Board would be glad to receive any explanation they might desire to submit, and that the Kingston Corporation be informed that the Board or their successors would consider their letter in connection with any tramway scheme that might come before them. This was adopted without discussion.

Croydon.—The County Council have adopted the following report of the Tramways Committee: "The committee do not recommend the acceptance of any tender for the new lines and reconstruction of the tramway track, but recommend that this committee do, in conjunction with the Roads Committee, carry out the work in hardwood, and that they be empowered to advertise for and to accept tenders for the necessary materials and work, and to engage such labour as is requisite for giving effect hereto. The following is a complete list of the estimated cost and tenders accepted and recommended for acceptance of the various works in connection with the tramways: reconstruction of track and paving, £102,000; overhead equipment, less £1,000 extra for lighting purposes (Contract No. 5), £20,045; feeders, test wires, and road-work (Contract No. 4), £12,963; cars (Contract No. 2), £9,670; motorcar equipment (Contract No. 3), £13,052; excavating and guard-wires, £1,400; Thomson-Houston car-shed additions (contract), £4,700; Brighton road car-shed (contract), £4,700; engineer's commission, £3,000; contingencies, £5,000 — total, £176,530. The committee also recommend that application be made to the Board of Trade for their consent to the laying of double lines of tramway from The Swan and Sugar Loaf, South Croydon, to the borough boundary at Purley, and from the Thornton Heath pond to the borough boundary at Norbury. Read letter from the British Electric Traction Company, Limited, stating that they are prepared to agree to the Corporation themselves carrying out the construction and reconstruction of the permanent way and to pay 6½ per cent. upon the reasonable cost of the work, it being understood that the maximum sum upon which such percentage shall be calculated shall not exceed £108,000, which was approximately the amount of the lowest tender, and that it is to be understood that if the Corporation should effect any saving and be able to complete the work for a less sum of money than £108,000, then that the company as lessees shall only be debited with 6½ per cent. upon any total sum less than £108,000, and suggesting that this understanding should be confirmed by a resolution of the Council. The committee recommend that the Council do pass a resolution accordingly."

COMPANIES' MEETINGS AND REPORTS.

HALIFAX AND BERMUDAS CABLE.

The report of the directors for the year ended June 30, adopted at the meeting on Friday last, states that the net result of the year's working is a profit of £3,795, as compared with £10,142 for the previous year. An interim dividend of 2½ per cent. has already been paid, and it is now proposed to make a further equal payment, which will together absorb £2,500, and leave £1,295 to be carried forward. Offers for the sale of debentures to the trustees were invited in December and June last, and £5,197 was paid for £5,200 of debentures, which amount has been written off capital expenditure.

DIRECT WEST INDIA CABLE.

The report of the directors for the year ended June 30, adopted at the meeting on Friday, states that the net result is a profit of £5,456 An interim dividend of 2½ per cent. has already been paid, and it is now proposed to make a further distribution of 3½ per cent., which will leave £3,656 to be carried forward. Under the deed the redemption of the Company's debentures commenced in June last and £9,000 of debentures have been acquired and cancelled, which amount has been written off capital expenditure.

HAWAIIAN TRAMWAYS.

The ordinary general meeting of the Hawaiian Tramways Company, Limited, was held on the 2nd inst. at Cannon-street Hotel, E.C.

The **Chairman** (Colonel C. M. Davidson), in moving the adoption of the report and accounts, said that the progress of changing the motive power had been checked by the action of the opposition company in Honolulu. The new electric motive power would be generated by steam.

The report and accounts were adopted and a dividend of 6 per cent. declared.

RECORDING TELEGRAPHS.

An extraordinary general meeting of this Company was held on Monday at Winchester House, Mr. J. A. Sillars presiding. The following resolution was carried: "That the Company be wound up voluntarily, and that a liquidator be appointed for the purposes of such winding up."

The **Chairman** said the new company—the Typewriting Telegraph Corporation—had been successfully formed, and he congratulated those who were holders of its shares. The first meeting of that company would take place on the 4th inst., when the chairman, Sir James Fergusson, who was a former Postmaster-General, would have an interesting statement as to the invention to lay before the shareholders.

PROVISIONAL PATENTS, 1900.

SEPTEMBER 24.

16312a. Improvements in and connected with wireless telegraphy. Charles Edwin Wilson, 24, Southampton-buildings, Chancery-lane, London. (Date claimed under Patents Rule 19, June 5, 1900) (Complete specification.)

16966. Improved electromotor. August Emil Sauer, 60, Queen Victoria-street, London. (Complete specification.)

16983. An improved electrograph. Wilhelm Carl Emil Faber, 53 Chancery-lane, London.

16993. Improvements in or relating to trolleys for use in electric traction. John George Lister, 111, Hatton-garden, London.

17003. An application of electricity to the imitation of snakes, reptiles, and insects for theatrical and other purposes. Charles Alias and John Joseph Webber, 36, Soho square, London.

SEPTEMBER 25.

17033. An improved electric automatically-indicating target for rifle practice. Percival William Merfield and Edgar Tozer, 33, Chancery-lane, London.

17049. Improvements in coin-operated electric meters. Frank Kraemer and Eugene Weber, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17077. Improvements in arc lamps. Henry Stansfield Dodd and Robert Ironside Bagnall, jun., Norfolk House, Norfolk-street, Strand, London.

SEPTEMBER 26.

17110. An arrangement of connections for sets of electric glow lamps in series so as to maintain the circuit in case of the extinction of one or more of the lamps. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

17125. Electric generators for military and other cycles. Henry Vander Weyde, 53, Chancery-lane, London.

17128. Improvements in magneto-telephones. Henry Edward Newton, 6, Bream's buildings, Chancery-lane, London. (Parnell Rabbidge, New South Wales.)

17131. Improvements in and relating to incandescence electric lamps. Charles Alfred Henry, 55, Chancery-lane, London.

17135. Improvements in electrodes for accumulators. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Richard Goldstein, Germany.)

SEPTEMBER 27.

17154. Improved mode of attaching glass shades to electric light and the like fittings. James Armsby Ellis, 34, Castle street, Liverpool.

17160. Improvements in electrical fuse boxes. Arthur Denby Smith, Sunbridge-chambers, Bradford.

17172. Improvements in electric switches. Vittorio Giovanni Lironi, Luna Electric Works, Harpurhey, Manchester.

17174. Improvements in carbon brush-holders for dynamos. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

Digitized by Google

17164. Improvements in electric switches. James Mitchell Hewitt and William Gould Rhodes, 46, Lincoln's-inn-fields, London. (Complete specification.)

17194. A fusible alloy specially adapted for use as an electrical circuit breaker. Richard Pearson, 53, Chancery-lane, London.

SEPTEMBER 28.

17211. Improvements in electric conductor casings or conduits. Louis Marsh, 15, Water-street, Liverpool.

17234. Improved means for generating variable electro-motive force. James Edgar Miller, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 1, 1900, being date of application in United States.)

17246. Improved prepayment of electricity meter with coin-freed control mechanism. Benedetto Avena, 322, High Holborn, London. (Complete specification.)

17262. Improvements in electricity meters of the electrolytic type. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

SEPTEMBER 29.

17289. Improvements relating to automatic electric switches. Arthur Henry Adams, 34, Castle-street, Liverpool.

17294. Improvements in or relating to electric telegraph or telephone instruments. Alfred Julius Boult, 111, Hatton-garden, London. (Alexander Bannerman, South Africa.)

17310. Improvements in apparatus for the generation and electrolytic application of electric currents. Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Partly by John Oliver Surtee Elmore, India.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Oct. 20.

1899.

19189. Means and apparatus for electrically working vacuum and air pressure railway brake. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

24116. Electric accumulators. Perrin.

25767. Electric motors. Rowntree.

1900.

12063. Dynamo-electric mine exploders or apparatus for firing explosives. Wetter. (Gomant.)

14288. Electromagnetic apparatus for jacquards. Szczepanik and Kleinberg.

14280. Electric switches. Pearson.

15167. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Davis.)

15285. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Lunt.)

15313. Autometer trolleys for electric current. Lombard-Gerin.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Sept. 29	801	566	+ 235	13,211	11,531
Birmingham Trams.	,, 22	4 630	4,314	+ 316*c*	165,087	157,112
Blackburn Corp'rat'n	,, 22	499	438	+ 61	17,147	15,050
Blackpool Corporatn.	,, 27	1 034	575	+ 459	24,472	18,224
Blackpool-Fleetwood	,, 29	768	768	—	17,662	17,536
Bradford City Trams	,, 30	571	352	+ 219	13,489	10,628
Bristol Tramways Co.	,, 28	3,402	3,059	+ 343	—	—
Carlisle Tr'mw'ys Co	,, 29	189	—	—	2,687*f*	—
Central London Ry.	,, 29	5,208	—	—	42,407*e*	—
City & South London	,, 30	1,574	963	+ 611	19,621*e*	12 185
Cork E. T. and L. Co.	,, 27	443	396	+ 47	16.167	14,849
Dover Tramways ...	,, 29	255	210	+ 45	8,233	7,872
Dublin & Lucan E.R	,, 22	103	92	+ 11	1,401	1,140
Dublin U.T., elec. cars	,, 28	3,651	1,933	+1,718	—	—
Dublin S.D. Electric	,, 28	854	785	+ 69	—	—
Glasgow Corporation	,, 29	9,748	9,519	+ 229	—	—
Halifax Corporation	Oct. 1	794	570	+ 224	21.070	16,370
Hull Corporat'n E.S.	Sept. 29	1,277	—	—	32,581*a*	—
Liverpool Corporat'n	,, 22*b*	9,874	7,106	+2,768	296,137	260,373
Liverpool Overhead	,, 30	1,685	1,481	+ 204	22,680*c*	21,617
St. Helens Tramwys.	,, 26	—	—	+ 225	—	—
Sheffield Corporation	,, 30	2,513	—	—	—	—
Southampton Trams	,, 27	735	392	+ 343	—	—
Swansea Tramways..	,, 28	447	269	+ 178	6,647	4,199

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *e* From July 30. *f* From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	⅞ ⅞
British Insulated Wire, Ord., 1-40,000	5	..	11-12
—— 40,001-70,000	—	—	10¾-10¾
—— 6 per cent. Cum. Pref., 1-40,000	5	..	6¼-6½
—— 5 per cent. Mortgage Debentures	100	—	98-100
British Electric Works, Ordinary, 80,001-96,000	1	—	¾-¾
—— 6 per cent. Cum. Pref., 1-80,000	1	—	¾-¾
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	—	2¼-2⅜
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	101-106
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12¼-12½
—— 5 per cent. Pref.	5	—	5-5¼
Crompton and Co.	2	—	3¾ 4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	2	—	1¾-2¼
—— 5 per cent. Debentures	5	—	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	—	96-100 xd
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾ 3¼
—— 6 per cent. Perp. 1st Mort. Deb.	100	—	103-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-12¾
—— 4½ per cent. Preference	5	—	5-5¼
—— 4½ per cent. Debentures	100	—	108-113
India Rubber, Gutta Percha, and Telegraph Works	10	—	20¾ 21¼
—— 4 per cent. Debentures	100	—	99-102 xd
Telegraph Construction and Maintenance	12	—	34-38
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10¾-11¼
—— 5 per cent. Cum. Pref.	5	—	5-5¼ xd
Willans and Robinson, Ordinary, 1-30,000	5	..	10¾-11¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-⅝
Bournemouth and Poole, Ordinary	10	..	12-13
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	100-103
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¼-6¾
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5¼ 5¾
Chelsea Electricity Supply	5	—	6¾-7¼
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	8¾-9¼
—— 6 per cent. Cumulative Pref.	10	..	12¼-12¾
—— 5 per cent. Debenture Stock	100	..	124-129
County of London and Brush Provincial, Ordinary	10	—	8¾-9¼
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¼-5
—— 4½ per cent. First Mort. Deb.	100	—	100-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	3	—	1¾ 2¼
—— 6 per cent. Pref.	5	—	4¾-5¼
—— 6 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-102
Metropolitan, Ordinary	10	—	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 5½ per cent. Mortgage Debenture, Red	100	—	97-100
Notting Hill Electric Lighting	10	—	14¾-15¼
Oriental, 1879	1	—	1¾-1¾
—— £5 Shares	5	—	7¼-7¾
—— £4½ Shares, New	4½	..	6-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	..	8-9
Westminster, Ordinary	5	—	12-13
—— 80,001-109,437	5	—	11-12
Electric Railways.—			
Central London, Ordinary	10	—	10-10¼
—— Pref. Half-Shares	5	..	5-5¼
—— ,, ,, deferred	5	..	5-5¼
City and South London, Consolidated Ordinary	100	—	58-61
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	92 95
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	..	101-103 xd
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10¼
British Electric Traction, Ordinary	10	—	14-15
—— 6 per cent. Cm. Pf. 80,001-90,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-122 xd
—— ,, ,, ,, 1900	100	—	120-123 xd
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	4¼-5 xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	3¾-4¼
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9¾-10¼
New General Traction, Ordinary	3	—	2¼-2¾
—— 6 per cent. Cum. Pref.	5	—	4¾-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-19
—— 5 per cent. Cum. Pref.	10	..	10¼-10¾
Potteries Electric Traction, Ordinary, 25,667-40,000	10	—	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9¾-10¼
—— 4½ per cent. Debenture Stock	100	—	104-107
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5¼-5¾
—— 2½ per cent. Deb. Stock, Red.	100	—	98-101
Oriental Telephone and Electric Company	1	—	¾-1¼

Digitized by Google

NOTES.

Institution of Electrical Engineers.—We are informed that the first meeting of the new session of the Institution of Electrical Engineers will be held in the rooms of the Institution of Civil Engineers at 8 p.m. on Thursday, Nov. 8, when the premiums for the session 1899-1900 will be presented, and the president, Prof. John Perry, M.E, D.Sc., F.R.S., will deliver his inaugural address.

Institution of Mechanical Engineers.—We notice that the first monthly meeting of this institution is to be held on Friday evening, Oct. 19, at 8 p.m. The paper to be read on that occasion is one on "Observations on an Improved Glass Revealer for Studying Condensation in Steam-Engine Cylinders and Rendering the Effects Visible," by Mr. Bryan Donkin. The points to be dealt with in the paper include a general description of the revealer, the size of condensed globules, fog in the revealer, condensation on the cast iron, from the low-pressure cylinder, appearance of condensation when fixed of the high-pressure cylinder, fall of temperature in metal cylinder on a jacketed factory engine, the measurement of radiation, etc. A communication is also added from M. Nadal, Ingenieur des Mines, France.

London University.—The election of the members to erve on the senate of the university was proceeded with on Tuesday, when the following gentlemen were elected: Persons nominated for election by the registered graduates in arts—John Fletcher Moulton, M.A.; John David McClure, B.A.; Sir Albert Kaye Rollit, LL.D., B.A.; Thomas Bateman Napier, LL.D.; James Bourne Benson, LL.D., B.A.; Thomas Lambert Mears, LL.D., M.A. For election by the registered graduates in laws—Sir Herbert Hardy Cozens-Hardy, LL.B., B.A. For election by the registered graduates in medicine and in surgery—Thomas Barlow, M.D., B.S, B.Sc.; Frank Joseph Payne, B.Sc. For election by the registered graduates in science—Sir Philip Magnus, B.A., B.Sc.; Sophia Bryant, D.Sc.; Charles William Kimmins, D.Sc.; Frank Clowes, D.Sc.; Silvanus Phillips Thompson, D.Sc., B.A.; Francis Sowerby Macaulay, D.Sc. For election by the registered graduates in music—Joseph Watson Sidebotham, Mus.Bac. (Oxon).

Cable Splicing.—Mr. T. J. Tighe contributes to the *Electrical Review* of New York a description of a method which has been invented for splicing large feeder cables by the Splice and Terminal Company, of New York. The apparatus is made with various pressures, that described being capable of giving a pressure of 20 tons. It consists of an independent hydraulic pump and flexible connection, and though easily capable of exerting the above-mentioned pressure, the press alone with its splicing dies weighs only 14lb. The pump weighs 15lb., and the connector and couplings less than a pound. The size of cable taken in this press is No. 0, or smaller sizes, and it is stated that it is very useful for the work of wiring buildings, it being able to joint the wiring all through the house without using any solder, applying any heat, or damaging the insulation. The whole outfit weighs less than the ordinary solder pot and furnace, and wires of different sizes can be spliced. The apparatus is also useful for attaching terminal blocks for switchboard work to cables.

The Central London Accident.—The most lamentable accident which occurred last Saturday on the Central London Railway was in every way to be regretted. The accident was one for which the unfortunate man who was killed was alone responsible, and he must have opened the gate and have been looking over the side of the train when it occurred. It is well, however, to point out that this accident was one which could not happen to passengers. From a passenger's point of view the railway is absolutely free of some of the risks which are found on the ordinary steam lines. Thus there could be no danger of a door flying open and precipitating a passenger on to the metals, as the doors do not open on to the line, and, apart from this, are carefully closed between each station. Another good thing in this system is that when trains are entering or leaving a station the gates do not stand open ready to knock under the train any passenger who approaches a little too near the edge of the platform, or at least bruise him badly. It is a great pity, therefore, on one of what may be termed the safest of railways, that a fatal accident should have occurred within so short a time of the date of opening.

The Chicago Automobile Exhibition.—The International Automobile Exhibition and Race Meet, held at Washington Park, Chicago, recently, is described in the *Electrical Review*. The race events were, we learn, on the first day, nine in number, and included a one-mile race for electric vehicles alone, and a 10 mile race for any vehicle. There was only one entrant for the former race, Mr. C. A. Lindstrom, who went over the course in an electric runabout in 2 minutes 34 seconds. An American gasolene vehicle won the 10-mile race. A very interesting event on the fourth day was a contest between two electric vehicles. In this contest again the Hewitt-Lindstrom vehicle, driven by Miss Lindstrom, who is only 13 years of age, won the first mile in 1 minute 57 seconds, and the second in 1 minute 59¾ seconds. Other races also took place, amongst these being a backward race for locomobiles. The prize for the vehicle carrying the greatest number of seated passengers also went to the Hewitt-Lindstrom Company for an electrical omnibus. The exhibits at the exhibition included a large number of steam, electric, and gasolene vehicles, there also being shown accessories of all kinds.

The Paris Exhibition Awards.—Our contemporary, the *Electrical World*, calls attention to a curious case of prodigality of awards in connection with the Paris Exhibition. Perhaps it would be more correct to say it is a case in which a single award has been shared by a large number of firms which have comparatively equal rights, and hence may each consider themselves recipients of the grand prix. The exhibit in question was in the liberal art section, where some two or three hundred American journals were exhibited together, being represented by bound volumes. We gather that the company which issues the *Electrical World and Engineer* had, or ought to have had, three exhibits in this bookcase, and it has accordingly received three intimations that it is entitled to use the grand prix amongst its qualifications. These volumes, it appears, were not actually in the bookcase—but to a French jury that is qui e a detail. The owners of the volumes hope that in due time they will be able to find the packing case in which their exhibit was dispatched. The French railways seem to have had an exceptional opportunity of losing consignments during the past year, and to have utilised this opportunity to the fullest possible extent.

Grantown-on-Spey.—As will be seen from our advertisement columns, the Town Council of the burgh of Grantown-on-Spey wish to have the electric light introduced on the most favourable terms to the inhabitants, and that without incurring financial risks. They accordingly have advertised for tenders from contractors for the establishment of such works and the running of the same, and propose, subject to other conditions being equal, to give

Digitized by Google

their support to the company who will supply at the cheapest rates and will give the most favourable terms for repurchase. The small number of inhabitants (1,500) makes the lighting scheme a comparatively small one, but we are assured that the population is largely augmented in the summer and autumn by visitors. The electric light would have quite a free field, as the gas undertaking which used to supply the town suspended operations about two years ago. This seems to be a case in which the course taken is an advantageous one to all concerned, and we presume that a provisional order would be dispensed with and an agreement entered into between the company and Town Council. With overhead wires and economic management, no doubt a fair return may be earned on the capital expenditure.

"The Chamber of Commerce Journal."—As one would expect, with the October issue of the *Chamber of Commerce Journal* is published a supplement containing a report of the proceedings at the meeting of the association of Chambers of Commerce, which was held in Paris from Sept. 5 to 8. Amongst the subjects of particular interest that were discussed we notice that of lighthouse communication, on which subject a resolution was carried to the effect that the association was of the opinion that arrangements should be made without delay for connecting all lightships and isolated lighthouses with the shore by means of wireless telegraphy, and the association regretted that, pending the decision of the Inter-Departmental Committee appointed by the Board of Trade, the installation between the South Foreland lighthouses and East Goodwin lightship was allowed to be removed. On the question of Imperial telegraphic communication the association decided to give every support to the House of Commons Committee appointed to investigate the matter. A resolution was passed urging upon the Postmaster-General the necessity for underground telegraphic communication between the larger towns and seaports to prevent interruption being caused by gales, etc. The discussion on the question of the cheapening of telegrams was adjourned until the spring meeting.

The Telegraph Service at the Paris Exhibition. *Journal Télégraphique* publishes a plan showing the postal and telegraphic service which is in use in the Paris Exhibition. There are, we learn, eight offices placed at the disposition of the public at the Exhibition, one of these being a central office and the others sub-offices. The whole are under the direct direction of the chief of the postal and telegraph services in Paris. The offices undertakes all postal, telegraphic, and telephonic business, having special accommodation for the latter. Besides the telephones in the post offices there are a number of telephone cabins in the grounds, the total number of these, including eight at Vincennes, being 82. Telegrams are received by all the post offices, but are only distributed from the central office, except in the case of Vincennes. Telegraphic business is conducted during the whole time the post offices are open. Telegraph wires connect each of the offices with the central office, and each office contains a Morse instrument; in four of them also being two Hughes instruments. The pneumatic telegrams which are sent from one office to another in the Exhibition have reached the high number of 26,000 in one day. There are 38 messengers employed for distributing the telegrams. As regards the telephone service, the public can communicate from any of the 82 telephone cabins with any part of Paris, or with any district connected to Paris by telephone. Season tickets are issued for these telephonic cabins by which one can use the lines to communicate with subscribers in Paris, the tickets costing about 16s., and being available as long as the cabins remain working. The telephone cabins are open from 7 a.m. till 11 p.m., and have each two attendants.

Electric Lighting at Stroud.—From a report which we have received from a local source, we gather that the Urban District Council held a special meeting to consider the advisability of applying for a provisional order for the electric lighting of the district. We gather from the remarks made by the chairman that he did not take an active part in the organisation of the meeting, as he does not support electric lighting being carried out at the present time. He stated that Stroud had a population of 5,000, and that it would cost £30,000 to provide an electric lighting system. The alternative course which he suggested was one with which we disapprove *in toto*. It is that they should spend a small amount of money now in order to get the matter into their own hands, and then do no more for the present. The sum suggested to be spent—£150—could only refer, we fancy, to the obtaining of a provisional order, and we trust that if the meeting, which is now adjourned, agrees with the chairman, and applies for an order on the lines suggested, that the discussion in the Council will be forwarded to the Board of Trade. If the Urban District Council of Stroud is not prepared to undertake the supply of electric light, which need not cost in such a small place anything like the figure suggested, they ought to withdraw entirely from the matter, and make arrangements with a company for the lighting of their district. The suggested dog-in-the-manger policy will, if carried out, ultimately cause considerable inconvenience to the townspeople generally.

Central Technical College.—The Old Students' Association of the City and Guilds of London Central Technical College held its third annual dinner on Tuesday, Oct. 2, at the Restaurant Frascati, Prof. O. Henrici, LL.D., F.R.S., dean of the college and president of the association, taking the chair. Amongst those present were the professors of the college, Sir A. R. Binnie (who had in the afternoon given the inaugural address at the opening of the college session), and Mr. A. L. Soper (assistant secretary to the institute), in addition to a large number of old students. After the toast of "The Queen" had been duly honoured, the Chairman rose to offer the suggestion that in future some business should be taken in connection with the dinner. The toast of "The College" was ably proposed by Mr. M. J. P. O'Gorman, who praised the occasion as one eminently calculated to make the members lose that awe of their professors which they had held in their student days, and laid great stress on the duty of successful old students to help on the younger members, and do all in their power to bring forward the name of the college. In replying to the toast, Prof. Henrici said that the college took the greatest interest in its old students, and pointed out the importance of having a large and efficiently organised Old Students' Association. Prof. W. E. Ayrton, in toasting "The Association," laid special stress on the establishment of an old students' register, and said that it should be the aim of all the members to make their association a miniature empire. Mr. E. F. Armstrong, replying on behalf of the association, in the unavoidable absence of the hon. secretary, sketched briefly the work of the association, and appealed to all members to support it energetically, and to forward in every way the interests of the college. Prof. W. C. Unwin, in proposing "The Visitors," gave an interesting account of what some of the old students were doing. Sir A. R. Binnie and Mr. A. S. E. Ackermann also spoke.

An Electric Exerciser.—A combination medical coil and exerciser is the latest novelty from the States. The instrument, which is described in the *Scientific American*,

Digitized by Google

has been placed on the market by the Badger Brass Company, of Kenosha, U.S.A. The machine resembles the ordinary exerciser in appearance, elastic cords passing over pulleys in the usual way. The cords, however, serve as conductors and the handles as electrodes. Somewhat below the middle portion of the board a cell is held in a recess and wired to an induction coil, secured to the upper part of the board, so that the current strength can be increased. The induced current is conducted through the elastic cords to the handle and back again. In order to interrupt the battery current and incite a secondary current in the coil, one of the pulleys is provided with an interrupter, which, in turning with the pulley, automatically makes and breaks the circuit as it passes a contact secured on the pulley block and wired to the secondary coil. The pulley is suspended from a hook forming part of a movable plate which constitutes a circuit controller. When the cord is pulled, the hook-plate is drawn forward against a stop to complete the circuit. When the handle is released, the hook-plate is automatically retracted to break the circuit. A metallic footplate furnished with the apparatus can be placed in the circuit, so that the current can be passed through the body. By means of a conveniently located switch the current can be directed from either hand through the body to the other hand, or by means of the footplate through the body to the feet, or *vice versâ*. By drawing out the slide of the induction coil, the current can be regulated in strength to meet the requirements of all persons. The stimulating effect of electricity has long been recognised by medical men. The physical development resulting from the use of exercisers has earned for the elastic cord machine a wide popularity. The benefits to be derived from an electric exerciser in which muscular exercise is combined with electrical stimulus are, therefore, thought to be so obvious that further comment is hardly necessary.

The Automobile Club. — We have received a memorandum concerning the trials of electrical vehicles which are to take place from Nov. 5 to 9, 1900. To take part in these trials, vehicles must be entered on or before Friday, Nov. 2, the entry fee being two guineas per vehicle per trial. Forms of entry can now be obtained on application to the Secretary, Automobile Club, 4, Whitehall-court, London, S.W. The vehicles entered may be subjected to the following trials: on Monday, Nov. 5, a run over a given course for an unlimited distance on one charge, the driver declaring to the judge when the run is to be considered as finished; on Nov. 6, a course of 30 miles, to include considerable gradients; on Nov. 7, a course of 30 miles of average road; on Nov. 8, a course of 30 miles of flat or nearly flat road. Vehicles may be entered on or before Friday, Nov. 2, for an additional optional trial to take place on Nov. 9, when the run will be over a given course for an unlimited distance on one charge. The driver is in this instance also to declare to the observer when the run is to be considered as finished. The same batteries are to be used throughout the whole course of the trials, and will be under the supervision of the club. The competitors are, however, responsible for the supervision of the charging of their batteries. The energy consumed, the number of passengers carried, and the average speed attained will be recorded on certificates, which will be granted by the club to competitors, but no speed in excess of the legal limit of 12 miles per hour will be recorded or recognised. The competitors must supply drivers for their vehicles, and must provide on each vehicle a seat for an official judge. The routes on which the trials will take place will be within 50 miles of London, but will not be made known to competitors until immediately before the trials. All the vehicles in the trials are to be fitted with reliable and accurate voltmeters and ammeters, which can be read during the trials by the observers, and these meters must be fitted with terminals, by means of which they may be tested by the judges. In entering vehicles competitors are asked to supply, for the information of the judges only, a diagram of the electrical connections of each vehicle. Competitors must agree to accept the rules and decisions of the judges' committee in all matters, and the judges' committee reserves to itself the right to amend the rules affecting the trials.

A Leclanche Cell for Automobiles.—We notice in *L'Industrie Electrique* a description of a Leclanché cell which it is proposed to use for automobile purposes. The electrodes of the cell have a large surface area, the zinc being made in the form of a box, and thus replacing the outside jar and the carbon, being surrounded with a mixture of manganese dioxide and graphite. The electrolyte has been rendered immovable by a kind of gelatine, and cars supplied with these cells have been worked for a month nearly as continuously as ordinary motor cyles. An improvement, however, has been made on this arrangement, and a new model has been made which has a yet lower internal resistance. In this case highly compressed half cylinders of a depolarising material are formed. The material has as its base manganese dioxide and natural pure graphite. Two of these half cylinders are placed in a canvas bag, and there is then forced between their two inner surfaces a carbon stick with a metallic screw head. The two half cylinders when forced apart hold the sides of the bag tightly enough to render tying useless, and the whole forms a solid cylindrical block, which is not easily broken, and of which the cohesion is made even better by being immersed in the exciting liquid. In this arrangement the weight of the depolarising matter for the same volume is double that used with a porous pot of the same size, and this accounts for its longer durability. Generally, in Leclanché cells, the exciting salt must not be very strong, owing to the deposition of insoluble crystals of zinc chlorides on the zincs, but these cells are able to take a very strong solution of hydro-chlorate of ammonia and zinc chlorides. The inventors recommend that the arrangement shall stand in the electrolyte for 24 hours in order that it may soak through the bag and mixture surrounding the carbon, so as to obtain a very low internal resistance. With this cell it is stated that 25 to 30 amperes can be obtained. Our contemporary gives the curves obtained by the discharge of cells of this kind at the electrical laboratory at the School of Physics and Organic Chemistry. The curves represent three different conditions. The first curve was obtained by passing the current from the cell through a resistance of 20 ohms, when after 33 days the difference in potential was still 1·25 volts; the second curve illustrates a test in which an external resistance of 10 ohms was used, when the results were not so good, the difference being about ·8 of a volt; with a five-ohm resistance the value for the same line was about ·45 volt. The current furnished in each case was 52·5 amperes, 87·9 amperes, and 127·6 amperes respectively, thus showing that the capacity of the cell is great enough for the majority of the applications to which it would be put.

The Central London Railway.—In our last week's issue will be found some interesting figures as to the success obtained by this railway in providing a good and efficient means of communication between one of our great London suburbs and the heart of the City. We did not in it refer, however, to the extraordinarily low fares which are charged in comparison with those which obtain on other

Digitized by Google

lines which give communication between the same parts. One result of these low fares has naturally been a tremendous rush of traffic morning and evening, as such a large number of workers in the City have been induced, on the score of cheapness, to travel on the new line. In consequence of this rush there has been overcrowding, and it is interesting to read the untechnical advice given in the daily papers as to the way in which this overcrowding should be overcome. We have noticed particularly that the *Times* has opened its columns to most impracticable suggestions, amongst which was one that during the morning rush both of the tunnels should be used as up lines, and that again in the evening they should be used both as down lines. The writer in this case did not go into the question as to what was to happen to the trains after they got to the City in the morning, nor state that with a three minutes' service and a continuous run in one direction only even for an hour, instead of two hours, as suggested, would mean that 80 trains would have to be provided, each one of which would only be working for a single journey in the course of at least 2½ hours. The capital charges would of course be prohibitive, as would also the cost of the miles of sidings which would have to be constructed at the Bank. Another suggestion which would certainly have the effect of making the line more convenient in the early morning to those who wish to come into the City, is given in the *Times* of Tuesday last. The writer suggests that, instead of providing for the demand, it should be killed by increasing the fares during the time of rush. In other words, that the company should refuse to carry out its parliamentary obligations, and also fail to fulfil the very object for which the line was designed. The only solution of the difficulty is a more frequent train service, and this the company are arranging to give as quickly as possible. It will be quite recognised that with a new venture such as the Central London, the maximum carrying capacity cannot safely be obtained in the early days of running without the risk of sacrificing continuity of service.

The Smoke Nuisance.—We notice in last week's *Lancet* a letter from Sir W. B. Richmond, of the Coal Smoke Abatement Society, in which he states that this society is by no means moribund. From this letter we are surprised to hear that the London County Council and the various vestries and parish councils in Greater London have shown great negligence and apathy in dealing with the smoke question. From the number of references we have given in our columns, we had believed that the reverse was the case, and that several of these vestries carried their smoke prosecutions to an absurdity. Still, the Coal Smoke Abatement Society thinks that there is no chance of improving matters until the police are again made responsible for the prosecutions. Sir W. B. Richmond states that "jobbery is rife and bribery constant. The reports which our inspectors have laid before the County Council, parish councils, and vestries have been ignored or given the lie by these bodies." It is evident from the above that the society with its two inspectors is rather sore that its efforts to improve the conditions of life are not more highly appreciated by the other authorities who have this work in hand. We think, however, that Sir W. B. Richmond should moderate somewhat his language on the subject, and should also make sure from personal experiments carried out by his two inspectors that his own chimneys do not smoke. While we agree that certain manufacturers in London do cause some considerable nuisance from smoke issuing from their chimneys, it is the domestic fire which is often the chief offender. The smoke issuing from a chimney is judged by the blackness when looking through it to the sky, and this is, of course, in proportion to the size of the orifice through which the smoke issues, provided that it carries equal quantities of soot in a given volume. When judged in this way, therefore, the small domestic will pass the test, whereas a large factory chimney, sending out no more smoke per cubic foot of gas, will appear to be a great offender. In the same issue of the *Lancet* a gentleman who signs himself "L. R." complains terribly of the nuisance caused by the chimney of the South London Electric Lighting Corporation. It will be remembered that this company burns the refuse of the parish of Lambeth, and that it has been fined for the nuisance caused on several occasions. This the correspondent admits, but he joins with the previous writer in insinuating that the Lambeth Vestry do not prosecute the company more frequently because the company is burning the ashbin refuse of the parish. It is a great pity that these advocates of purer air cannot conduct their crusade against the smoky chimneys without blackening the characters of public men in London.

Military Hospitals.—Much has recently been heard about the management of the hospitals in which during the past year the sick and wounded of our troops have been placed. It is interesting, therefore, to find in the *Lancet* descriptions of some of the South African hospitals, which have been sent in by correspondents who have actually been in the buildings, and who understand whether the best is being done for the soldiers. Thus, in speaking of the hospitals in the Transvaal, a correspondent says that without question that at Johannesburg is one of the best. At Pretoria, which is practically the headquarters of the army, there is provision made for about 2,000 beds. These are placed in three hospitals placed side by side on the plain east of the town and near the railway. The hospitals, which were erected by the Royal Army Medical Corps, consist of tents. Of these three, No. 2 General Hospital is mentioned as being the best of its kind during the war, and it is one of the few hospitals possessing a disinfector for bedding. It is provided with a telephone and electric light for the central avenues of the camp. This latter fact should be gratifying of electrical engineers, and one is tempted to ask whether the electric machines were "commandeered" from the slim Boer. The Palace of Justice, which was converted into the "Irish" Hospital, has also received a large amount of praise for its admirable arrangements. Sir W. Thompson, who organised this hospital, also installed electric lighting in the building, and it is stated by our contemporary's correspondent to be a hospital which is hard to beat, if one remembers that the building was not constructed for a hospital. What, however, seems likely to become the best hospital is that recently opened by Lord and Lady Roberts. It is a yeomanry hospital, and is erected on an estate which was commandeered for the purpose. The estate, which has an extent of 130 acres, belonged to a rebel English burgher who had enriched himself by plotting against England with the Transvaal Government, and who introduced among the Boers the soft-nosed bullets and other similar infringements of the rules of war. His house is situated on a hill which catches fresh breezes when Pretoria itself is misty and sultry. Fifty patients are accommodated in this residence, which now has an operating theatre, 40 nurses being also provided for in two neighbouring houses. The remainder of the patients, to the number of 400, are placed in marquees. In the principal house electric light has again been installed, and the hospital was prepared and in readiness within the short space of 12 days. We are glad to see from the above descriptions, and others which are given in the *Lancet*, that wherever it is possible electric light is installed. This must add greatly to the

Digitized by Google

comfort of the sufferers, and at the same time render the tasks both of doctors and nurses a great deal easier and more pleasant than would otherwise be the case.

Editing.—We can quite understand any journal devoted to science inserting extracts from unscientific publications in order to show what great mistakes can be made from incorrect descriptions and misrepresenting facts, but we fail to see why a paper like *Invention* should insert, under the heading of "Electrical Dangers," extracts from an insurance journal which are absolutely unintelligible. The insertion may please the popular taste, and we can only assume, not having seen the insurance journal in question, that the editor of *Invention* was impressed by the incomprehensibility of the statements. Why he could not frankly say so we do not know, and we certainly do not credit the statement at the end that every electrical engineer and expert knows such mishaps are inseparable from the systems. The paragraph we complain of reads as follows: "An insurance journal gives 40 or more instances of novel troubles and disasters attendant upon the omnipresent conducting electric wire. Not the ordinary, readily understood trouble that results in severe shocks, or death tragedies, or fire scares and fire loss, but of incidents of unexpected demonstration and phenomena that not even experts could anticipate and provide for to guarantee safety of person and property. Defective wiring, severed current, surcharged conductor, broken or disjointed insulator, disordered switch, tremendous voltage, deadly third rail, etc.—all are such common sources of annoyance and injury as to command but passing notice, and death or destruction that may ensue are relegated to the category of accidents due to avoidable or easily-corrected conditions. But there is a long line of haps and mishaps associated with light and power distribution at once curious, mysterious, and alarming, and which greatly adds to public distrust of the 'harnessed lightning.' As, for example: A man engaged in pressing trousers with an electric iron using alternating current made a ground contact somehow, and was instantly killed. Current of series arc circuit grounded through porcelain. Arc was established and ignited insulation. Fire communicated to wooden beam. A young man standing upon a register of a hot-air furnace attempted to turn on an incandescent lamp; primary and secondary circuits of transformers were in contact. He somehow escaped death, but several toes on one foot and the thumb and forefinger on one hand were so badly burned that they had to be amputated. Two-wire circuit run on wooden moulding in a damp place, fastened to a brick wall under sidewalk. Fire caused by accumulation of sodium salts. During violent thunderstorm lightning discharge entered office building over signal circuit. Insulation took fire, and fire communicated to lighting and other wires in a vertical shaft used as a runaway. Woodwork in shaft consumed. Overheated rheostat set fire to adjacent woodwork, having been placed too near latter. Fire spread rapidly." We believe, from the words used, that the insurance journal was an American one, but surely this ought to have been stated in an English paper.

Quebec Electric Railways.—Mr. D. E. Blair read before the Canadian Electrical Association at their recent meeting a paper dealing with the electric railway system in Quebec. He stated that the city had a population of 75,000, of which 65,000 were French Canadians. A large percentage of the population were not only limited in means, but lived in congested districts near their employment, and had but little need for street cars. The life of the city was a very easy-going one, haste in getting about being considered unimportant. The very heavy snowfalls also militated against the success of an electrical tramway undertaking. The Quebec Railway, Light, and Power Company, however, started work, and soon had a street railway in successful operation. The work of tracklaying was started on Nov. 1, 1896, and by July 1, 1897, the road was open for traffic. The track was constructed of 72lb. 6in. T-rails in 30ft. lengths, laid to standard gauge on 7in. ties at 2ft. centres. Each joint was double bonded, and there were double cross-bonds every 150ft. The total length of the track is 17½ miles, of which 7¼ miles are single and 5⅛ miles are double track. The poles are tubular iron ones, 28ft. long, and placed 90ft. apart. The trolley wire is No. 00 hard drawn, and the lightning arresters are of Wurts's non-arcing type. There are two car-sheds, the repairs being done in one of these, in which are seven floored pits communicating with the workshops underneath. The streets in Quebec are very narrow and winding, there being hardly room for a cart to pass an electric car on a single track. The return track comes through a very difficult part of the town, on one mile section there being no less than 11 curves of from 35ft. to 40ft. radius. The upper and lower towns, which are at very different elevations, are connected by two lines, ascending obliquely along the face of the cliff, one of these lines rising 172ft. in a length of 3,440ft. This is an average grade of 5 per cent., but certain sections have grades of 12½, 10, and 9 per cent, others being level. All these grades have sharp curves. The other cross-line has an average grade of 6·8 per cent., and is carried along part of the cliff by a steel trestle at a grade of 7·5 per cent. On this line, when a car leaves the trestle to take the up-grade, it is running at half-speed, and must be accelerated on grade, this being a heavy drag on the motor. The average speed on all lines is about eight miles per hour, the average number of cars employed being 35 in summer and 30 in winter. Speeds on down grades must not exceed four miles per hour, and hand brakes are used. Soft cast-iron brake shoes are used, this being found to work better than hard cast iron, especially in winter. The cars are 28ft. double-vestibuled closed cars, with a seating capacity of 30. There are also 24 double-end open cars, seating 50 passengers, six snow-sweepers, two way ploughs, and one street sprinkler. The motors are of the Westinghouse No. 12 A 30-h.p. type, the controllers and resistances being supplied by the same manufacturers. The sweeper and snow-plough equipments are necessarily much overloaded at times, the overload often being 100 per cent. for several minutes at a time during heavy storms, and a sweeper will occasionally burn out five or six copper wire fuses, or draw 200 to 250 amperes at 520 volts before it can pass a difficult spot. This does not seem to have any bad effect, beyond the temporary softening of the armature insulation, and sometimes the loss of some solder from the commutator connections. Not a single armature has been burned out since the road was in operation. All closed cars are heated electrically during six months of the year, there being two sections of heaters on each side of the car, each pair being separated by a controller. In four months of the six both sides are in use, but in November and April one side is enough to heat it comfortably. The tramway is operated through a sub-station within the city from a power-house situated at the Falls of Montmorency. The power-house contains three 600-kw. two-phase alternators, one 750-kw. alternator, one 600-kw. double current, 275-500-volt Westinghouse generator, and two 30-kw. bipolar exciters. All the larger machines are direct connected to 52in water-wheels of 1,000 h.p. each, running at 286 revolutions per minute. The sub-station has two 600-kw. two-phase synchronous motors taking current at 5,000 volts, and are direct connected by two 500-kw. 500-volt General Electric railway generators. There are also other lighting machines in the sub-station.

Digitized by Google

THE EVOLUTION OF SWITCH GEARS FOR HIGH-PRESSURE ALTERNATING CURRENTS.

BY W. E. WARRILOW.

(Concluded from page 492.)

A switchboard constructed on the lines described should recommend itself to engineers who run a number of alternators in parallel, as the machines can be previously plugged up to feed a number of circuits equivalent to their output, and in case of breakdown of a machine or machines they may be isolated at once by opening the 'bus bar interconnector switch. Spare engines can then be run up on the isolated bar, which is subsequently paralleled with the rest of the board. In case of a sudden rush of load, when synchronising is rendered very difficult or impossible, the bars may be separated, and three units run up on each bar quite independent of their synchronism, provided the board is previously arranged for such an event. When the alternators have taken up their load, they may be put in parallel by interconnecting the bars. The circuits would be out a shorter time with this arrangement than if they remained open while machines were being synchronised. The possibilities of connecting two bars together when differing in phase and potential at the 'bus bar fittings by inserting two plugs may bring about unpleasant results, but with ordinary care such chances are very remote. Provided the plug is not withdrawn, the worst that can happen is the blowing of a machine fuse. The advantages of flexibility quite outbalance the disadvantages presented by remote possibilities.

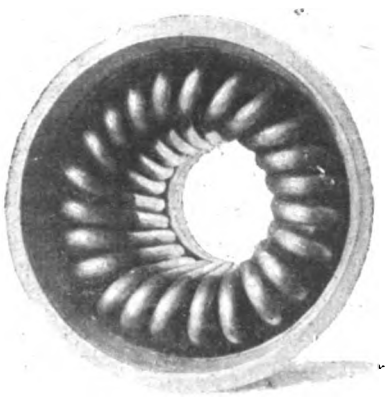


FIG 54.—Proctor-Blaikie Patent Plug Contact.

A board constructed on somewhat similar lines has been recently erected at Bristol. It differs only in the size of the machine panels and in the plugging device for connecting dynamos or circuits to the three 'bus bars. This latter, which comprises a novel form of socket presenting a great number of surfaces to the plug inserted in it, is the Proctor-Blaikie patent plug contact. The adjoining photograph (Fig. 54) illustrates the contact, which is constructed as follows: A hard-drawn copper or phosphor-bronze wire of suitable section is wound round an elliptical mandril, and the coil thus formed is bent so that its longitudinal axis forms a circle. It is then placed in a tube or socket having a hole through the centre capable of taking the required size of plug. The action of pushing the plug into the aperture formed by parts of each convolution of the spring will create a pressure between the plug and the spring and the spring and the socket or tube, while each convolution of the spring acting independently ensures a good contact for all. The pressure of the spring is adjusted by a screw cap (Fig 55) at the top of the socket, which, when screwed in, tends to bulge the elliptical spring, and thus put more pressure on the plug. The carrying capacity of the contact is controlled by (1) gauge of spring wire; (2) number of convolutions that can be accommodated round the circumference of the plug.

Let A = sectional area of wire;
B = number of convolutions;

then effective sectional area of contact = 2 A B.

It will be found that when the diameter of the plug increases, B becomes too small in proportion to the sectional area of the plug. Two contacts may then be arranged in tandem on one plug, or two separate contacts can, where practicable, be put in parallel. Some critics have mentioned that the contact is made by the "touching" of circles, thus only consisting of a number of fine lines. They have suggested as an alternative that wire of rectangular section be used, overlooking the fact that, on their own showing, the contact would still be only of fine lines, as a line also only touches a circle at a point. It has, however, been proved experimentally that the contact offers considerably more surface than the above would tend to show, as the plug soon makes its own flats on the wires. Wire of rectangular section has proved its inferiority when a convolution has twisted out of its place, for the plug has then been scored badly.

Fig. 56 is a photograph of the Ferranti board at Bristol, and its arrangement will be readily understood therefrom. The three 'bus bars are marked "Section 1," "Section 2," and "Hospital" respectively, and an interconnector switch is fitted at the left-hand end of the board to connect the bars together. Current from the three bars is led through wattmeters (seen at the right-hand side of the board) fitted

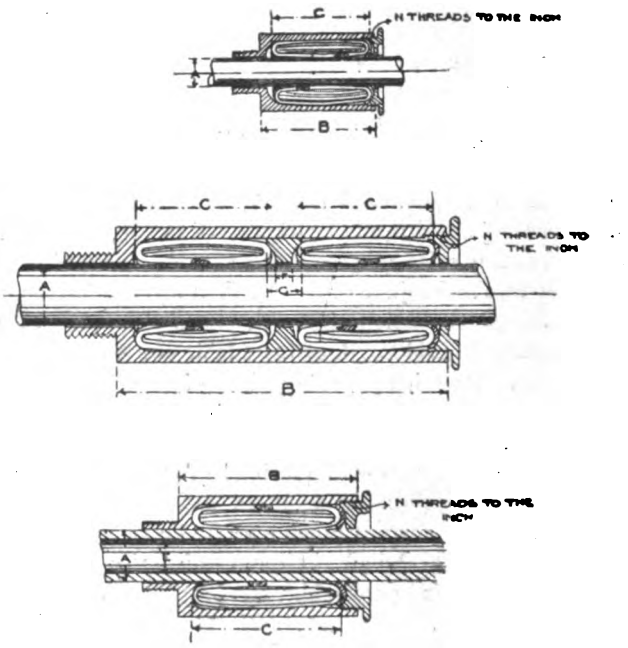


FIG. 55.—Proctor-Blaikie Patent Contact.

each in its own panel, and provided with an ammeter. Two wattmeters and ammeters are capable of carrying 1,000 amperes each, the remaining panel dealing with 500 amperes. Both instruments are provided with short-circuiting devices to facilitate removal while current is passing. The synchronising arrangements possess some interesting features. The alternators installed being of the copper armature type have little or no self-induction, and when by accident machines were switched in a little out of phase the mechanical strains on the plant were great, besides in some instances causing annoyance to consumers by a "jump on the lights." It was therefore suggested that some self-induction should be introduced prior to paralleling, and be gradually removed as the incoming machine pulled into in phase. This was first accomplished in the following manner. A third 'bus bar, called the synchronising bar, was connected to one contact of a synchronising switch, the other contact being coupled to the main 'bus bar *vid* two impedance coils of sufficient self-induction to allow of only 30 amperes passing at 4,000 volts. Each of these coils, which were in series, were provided with short-circuiting switches, and the self-induction could be thus removed in two steps. Paralleling was performed as follows: (1) plug the incoming machine to synchronising bar; (2) when in phase (or nearly so) close the synchronising switch; (3) observe ammeters of running machines and ammeter in series with incoming machine, and when swing has died down short-circuit half impedance; (4) if the parallel is a bad one, a fresh swing will probably be started by this on the ammeters, which will gradually die down until the alternator switch can be closed with impunity.

When the old board was replaced by one of the Ferranti

Digitized by Google

type, the same principle was adhered to with the following modifications: The "half-cock" switch arrangement was enlarged to carry a current up to 30 amperes, the contact being connected to a synchronising bar and switch as above described, having an impedance coil in series. The impedance coil was made in one, and was provided with a mechanical arrangement for raising or lowering the iron core.

A gradual increase or decrease of the inductance in series with the incoming machine could thus be obtained, and the operation of paralleling rendered still more rapid and safe. The energy, however, required to pull two loaded alternators into phase is greater than when they are running light, so that in the case of paralleling sections a high impedance is useless, as it will not pass sufficient energy to hold the machines in phase. This is an error that a switchboard attendant is liable to make if the gear happens to be arranged so that he may use it when paralleling sections. The above system has been in use at Bristol for over six years, and has proved itself eminently satisfactory.

The general flexibility of the Ferranti switchboard has brought it into great favour for high-pressure work, and though it may not represent the last word said on switch gears, it bids fair to maintain its good reputation through

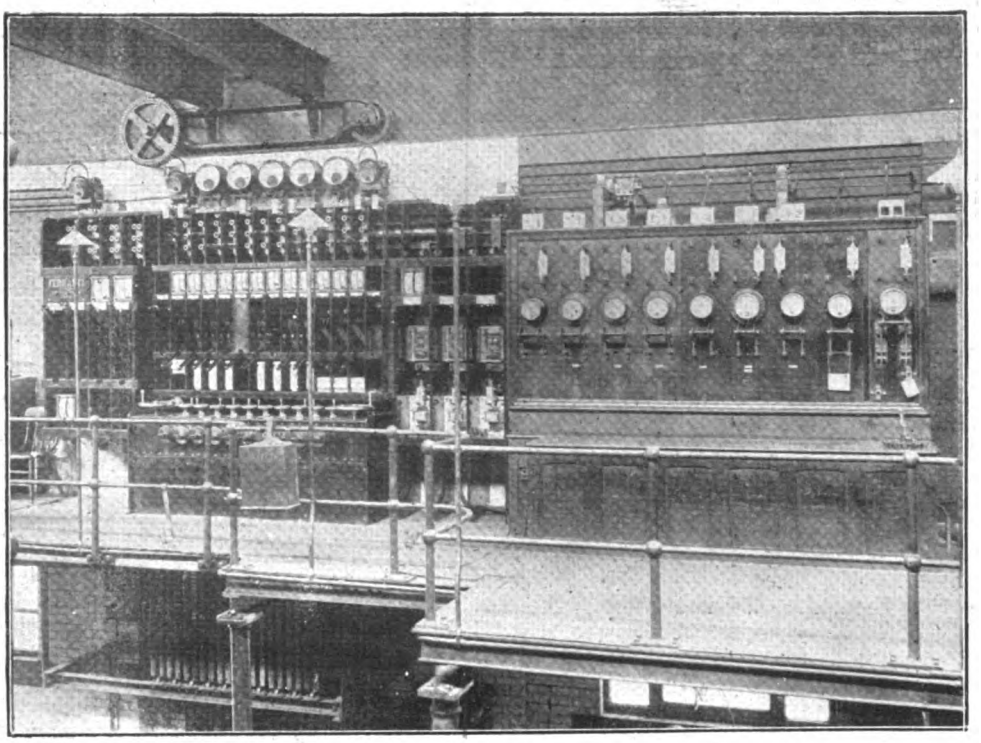


FIG 56. Bristol Main Board.

many years. The descriptions of this gear have been somewhat lengthy by reason of the information to hand. It must not, however, be thought that the above by any means tells the whole tale, as that would fill a volume of no mean dimensions with very interesting matter.

CONCLUSION.

From the foregoing it will be seen that vast improvements in the construction of switch gears have been effected within a very few years, but though the time has been short the changes brought about have been none the less real. One of the greatest factors in the development has undoubtedly been the concentration of so much power in a single generating unit. This circumstance has necessitated the complete remodelling of the switchboard in those stations which were originally installed with plants of small output, and which are extended for the erection of large units. In many cases this remodelling has resolved itself into the supplanting of the old gear by an up-to-date apparatus, as the construction of the former has been such that it were folly to entrust it with the control of heavy currents. Double-pole switch gears erected in wood framings and mountings, connected electrically by rubber-covered cables and composed generally of materials of a more or less inflammable nature, present possibilities which in case of disaster hardly bear thinking upon. It may be said that such boards do exist and fulfil their conditions satisfactorily, but such a statement takes nothing from the aforesaid possibilities, nor is it in any way an excuse for the existence of the board.

In replacing his old board by a new one the station engineer has some difficulties to meet, differing according to circumstances, in making the change. Where the old board occupies the most favourable situation, the erection of the new gear in its place without interrupting the supply will be a matter of considerable difficulty. When this is impossible, the new board must be fixed in as advantageous a position as can be found, as the extension of the old board is but a temporary solution of the problem. Speaking of the situation of the gear, there can be no doubt that it should be placed in a room which is out of reach of all machinery, though commanding at the same time a complete view of the engine-room. Such an arrangement keeps the switchboard, which represents the "vitals" of the station, out of harm's way, and there need be no difficulty in carrying out the control of the alternators when efficient signalling apparatus is employed.

The general improvement of high-tension switch gears has added greatly to the keeping up of a continuous supply to consumers, who are accordingly better pleased, and to the reduction in the number of fatal accidents at the generating station. An all-round popularisation of the electric light has thus been brought about, with corresponding beneficial results. The marked effect thus produced on the electrical industry cannot be over-estimated, as the failures of supply in early days did much to prevent the progress of many concerns. That switch gears were answerable for a great number of these interruptions goes almost without saying, and the improvements effected speak well for the enterprise of those who had the difficulties to overcome and the manner in which they surmounted them.

In conclusion, the author begs to thank those firms whose gears have been described for their kindness in giving him particulars, with photographs and diagrams, of their manufactures, and also to the electrical engineers of Bristol, Huddersfield, and Leeds for their kind permission to reproduce photographs of switchboards in their respective stations.

[By error, Fig. 51, illustrating one of the circuit boards at Huddersfield, in our issue of last week was inserted upside down.—ED. *E. E.*]

Digitized by Google

A CONTINUOUS-CURRENT DYNAMO FOR WIDELY VARYING VOLTAGES, DESIGNED BY E. LANHOFFER.*

The voltage available at the terminals of a continuous-current dynamo is not capable of wide variation. If one considers a machine revolving at its regular speed and supplying a given current, all that is necessary to increase the voltage at the terminals is to increase the magnetic flux by means of increasing the exciting current. One soon finds, however, the limit in this direction, which is given by the magnetic saturation of the iron in the field magnets. From this cause the magnetic flux cannot be increased above a certain limit, however much the ampere-turns are increased. On the other hand, if one tries to diminish the voltage by reducing the excitation, sparking

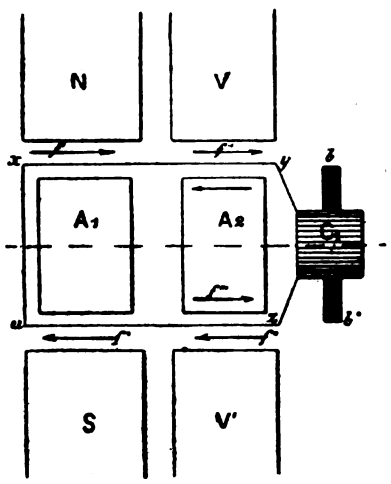


FIG. 1.

occurs on the commutator, because under the then conditions the current through the armature cannot be commutated satisfactorily. The coefficient of the range of potential difference at the terminals of a dynamo is used by the authors to denote that under given conditions of speed and current the machine shall work equally well at either extreme of voltage. In practice this coefficient usually is less than 1·5—that is to say, for example, that a dynamo designed to give 120 volts will not work well over a range greater than from 100 to 150 volts when at normal speed and with its maximum current output. In a number of cases of great interest

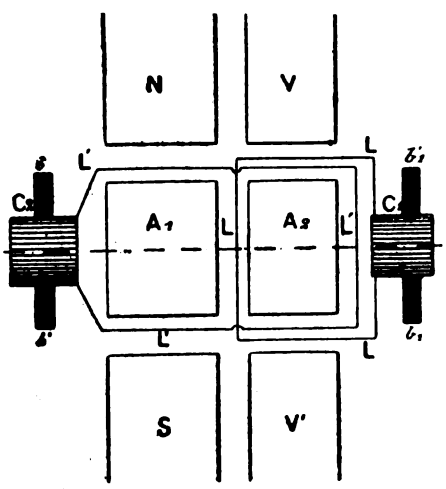


FIG. 2.

machines are wanted which have a higher coefficient than 1·5. The so-called differential dynamo designed by Mr. E. Lanhoffer, in the authors' opinion, completely solves the question. The maximum limit of the voltage of this machine is still fixed by the saturation of the field magnet,

* This article is taken from the columns of our French contemporary *L'Electricien*. In the translation we have had to condense it slightly, but the general arguments of the original article are followed in full.

but the minimum voltage can be made extremely small without resulting in any inconvenience with respect to commutation. The coefficiency of the range of voltage can be made even greater than 5, which is a remarkable result.

The working of the Lanhoffer dynamo depends on the possibility of developing several distinct E.M.F.'s in the various parts of the winding of an armature. If one considers a wire in which there are induced several

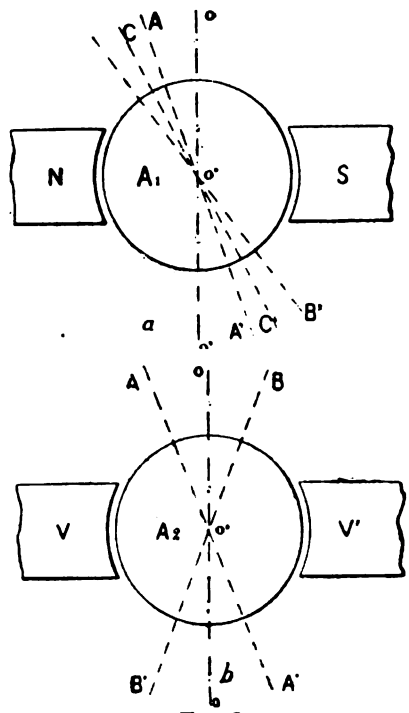


FIG. 3.

E.M.F.'s, the potential difference between its extremities will be equal to the algebraical sum of the elementary E.M.F.'s, which either aid or reduce the resultant according to their respective signs. In order to be able to develop simultaneously the different E.M.F.'s in the same wire, it is quite evident that the various parts of this wire will have to be placed in independent magnetic fields. Practically two fields are sufficient, and the differential machine is composed of two ordinary dynamos placed with their axes

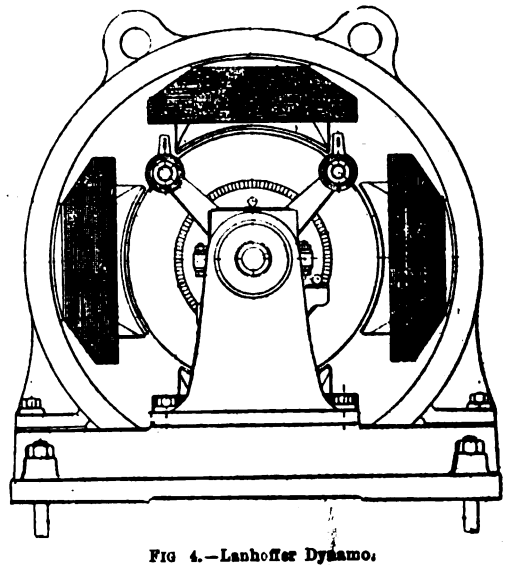


FIG. 4.—Lanhoffer Dynamo.

in the same line, so as to enable a common shaft to be used for the two armatures. The armature cores are thus separated, each being placed in symmetrical relation to its field. The wires on the armature are so disposed that the different turns embrace both these armature cores. Any one wire is thus placed under the inductive influence of two independent fields, which act in reality each independently. When these magnetic fields are in the same direction the E.M.F.'s induced in the machine will add, and the machine acts as

Digitized by Google

an ordinary single dynamo. When, however, the independent magnetic fields are in the opposite direction, the E.M.F.'s oppose one another, and may even completely annul each other's effect. The dynamo thus works differentially.

Again, if one field is not excited, the other acts on the armature core as if the first did not exist. Fig. 1 gives diagrammatically the arrangement of the Lanhoffer dynamo. It will be seen that the magnet poles N S act on the core A_1, while the magnet poles V V' act on the core A_2. The wire, $x y z u$, is one turn of the armature winding. We may call E the E.M.F. developed by the poles N S, and e that due to the action of the poles V V'. Let us suppose that the excitation of the poles N S is constant, and that in consequence E is constant, and is in the direction indicated by the arrows ff, and e is the maximum E.M.F. which can be developed by the core V V'. It is easy to see that the resultant E.M.F. at the terminal will be able to have all the values which lie between $E+e$ and $E-e$. The intermediate values between these two limits will depend on the direction and strength of the exciting current in the coils placed round the electromagnets V V.

If e is positive—that is to say, has the same sign as E—the machine V V will act as a booster, the voltage in the coil being in the direction shown by the arrow f''. If, on the other hand, e is opposed to E, the voltage in the machine will then be as shown by the arrow f''. The ratio of the sections of the poles, N S and V V', determines the relation between E and the maximum E. It fixes in the same way the limits between which one is able to vary the voltage on the collector of the machine. The differential dynamo designed by Mr. E. Lanhoffer, with its two distinct magnet circuits, will act then from the point of view of its maximum output as a dynamo of which the magnetic circuit would be equivalent to the sum of its two parts. The dimensions of the winding will in reality be the same, and the two field-magnet systems ought to be brought as near together as they conveniently can be. The machine can be driven in any way that may be desired.

The regulation of the voltage at the brushes, $b b'$, is effected by means of a rheostat and reverser placed in the circuit of the field magnets V V so that that side of the machine acts as a compensator. The excitation of the magnets N S, which should be constant, can be obtained either by separate excitation, or, preferably, by a special winding, L L, on the armature core A_2. The machine will then be self-exciting, the small supplementary armature winding furnishing the excitation for both systems of field magnets. This arrangement is shown diagrammatically in Fig. 2.

The differential dynamo may equally well be constructed as a transformer of continuous currents of which the ratio of transformation can be varied through very wide limits. Instead of being mechanically driven, the dynamo would then be connected on one side to the source of supply, while the voltage taken off could be varied at will. Fig. 2 would represent this arrangement, if the motor winding, L, was placed over the core A_1, instead of being on A_2, the current from the mains would then go to the motor winding, L, on the core A_1, and would be supplied through the commutator C_1. The excitation for both the sets of field magnets will also be taken from the street mains. The winding L_1, which embraces both cores, and which is connected to the commutator C_2, then gives out the transformed current, the voltage of which can be varied at will by means of the rheostat and reverser in the field circuit round V V'.

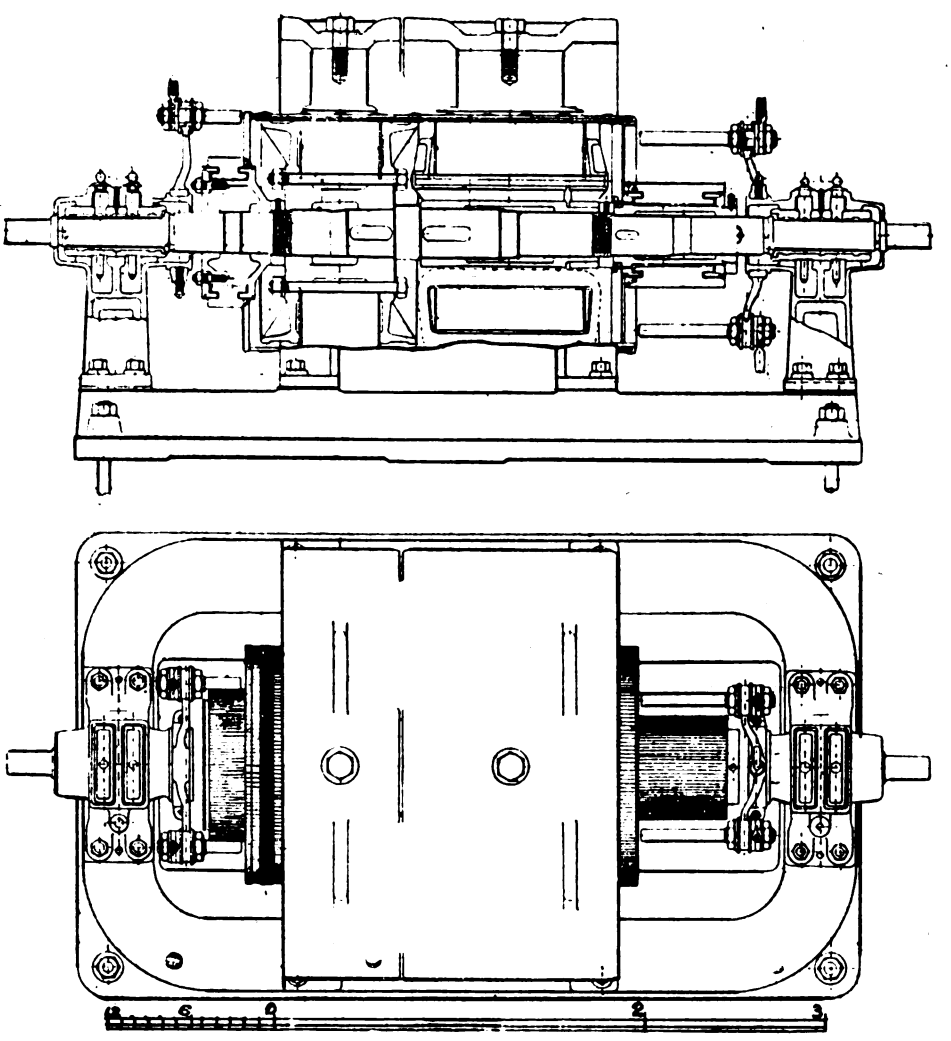


FIG. 5.—Plan and Section showing Details o the Lanhoffer Dynamo.

It is interesting now to consider how the differential dynamo will act as a motor. If this is supplied under constant voltage, it will be able to develop its torque at exceedingly different speeds. This machine with the variable speed will be exactly as represented in Fig. 1. The current from the mains would supply the excitation, and would also feed the commutator C_1. If, then, the electromagnets V V' act in the same direction as N S, the machine

Digitized by Google

will behave as an ordinary motor of the equivalent dimensions. When, on the other hand, the poles V V′ act in the opposite direction to the poles N S, the resultant counter E.M.F. will diminish. The speed of the motor will then augment until the point is reached at which the counter E.M.F. has acquired again a value approximately equal to that supplied, as is always the case in motors. If one denotes by ω the speed of the motor when the poles N S and V V′ are in the same direction and developing the maximum counter E.M.F. $E+e$, then when the poles V V′ act in the opposite direction and produce the voltage $-e$, the total E.M.F. becomes $E-e$. The speed ω' then will have the value $\omega' = -\omega\frac{E+e}{E-e}$.

If, for example, the poles, N S and V V′, had the same section, and were able in consequence to develop exactly the same flux, one could have $E-e=0$, and the speed would then have the value $\omega' = \omega\frac{E+e}{0}$, which would be infinity. This case is only theoretical. In practice the flux developed by the poles V V′ is always less than that from the poles N S, and for this reason the electromagnets V V′ have always a smaller section than that of the electromagnets N S. The limit on the ground of speed is reached by considerations of a purely mechanical order. With smooth armature cores it is hardly possible to go beyond a circumferential speed of 4,000ft. per minute, and if the core is toothed to receive the conductors, which are secured by a dovetail of wood, 6,000ft. per minute may be obtained.

The next point to be considered in the working of this machine is that of the armature reaction with respect to the commutation. If, in Fig. 1, the two sets of field magnets act in the same direction, the resultant flux in the air-space will have its neutral axis at A A′, Fig. 3, for the field-magnet system, N S, of the machine, and along B′ B for the system V V′.

From the point of view for the total armature reaction this will pass as if the reaction flux had its axis along C′ C. For any given load the angle formed by the lines A A′ and o o′ will be constant, while the angle B o″ o varies according to the voltage developed by the compensating machine, V V′. When this voltage is small—that is, when the poles V V′ are only a little excited—the angle B o″ o is greater than A o″ o. It diminishes when the excitation increases, and when the voltage is in the neighbourhood of e, B B′ will be superimposed upon A A′.

In order to get good commutation, the brushes ought to be placed in order to satisfy the two positions A A′ and B B′ situate on the same side of o o. When the electromagnets V V′ act in the opposite direction to N S, the reaction of the flux relative to the machine N S remains, as before, along A A′. The reaction of the flux in the side V V′ passes from B B′ to the other side of the line o o′. From the point of view of the position of the brushes the armature winding placed on the core A_1 demands a lead in advance of the direction of rotation, as is the case in ordinary generators. The lead is, on the contrary, on the reverse side of the axis, as in motors, for that part of the winding on the core A_2.

The only way to satisfy these two positions of leads which are so different, consists in giving the various elements of the machine such dimensions that the brushes are able to rest in one position independently of whether the machine is running as a motor or as a dynamo. It is now known how to construct dynamos which are sufficiently perfect to be able to work well with a fixed position of brushes, whatever may be the output or direction of rotation. With respect to the fall of voltage caused by the armature reaction, the effects are the same in the Lanhoffer machine as in ordinary dynamos which are well known. Each part, A_1 A_2, of the armature acts, in effect, on its own account, and the effects set up in all cases are just what would happen if one had an armature with a single core equivalent to the sum of the parts A_1 and A_2. Let us see now what happens when the Lanhoffer dynamo is wound so as to be a transformer with variable ratios. The armature reactions on the core A_1 will thus counteract the ampere-turns of the motor winding, which we have called L_1, as the reactions are equal and opposite. The ampere-turns of the differential winding on A_2 are the only ones to act, and the resultant flux is its neutral axis along B B′, or following B_1 B_1', according as the poles V V′ act with or against the poles, N S. The armature reaction is less in these two cases, and the commutation still more easy, than when the machine does not use the motor winding, L′, and acts only as a generator which is driven mechanically. The same applies when the differential dynamo is used as a motor with variable speeds. There is still to be examined the case in which the poles V V′ are not excited, and the part of the winding of the armature on the core A_2 does not develop any E.M.F. This case is evidently the most unfavourable, because the winding on the core A_2 carries the whole current before poles which are not excited. In

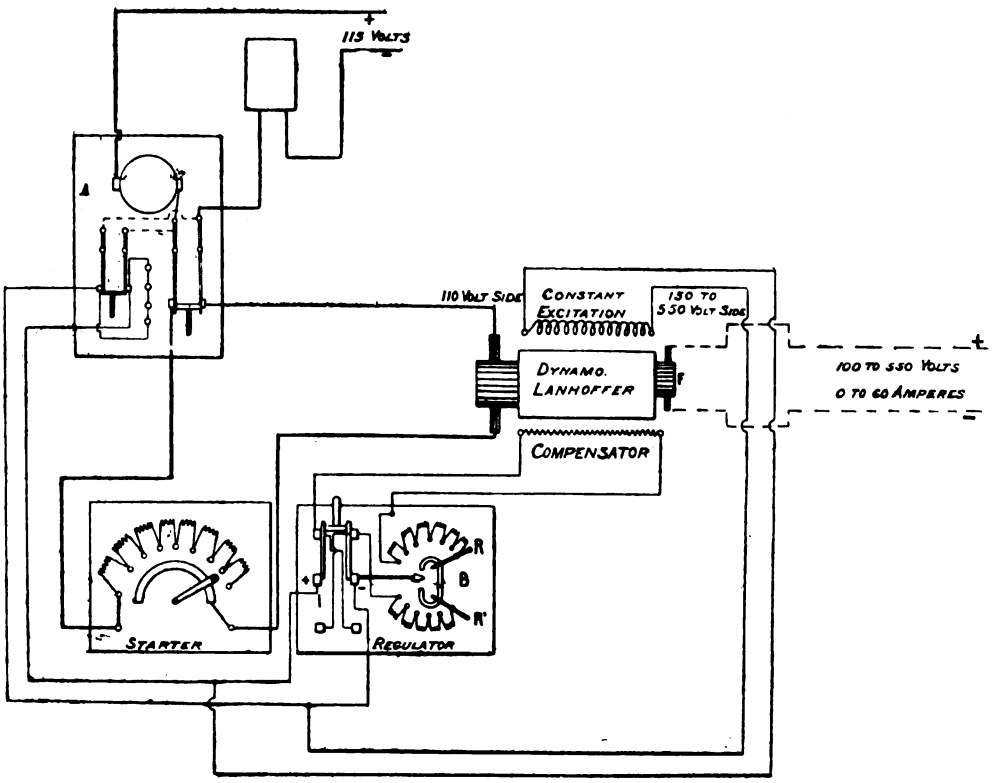


FIG. 6.—Diagram of Connections

Digitized by Google

order that the commutation may not give trouble, it is necessary that a part of the winding, L, should be taken back round the core A_1 only. This shows that the differential dynamo does what cannot be done by mounting in series two independent armatures. The armature which developes a small difference of potential, and which in the meanwhile has to carry the current of the other, would behave very badly with respect to sparking. On the contrary, the arrangement of Mr. Lanhoffer, if one portion of the turn tends to give trouble in working, the rest of that turn opposes it, and practically the machine behaves exceedingly well under all loads, voltages, and speeds. A typical example is the case of a transformer with a variable ratio designed and constructed for the Compagnie du Nord by Le Maison Breguet, who are the licensees in France of the Lanhoffer patents. The Compagnie du Nord lights a great number of trains by means of incandescent lamps run from accumulators in such a manner as to run them independently of each other. According to the method arranged by Mr. Sartiaux, the engineer of the company, the accumulators on those carriages making up a train are charged, while the train is at rest, in groups of batteries in series. This system gives the most economical results, and renders the charging installation exceedingly simple. It has also been approved by long practice. There is, however, one difficulty which is serious, and which results from the number of vehicles on a train varying from day to day according to the requirements of the service. The voltage of charge thus varies from one train to another and from one day to another. On the other hand, various trains are charged in the railway stations possessing electric lighting plant, and there is not, properly speaking, any special station for charging the accumulators on the carriages. In order to keep the advantages and the simplicity of the series charging, it was indispensable to have a machine with varying voltage for the needs of the service. The charging of the accumulators on a train takes from 30 to 35 amperes at a voltage which may vary from 140 to 500 volts, according to the number of carriages. This problem has been solved by the Lanhoffer dynamo. In this case was employed the type of differential dynamo shown diagrammatically in Fig. 1. In certain cases the machines are driven mechanically, and in a great number of workshops which possess no motive power, and which are supplied by transmission of electrical energy at high voltage, it is not possible to drive the dynamo mechanically. In other cases where motors can be attached direct to the dynamo, they were only able to supply these motors at 120 volts. It is in these cases that the transformer with variable voltage, illustrated in Figs. 4 and 5, was used. This machine consists of two laminated toothed armatures on a common shaft, which is mounted on self-oiling bearings. The field magnets are mounted in a cylindrical casting of steel. This cylindrical casting is divided into two halves, as seen in the plan. Six slits are provided, which are not very wide, as can be seen. Each of the machines is of the four-pole type, the poles being vertical and pointing inwards. The dimensions of the machines are given in the article in question, but as these can be taken from the illustrations, we have not reproduced them in full. The over-all diameter of the field-magnet ring is 2ft. 5in. The diameter of the core of the armature is 16in., while its length is 10in. It is wound on the Gramme principle, with three turns of wire in each of the 52 slits from the 52 sections in the commutator. These armature dimensions apply to the receiving side of the motor-generator, but the other side are very much the same, except that the length of the core is 5¼in. At full load the speed of the engine is 1,250 revolutions per minute, and the machine is able to give any voltage from 100 up to 550. The receiving side is fed at 115 volts, as are also the exciting coils. At full load—33 kw.—the efficiency was 82 per cent, which is not bad for this size of transformer. When the machine is driven mechanically, the efficiency is about 91 per cent. Fig. 6 shows the diagram of connections of this continuous-current transformer, together with its accessories for starting and regulating. The dynamo is practically self-centered. The value of E is about 300 volts, while e can be varied to 250 volts, according to the needs of the user. The reversing switch in circuit enables this voltage to be either in the same direction or to oppose the E.M.F., E. In order to vary the voltage between 0 and + or − 250 volts, it is necessary to have a rheostat with considerable resistance. It is more advantageous to excite the compensating side by means of a shunt current taken at a variable voltage between 0 and 110 volts. A rheostat of from 20 to 25 ohms shunted on the 110-volt circuit serves as a potentiometer, and permits a variable excitation to be obtained. The authors of the description, Messrs. E. J. Brunswick and Aliamet, conclude their article with the statement that they need not draw up a list of the advantages of the machine, because anyone can easily understand what can be done with a machine such as is described, which, while exceedingly simple, is able to give great variations of speed and voltage for continuous currents.

N.B.—A careful reading of the above article will show that the author's claims are rather too wide to be substantiated. The Lanhoffer dynamo when used as a motor-generator or constant-current transformer is not novel, at any rate in this country, as the idea originated many years ago with the Electric Construction Corporation, of Wolverhampton. They made a large number of machines of this type, which are employed at central stations on which continuous currents at high voltages are used. As an example, we may mention that such continuous-current transformers with a variable ratio are used by the Charing Cross and Strand Company. In these machines will be seen the exact arrangements illustrated in Fig. 2. It then remains to be considered what there is novel in the Lanhoffer dynamo beyond what we have referred to above? This, we think, is the claim for the exceedingly wide range in voltage for which a coefficient of 5 is claimed. By this we fancy that the authors mean that one of the dynamos in question would give its full current equally well at any voltage, say from 100 to 500. It will be noticed that no test figures are given to bear out this claim, and it is worth considering what feature in the machine allows the voltage to be reduced as low as 100 without sparking ensuing at the commutators. This, we believe, is not in the arrangement claimed, but to the fact as stated in the article that the fields have to be exceedingly heavy in order that the position of the brushes may be fixed. The sparking on the commutator is determined by, amongst other things, the field required to reverse the current in the section undergoing commutation. In this respect the Lanhoffer machine is no better off than an ordinary dynamo. The advantage of the two fields for a wide range is that by reversing the smaller field-magnet system, low voltages can be obtained without reducing the magnetisation of the iron of either machine to such a point as to be unstable. In fact, so far as sparking is concerned, the better way of getting a wide range of voltage with a constant current is to use a constant-current dynamo such as has been largely made by Messrs. Siemens Bros. and Co., and in which the voltage is varied by varying the position of the brushes round the commutator. The strength of field in the air-gap is then designed to be just that required to commutate the sections, so that the machine runs sparklessly for any position of the brushes. A dynamo of this kind could well be employed for charging in series the accumulators on the train referred to above.—Ed. *E. E.*

THE INAUGURATION OF THE ELECTRICITY SUPPLY AT POPLAR.

With considerable pomp and ceremony, the new works erected by the Poplar District Board of works for the supply of electrical energy to the districts of Poplar, Bow, and Bromley were formally opened on Monday last. These works are situated in Glaucus-street, Bromley, E., and the aristocracy of the neighbourhoods supplied turned up at the opening ceremony in their hundreds. The inauguration of the supply marks the practical completion of a very bold scheme, and one which will certainly tend vastly to the improvement and security of "Darkest London," at the same time securing to the poor of the

Digitized by Google

district better lighted streets than many to be found in the West-end of London. The undertaking has involved an expenditure of approximately £100,000, the work of instalment in connection with the same having been carried out according to the specifications of Mr. Alfred Blackman, M.I.E.E., under whose able supervision the works are happily destined to remain. It should be added that the necessary buildings have been erected by the direct employment of labour under the control of the Board's surveyor, Mr. Winter, who also designed the buildings.

The direct-current three-wire system has been adopted, with a supply at 230 volts for lighting purposes. Included in the first instalment of plant are two 320-b.h.p. engines running at 380 revolutions per minute, and coupled direct to two dynamos of 200 kw. capacity each; also two 165-b.h.p. engines running at 550 revolutions per minute, and coupled direct to two 100-kw. dynamos. Space is, however, left for considerable extensions. The arc lamps erected in the principal thoroughfares number about 200, and it is further intended to convert close upon 700 ordinary gas lamps by fitting them with incandescent electric lamps, whence it follows that Poplar should soon possess a very extensive system of street electric lighting. So far as supply to private consumers is concerned, arrangements have been made with the National Electric Wiring Company, Limited, for the free wiring of private premises, and current will be supplied on the maximum demand system, 5d. being charged for the first hour, 4d. for the second, and 3d. per unit afterwards for lighting, while 3d. and 1½d. will be charged for power. Already applications have been received for an equivalent of 5,000 8 c.p. lamps.

At the opening ceremony on Monday, Mr. J. Morton (chairman of the Board) presided, and it also fell to his lot to switch on the lighting of the buildings. Subsequently Mr. A. H. Valentine (chairman of the Electricity Committee) detailed the history and scope of the undertaking, and started one of the generating sets. Finally, Mr. Sydney Buxton, M.P. for the district, switched on the lamps in the public streets, at the same time declaring the supply formally inaugurated. He congratulated the district on the enterprise which had put put them in possesion of the supply. The Board, he considered, had always been equal to, if not ahead of, any similar body in London. Having had electric light in his house for 10 years, he recommended it as superior to gas in economy, convenience, and health. He was glad they had gone in for municipal enterprise in preference to private enterprise, and congratulated the expiring Board of Works on this, their great and final act, before giving place to the mayor, aldermen, and councillors of Poplar.

In the course of the further speechmaking, Mr. Blackman, the Board's electrical engineer, came in for a lot of merited praise for the energy which he has displayed in getting the plant installed. All circumstances considered, the works were found in a very advanced stage of completion, and time had also been found to make some elaborate special preparations for the opening ceremony, including some brilliant illuminating effects. We have little doubt but that the financial success of the undertaking will be rapidly assured under the able management of Mr. Blackman.

ELECTRICITY IN AN AMERICAN HOTEL.

The United States can truly boast of her fine hotels, the equipments and fittings of some of them being on such a grand and yet comfortable scale that they compare very favourably with even the best British and Continental residential hotels. Such a one is the Raleigh Hotel, of Washington, which ranks amongst the best hotels of the United States as regards its handsome and up-to-date equipments. These properties and fine appointments naturally led the public to patronise the hotel, with the result that it has become so popular that extensions have been necessary. A new wing, 11 storeys high, and of fireproof construction, has just been added, facing Twelfth-street. It is fitted throughout in the most luxurious style, and electrical power has been adopted wherever possible to take the place of less convenient machinery or hand power. This power is supplied from a central electric station in the basement of the new building. The plant is installed in an ideal place, being placed in a cellar excavated under the pavement of Twelfth-street. Here, being quite independent from the structure of the main building, all vibration and noises are completely isolated therefrom, and guests cannot detect when the plant is in operation. Using this cellar under the pavement also leaves the whole of the basement proper for other purposes. This vault extends for a length of 88·5ft., it is 19ft. wide for a distance of 21ft., and narrows down to 14ft. for the remaining. The average height of the ceiling is 9ft.; it varies with the gradients of the pavement. The roof of the vault is of I girders, with brickwork arches between. Over this is a layer of cement concrete, on which rests the pathway granolithic pavement, with a layer of tar and tarred paper between. The electrical equipment supplies lighting and the power for the older portions of the hotel as well as for the new extensions. The old belt-driven plant was abandoned, and the present up-to-date arrangement was designed and erected

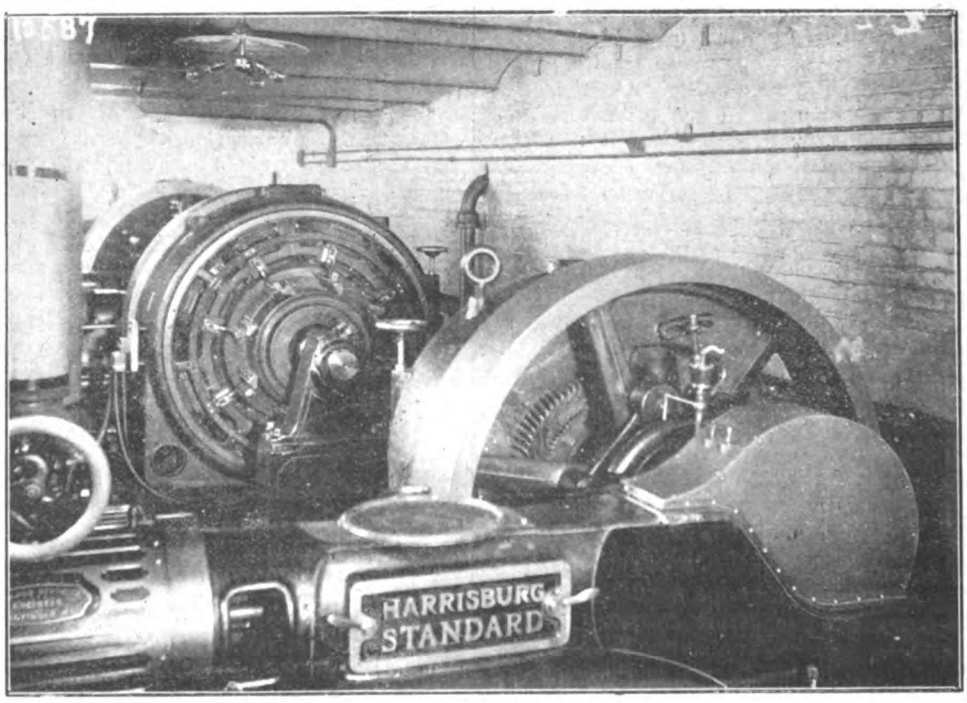


FIG I.—Two 100-kw. Westinghouse Direct-Current Generators, Raleigh Hotel, Washington, D.C.

Digitized by Google

by the Westinghouse Electric and Manufacturing Company to take up the whole of the electrical work.

The boiler-room is in the rear of the new addition; its floor is about 6ft. below the basement floor, and it contains two Geary boilers of about 200 h.p. each, working at 120lb. steam pressure per square inch. Steam is transmitted from the boiler-room to the engines in the power-room by an 8in. main. This main is, of course, well lagged, asbestos air-cell non-conducting material being used. In the widest part of the vault or power-room are placed side by side two 100-kw. Westinghouse direct-current generators yielding current at 125 volts pressure at a speed of 275 revolutions per minute. Each of these generators is direct coupled to a Harrisburg tandem compound non-condensing engine. Beyond these two sets are two others, a 75-kw. generator and a 25-kw. generator, each yielding current at a pressure of 125 volts, the former at a speed of 290 revolutions per minute, and the latter at a speed of 320 revolutions per minute. Each of these generators is coupled direct to a simple steam-engine. These generators have frequently been operated under overloads of 25 per cent. to 45 per cent., and have always behaved very well, carrying the overloads successfully. There being no head-room in the vault, it was not possible to instal a crane to raise the machine or engine parts when necessary for inspection or cleaning. On this account the pole-pieces of the generators are split vertically and set upon guide-plates, so that access may be had to the armature and field coils without removing the outboard bearing. The building is wired for about 4,000 incandescent lamps, running at 110 volts. Some most artistic effects have been produced in the parlours, writing-rooms, and dining-rooms, where the effect of clusters of different-coloured lamps with their reflection from the marble walls is particularly soft and pleasing.

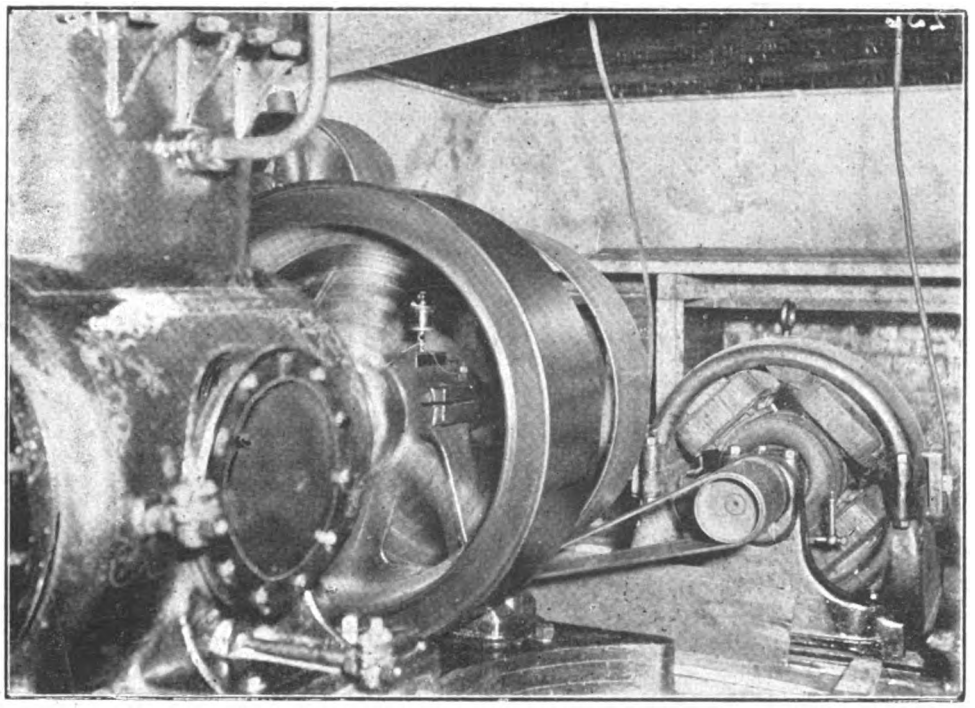


FIG. 2.—20-h.p. Westinghouse Direct-Current Motor operating Ice-Making Machine, Raleigh Hotel, Washington, D.C.

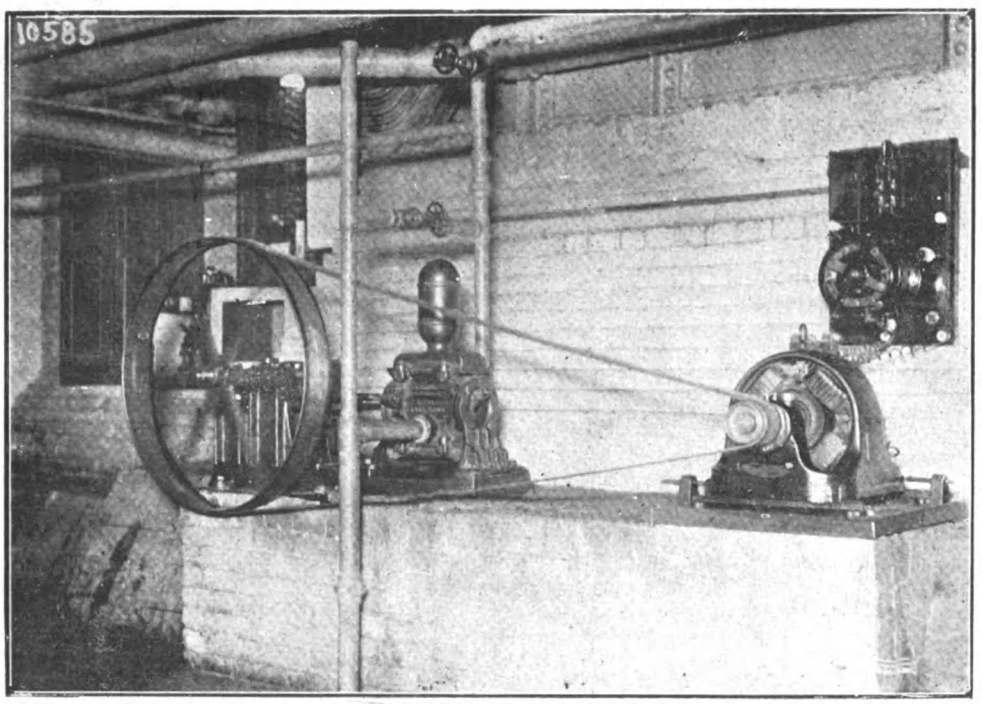


FIG. 3.—2-h.p. Westinghouse Motor operating Pump for Ammonia Condenser, Raleigh Hotel, Washington, D.C.

In addition to the lighting, power is used in various parts of the building to the extent of a total of about 60 h.p. As the places where this power is used were so widely scattered, steam driving was practically out of the question, and the conditions were such as to just prove

Digitized by Google

the great advantage of electricity for power distribution purposes. The electric motors, which are of the standard Westinghouse direct-current type, require very little attention, perform their work efficiently, and win universal praise. The largest share of the electrical motor power is taken up by the ice-making plant, which is capable of making 10 tons of ice in 24 hours. This plant requires three motors. A motor of 20 h.p., running at a speed of 600 revolutions per minute, operates the ammonia pump. The water for cooling the condensing coils is drawn by a Gould pump from an artesian well; this pump is driven by a 2-h.p. Westinghouse motor. A Gould triplex pump is driven by a 7·5-h.p. Westinghouse electric motor, running at a speed of 950 revolutions per minute. This pump is used for pumping brine for the ice plant.

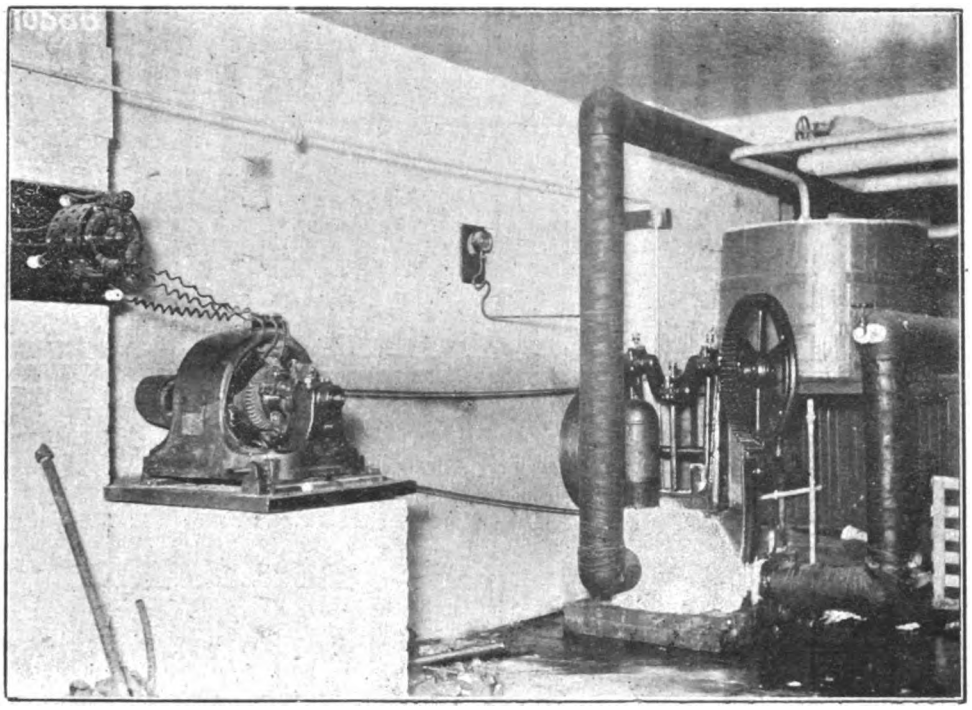


FIG. 4.—7½-h.p. Westinghouse Motor driving Brine-Circulating Pump, Raleigh Hotel, Washington, D.C.

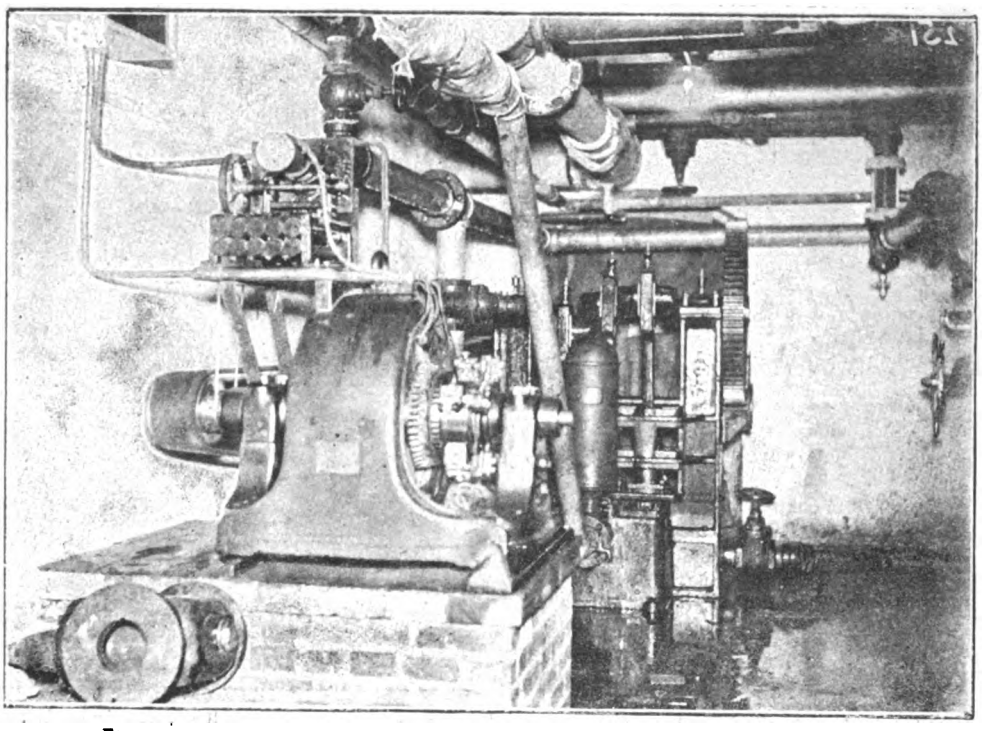


FIG. 5.—10-h.p. Westinghouse Motor operating Triplex Pump, Raleigh Hotel, Washington, D.C.

The hotel water supply is taken from the city mains and passes, after going through a battery of three Loomis-Manning filters, into a large iron tank in the basement. The water is forced from this basement tank to another tank on the roof 160ft. above the basement by a Gould triplex pump, operated by a 10-h.p. Westinghouse electric motor running on the 110-volt circuit. This pump is also connected to the fire lines of the hotel, so that it may be brought into immediate use in case of fire breaking out before the city fire brigade could answer the call. The motor is operated automatically. When the water in the upper tank falls 2·5ft. below its full level, a float actuates the motor switch and closes it; when the water in the tank is up to its full level, the float again comes into action, opening the motor switch and stopping the pump. A 2-h.p. motor is also used to operate another triplex pump, which is for the purpose of lifting the draining from a well in the basement into the city sewers. This motor is also started and stopped by a device similar to the one described above controlling the hotel water supply. A dumb waiter running from the kitchen to the eleventh storey is operated by a 7-h.p. motor. There are several ventilating fans, and also, to alleviate the summer heat, there are a great many small

Digitized by Google

electric fans distributed throughout the hotel. A 1-h.p. motor is used in the kitchen to drive a dish-washing machine. A small rotary converter, taking a current of 2·5 amperes at 110 volts and yielding a current of 10 amperes at 16 volts pressure, is used for the Herzog telesme, with which the hotel is equipped throughout. Each room has a dial with a pointer on which the guest indicates the article or service required, a corresponding indication being given in the kitchen or house quarters of the hotel. These are usually operated by current from cells, but the system here is so extended that it was found to be much more economical to provide a small electrical machine for the purpose.

As yet, since the installation has only been in operation for a few months, no actual figures as to the economy resulting from such an extended use of electricity for hotel work have been obtained, but the convenience and reliability of the whole equipment has been well recognised. There is no doubt, however, that electricity will serve its purpose of actuating labour-saving devices with economy. By so doing, and by increasing the comfort of the guests in so many ways, the popularity, and therefore the financial state, of the hotel which adopts electricity is bound to be considerably improved.

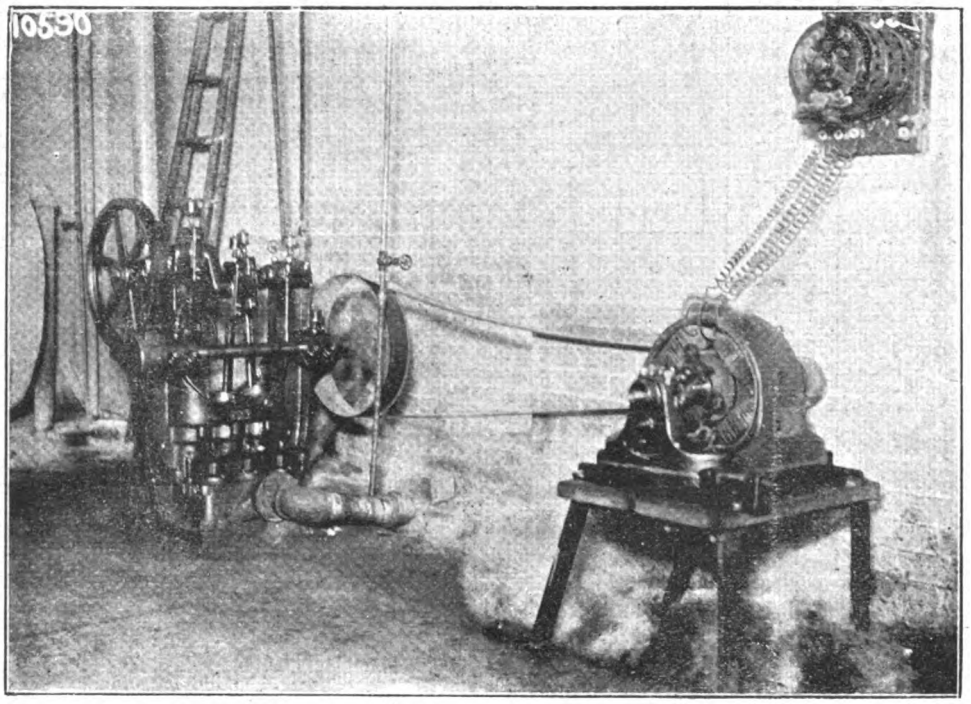


FIG. 6.—2-h.p. Westinghouse Motor operating Basement Pump, Raleigh Hotel, Washington, D.C.

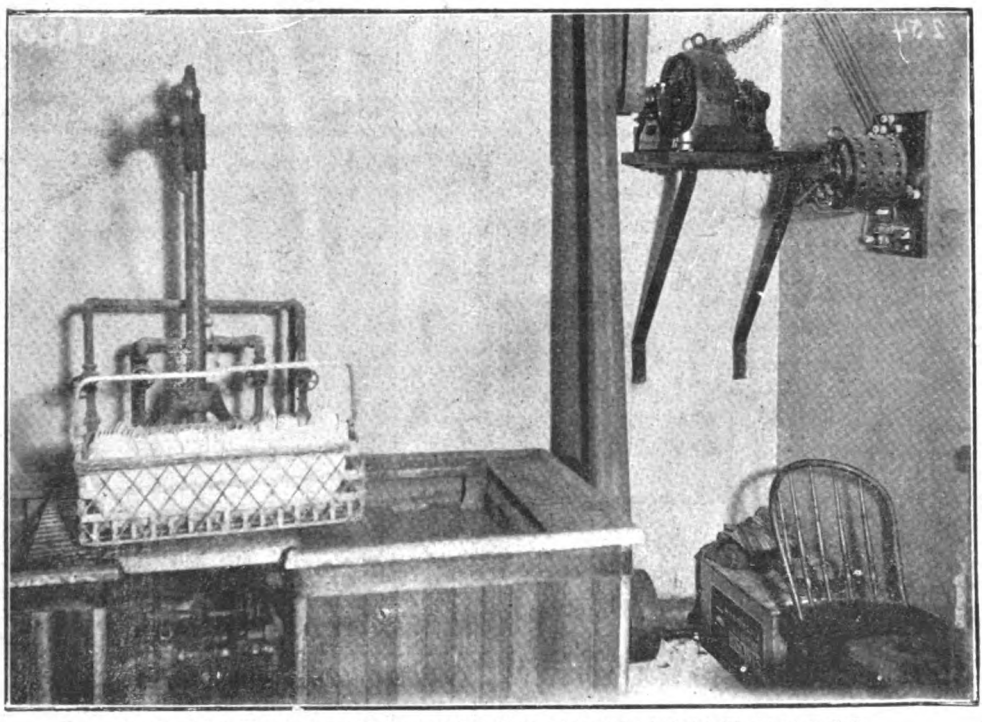


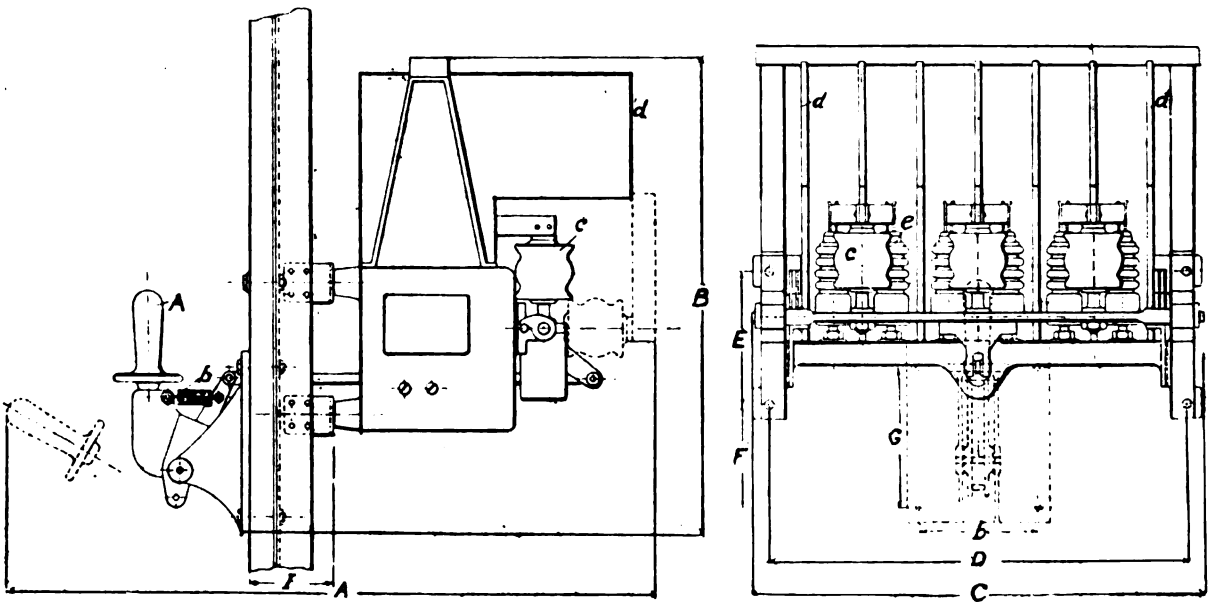
FIG. 7.—1-h.p. Westinghouse Motor operating Dishwasher, Raleigh Hotel, Washington, D.C.

NEW APPARATUS INTRODUCED BY THE HELIOS ELEKTRICITATS AKTIEN-GESELLSCHAFT, KOLN-EHRENFELD.

Herewith we illustrate a new form of high-tension quick-break switch introduced by the Helios Company, of Cologne. Several distinct advantages over types hitherto constructed are claimed for this switch. By means of the quick-break arrangement adopted, an instantaneous breaking of the circuit with a total absence of sparking is effected. All the conducting portions of the switch are arranged behind the switchboard panel, so as to ensure the greatest possible security in working. The action of the switch is extremely simple. As shown in the accompanying diagrams, the switch

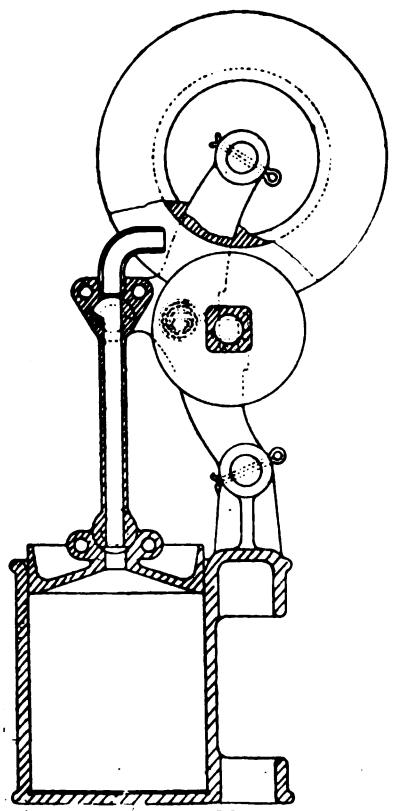
Digitized by Google

lever is attached to a spring arranged at the side of the lever handle, this spring being attached, in turn, through a lever to a connecting rod. In switching out, the elongation of the spring by the handle continues until the catch attached, as shown, to the handle lever releases the lever attached to the connecting rod and spring. At the same moment the circuit is opened with a sudden jerk, the spring having attained its maximum tension. By suitably adjusting the switch, it may be arranged that the circuit shall be broken only when a certain amply sufficient tension has been transferred to the spring. Upon the breaking of the circuit, the knife contacts supported on porcelain insulators describe an upward arc of considerable diameter, by which arrangement, coupled with the double breaking of each pole, the instantaneous elimination of any sparks is effected. The individual breaking points of the switch are insulated from each other by means of partition walls of slate. The conducting portions are mounted upon porcelain insulators, are employed for pressures up to 8,000 volts and current densities up to 500 amperes normal, according as they are to be used for alternating or multiphase currents. By means of a slight structural modification, the switch may also be adapted for pressures up to 15,000 volts. Practical experience with this type of switch gear has yielded, we are informed, most satisfactory results.



High-Tension Quick-Break Switch, Helios Company.

Another piece of apparatus recently introduced by the same firm is a device for lubricating the trolley wire of an electric railway. We referred to this device in a note some weeks since, but are now able to give further details, together with an illustration of the same. In the case of an electric railway equipped for the overhead trolley system the cast-iron frame being attached to the iron framework of the switchboard, and in this way connected direct to earth. Two or three pole switches of the type described



Trolley Wire Lubricator, Helios Company.

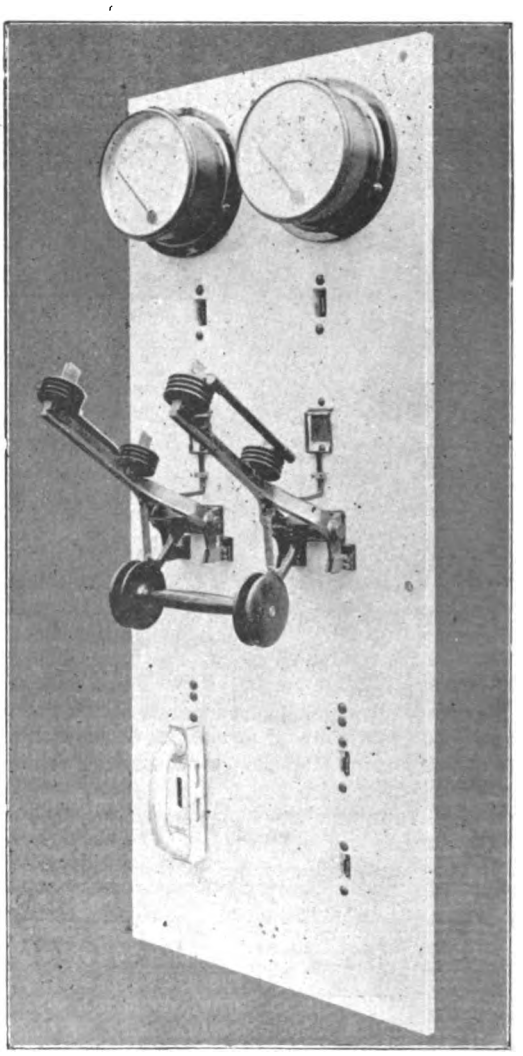


FIG. 1.—View of High-Tension Switch, designed by Mr. Reginald Wilson.

Digitized by Google

of electric traction, a wearing away both of the trolley wire and the collector bow or pulley naturally takes place, this wear being the greater the rougher and drier the surfaces in moving contact. Frequent attempts have, therefore, been made to reduce this wear by lessening the friction between the surfaces in contact, and in order to effect this purpose lubrication has been resorted to. Especially when collector bows have been employed, lubrication has been found essential in order to prevent rapid wear of the moving parts. Of the methods hitherto employed, perhaps the practice of liberally greasing the collector bow so that it may transfer some of the lubricant to the under surface of the trolley wire has found the greatest favour. But this practice is attended with the disadvantage that the lubricant is thereby distributed very unevenly in the neighbourhood of the termini or car depôts, an excess being transferred to portions of the trolley wire, while the more distant stretches are inadequately provided. The excess lubricant transferred to the trolley wire in the neighbourhood of the car-sheds is, moreover, liable to fall upon the roofs of the cars or on to the pavement, thus creating a nuisance. The device introduced by the Helios Company is therefore designed to effect a light and uniform lubrication of the trolley wire. Another feature of the device is that it may be employed with advantage, also, where the current is taken from the trolley wire by means of pulley collectors, since experience has shown the wear of the surfaces in contact even with the pulley to be no negligible quantity. By virtue of its slight weight and simplicity of construction, the device may be attached to the collector arm if desired. The apparatus shown herewith is constructed entirely of aluminium. Its principal dimensions are maximum height: 14in.; breadth, 4in. × 6in. The reservoir is designed to hold about 2¼lb. of lubricant, which is probably sufficient to cover a stretch of 2 to 2½ miles. As shown, the apparatus consists of a roller carried by a movable frame, pivoted to which latter is a piston which works in the lubricant reservoir or cylinder. The frame takes the form of a crooked lever, so that when the roller is pressed against the trolley wire the piston is forced down into the lubricant cylinder so far as the consumption of lubricant through the hollow piston rod allows. In order to distribute the lubricant uniformly in the groove of the transferring roller, and hence to the trolley wire, the lubricant, upon leaving the discharge nozzle is pressed lightly into the groove of the transferring roller by means of a rubber disc. In this manner a light uniform coating of lubricant is transferred to the underside of the trolley wire. The lubricator may be attached in several ways, or applied by hand with the aid of a long carrying rod.

A HIGH-TENSION SWITCH.

The switch illustrated below is one designed by Mr. Reginald P. Wilson for the Blackheath and Greenwich District electric lighting station. The gear for the station being supplied by Messrs. Johnson and Phillips, of Charlton, they also made this switch for the switchboards in the station. The features of the same are the long and quick double break which is obtained, and which is combined with an insulating shutter, which breaks any arc formed when the circuit is broken. This shutter, worked by a lever connected to the switch handle gear, knocks out any arc which, under unusual circumstances, might be formed, in spite of the good break. It will be remembered that a similar device for knocking out the arc has been used successfully for some years by the British Thomson-Houston Company. Another point in Mr. Wilson's switch is that all the contacts are sunk in the board, and cannot be accidentally touched. He also claims that when the switch is in use it can be handled with safety, as all metal parts connected to the high voltage are well protected. Another arrangement in connection with this switch is shown in Fig. 2, where it is provided with an automatic locking device, so that the switch cannot be closed under ordinary conditions until the synchronising plug connecting the machine with the synchronising transformer is in. The object of this interlocking is to prevent a machine which is standing being switched on to the 'bus bars by accident. It also prevents even a machine which is running and is not in synchronism with the 'bus bars being switched on until at least the synchronising connections have been made.

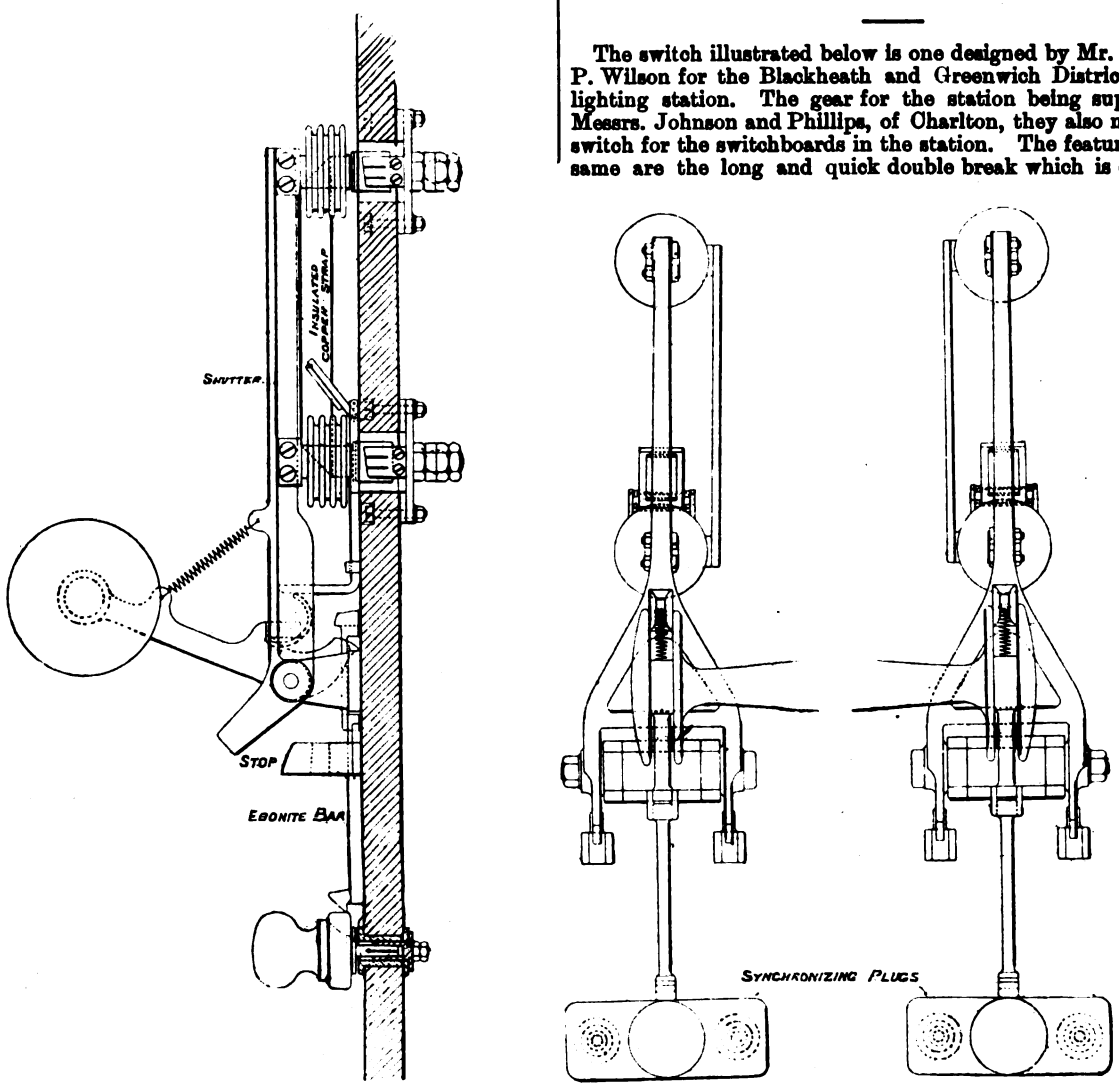


Fig. 2.—Plan and Elevation of the Switch.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	505	Reviews	523
The Evolution of Switch Gears for High-Pressure Alternating Currents	510	High-Speed Reciprocating Engines	524
A Continuous-Current Dynamo for Widely Varying Voltages, Designed by E. Lanhoffer	512	Connecting Service Cables	526
The Inauguration of the Electricity Supply at Poplar	515	General Electric Company, Limited	527
Electricity in an American Hotel	516	Light Railways	527
New Apparatus Introduced by the Helios Elektricitäts Aktien-Gesellschaft, Kolnehrenfeld	519	Forthcoming Events	527
High-Tension Switch	521	Questions and Answers	527
Finance	522	Contracts for Electrical Supplies	532
Correspondence	523	Traction Notes	534
		Lighting Notes	535
		Companies' Meetings and Reports	538
		Provisional Patents	539
		Specifications Accepted	539
		Traffic Returns	540
		Companies' Stock and Share List	540

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

FINANCE.

Now that politics may be presumed to be settled for a time, attention will again be directed to business matters. During the past ten years or so English companies have had an object lesson before them which ought by this time to have pointed a moral. Whether, however, any real decision upon the matter has been formed is a question still undetermined. The evolution of electrical power work and even of electric lighting in America and on the Continent has been determined, not so much from an existing demand, as by financial exploitation in connection with industrial concerns. This is especially the case in connection with tramway work and power distribution. It is easy to understand the reason of this course in the earlier stages of a new industry; the question now to be solved is, will the same course continue? In the earlier stages of electrical engineering the subject was not generally understood, and those who had its interests at heart and understood the matter had to convince a larger public by means of successful work. To carry out such work money was necessary, hence the combination of finance and manufacture. In America companies were formed, each of which controlled a large capital. In Germany the banks came to the assistance of the promoters of the various schemes, and in both countries large works have been carried out under these conditions. Perhaps it is too early to say with certainty whether this kind of forcing an industry has paid or will pay the financiers. According to all accounts, the business returns, whatever the speculative may have been, has hardly warranted, and certainly has not yet rewarded, the risk. The system, although not so extensively used in this country, has been largely used, and is being extended. Financial groups are more or less connected with manufacturing concerns, and even now, in one or two cases, the success or failure of the latter is absolutely dependent upon the success or failure of the former. It is recognised that the work required to be done from the proceedings of these financial groups will be done by the interested manufacturing firms, hence subsidiary questions involved relate to the possibility of the work done being of an inferior quality, and the price at which it is carried out being too high. The immediate success or non-success of a financial group is an entirely different matter to the success or non-success of the undertakings carried out. The former may be immediate, the latter remote. The success of financiers, again, may lead to future troubles, in that they may be tempted to promote enterprises which come under the head of over-promotion, and which, considered soberly, cannot hope to ultimately succeed. But there is another and important consideration. It is found throughout all industrial work that the giving of facilities increases a demand, or even creates a demand. At Niagara and Rheinfelden, facilities were given for obtaining power, the result being the erection and equipment of factories to take advantage of the supply offered. Other similar cases might be mentioned. In these

Digitized by Google

cases the demand has been due to the system pursued in America and on the Continent, and no doubt one result of the erection of power stations in this country will be the same. Probably the first few power stations will have to financed, not by obtaining money from the public, but by syndicates, the members of which will unload when success or partial success is achieved. The possibility of unloading at a profit will depend upon the way in which the facilities offered are taken. We have not attempted to draw any moral at present, only roughly to state a case.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—I think I can promise that this correspondence will not last much longer, for Mr. Johnston's letter this week completely gives his case away. In his first letter (*Electrical Engineer*, Sept. 7) he said: "Suppose that one of the vertical sides was moving in a weaker field than the other, there would in this case still be no change in the number of lines passing through the coil, and yet a current depending upon the difference between the two impressed E.M.F.'s would result." There certainly would be a current if Messrs. Slingo and Brooker's statement is correct, but there certainly would not be a current if Prof. S. P. Thompson is correct in the passage which I quoted last week, which concludes with these words: "Without a variation in the magnetic flux that penetrates the circuit, there will be no induction." Yet Mr. Johnston now actually says that the statement he defends "in no way contradicts either the laws of Faraday or the remarks quoted by Mr. Dunton from [Thompson's] 'Dynamo-Electric Machinery.'" I feel sure that Mr. Johnston is the only one of your readers who has not the ability to perceive the glaring contradiction I have pointed out, and therefore I should be quite content to let the discussion drop. But if Mr. Johnston chooses to take up the new ground that Messrs. Slingo and Brooker are right and Prof. Thompson wrong, I hope he will give a reason for his opinion. So far as the mere weight of authority is concerned, the balance is certainly in my favour. I will not deal further with the minor points, *first raised by Mr. Johnston*, for he complains that this is "drawing the discussion into side issues."—Yours, etc., W. F. DUNTON.

26, Tregothnan-road, Stockwell, S.W., Oct. 6, 1900.

REVIEWS.

Elementary Questions in Electricity and Magnetism. By MAGNUS MACLEAN and E. W. MARCHANT. Longmans, Green, and Co. Price 1s.

One of the most important aids to the real understanding of technical matters is the careful writing of answers to questions bearing upon the subject. It is of great importance that the questions should be properly selected. The engineer, as soon as he enters into practical work, finds that it is necessary to be exact—perhaps we ought to say exact within limits, because in all things human perfection is more or less unattainable. If, however, in his student days, he has been careless about exactitude, he will find himself left behind in the competitive race for success. Any student of electricity who, during his studies, tests his knowledge—if he have no teacher—by means of the questions in this work, will find that it will assist him to better understand his ignorance. There are 24 sections in the book, with questions under each section, there being a total of 311 questions altogether. Besides the questions, a series of 12 very useful tables are given, to which the student will find need of constant reference, and the collection altogether, given in such a way as this, will facilitate such references. The arithmetical value of the answers, when such are required, are given at the end of the book. Altogether, the book should prove of great service to students of electricity.

Electric Wiring Tables. By W. PERREN MAYCOCK, M.I.E.E. Whittaker and Co. 3s. 6d.

This little book is intended for the use of those who undertake electric installations in houses, etc., but the author hopes that it will be also found useful to electrical engineers generally. The information given is contained in about 144 pages, and at first it would seem rather a difficult subject to expand to fill this space. This is done by adding a number of tables connecting the price and quantities of the various materials used in wiring work. Coming now to the contents of the first part of the volume, we find the usual wiring tables, and are pleased to note that the author has taken up the Institution standard in working out his carrying capacities of conductors. The table of contents announces that wiring details and diagrams are to be found on p. 13, and we looked up the reference, hoping to find that some few diagrams of simple connections in wiring work would be given. We find, however, that the page is devoted to the advertisement of another book by the author. We think this hardly fair to the user of the wiring tables, who would naturally expect to get the information which is listed in the table of contents. The information given respecting the incandescent lamps is of the ready reckoner order, as it connects the current required in a great number of voltages with definite numbers of lamps consuming certain watts per candle-power. This will be of service to the wireman who objects to elementary mathematics. The page devoted to the amount of light required and to the arrangement of the lamps is also open to objection, on the grounds of scanty information. Surely, in a handy book for use by wiring contractors, more information should be given on this most essential subject. The page concludes with the statement that it is obviously impossible to formulate any rule to meet all cases, and suggests that for ordinary purposes one watt per square foot of floor area affords a useful basis on which to work. When the watts per candle-power of incandescent lamps are given by the author as varying between 2½ and 4½, the absurdity of this basis of comparison is obvious. It is not the watts which light a room, but the candle-power, and we think the user of these wiring tables has a right to expect a general idea, at any rate, of the candle-power required under various conditions, such as regards the purpose for which the rooms are used, and the scheme of colouring adopted in the rooms. Some tables as to the insulation resistance required by various authorities, and also as to the pressure drop, are given, after which we come to the price-list portion of the book, which is hardly of technical interest. On the whole, we think that much more information of an expert character ought to be introduced into a book of this kind, which is to assist the wireman in carrying out his work, and for which he has to pay 3s. 6d.

The A B C of Electricity. By W. H. MEDDOWCROFT. Sixth edition. John Heywood, Deansgate and Ridgefield, Manchester; 29 and 30, Shoe-lane, London, E.C.

This is the sixth English edition of a little work which was first published in New York about 12 years ago under the endorsement of T. A. Edison. The author, to judge from his treatment of the elementary principles of electricity, is evidently a born teacher, for he presents his subject in plain, simple language, thoroughly inducive of familiarising young people with the general outline of the science as well as with the more important electrical inventions which now enter into daily and commercial life even more than at the time of the first issue of the book. Adults who have left school before the completion of the many electrical appliances now in use, and have not the leisure to study the subject in its scientific literature, will be able to gather from the pages of this book all the general information they require in order to keep themselves up to date.

Digitized by Google

Injectors: their Theory, Construction, and Working. By W. W. F. PULLEN, Wh.Sch., A.M.I.C.E., M.I.M.E., etc. The Technical Publishing Company, 31, Whitworth-street, Manchester.

The book now before us is the second edition of a volume issued by Mr. Pullen in 1893, and which for years has been of great service to those engineers who wish to ascertain full details as to the theory and working of injectors. The explanations of the actions which go on when live steam or exhaust steam is used to force water into a boiler against the boiler pressure are most clearly given, and the higher theory connected with the same is by no means neglected by the author. We are pleased to see that he commences his volume with an index of the symbols used. We wish that all writers on scientific and engineering subjects would do the same for ease and clearness in reading. It is exceedingly awkward when in the middle of a mathematical description of the theory of any engineering problem to have to turn back page after page in the vain attempt to find what a certain insignificant symbol means, and perhaps eventally be unable to understand the reasoning for the want of a knowledge of the symbols used. This is entirely avoided by an index of symbols such as the author has introduced, and which is also a security against the author himself using any symbol with a double meaning, as not infrequently occurs in other cases. Another good feature of the book before us is the large number of practical examples of injectors, which are illustrated and described in detail. Credit is given to the manufacturers who have supplied the information concerning their injectors, but great credit is due to the author himself for the clear way in which he has edited the material supplied. The chapters devoted to the working of injectors and to the examinations which should be made when injectors fail to act, are interesting reading. The chapter devoted to exhaust-steam injectors shows that these are still being manufactured in quantity, although they are not so largely used as live-steam injectors. The eighteenth chapter deals with the problem of using the injector principle for the moving of large volumes of air. One of the most frequent applications of this is the use of a steam jet to obtain a forced draught for boiler purposes, although injectors and ejectors for other engineering applications in which air is to be moved are described. In contradistinction to the usual practice, the author gives the historical summary on injectors at the end of the book instead of at the beginning, and we think that he is not so far wrong in so doing, because the reader who has looked up the theory and present practice is much better able to appreciate the various steps in the development of the machine as shown by the historical chapters. The book is published at 3s. 6d., and should find its place on every mechanical engineer's bookshelf.

HIGH-SPEED RECIPROCATING ENGINES.*

BY ALLAN COATS, B.SC.

(Continued from page 479.)

Fig. 6 shows a section of Messrs. Alley and MacLellan's engine, who are the largest makers in Scotland of high-speed engines. On the expiry of Willans's patent they adopted the air buffer and redesigned their engine. Nearly all single-acting engines place the bottom bush in the centre of the bearing, and thus prevent the splash getting free access to the most important part. This engine is well drained, and is one of the few in which packing rings are put on the air-buffer piston. The valve is kept single-acting by receiver steam. This renders it liable to knock at light loads, and the application of an air buffer to the eccentric cross-head would be an improvement. There is a large receiver space which, in common with the Willans, would require to be well drained to prevent water accumulating. I think that these spaces ought always to have a small steam-trap, and be independent of the engine attendant. There are two bent and two straight ports in these engines. They are very reliable, and the makers' estimate of under 22lb. per indicated horse-power should be easily obtained.

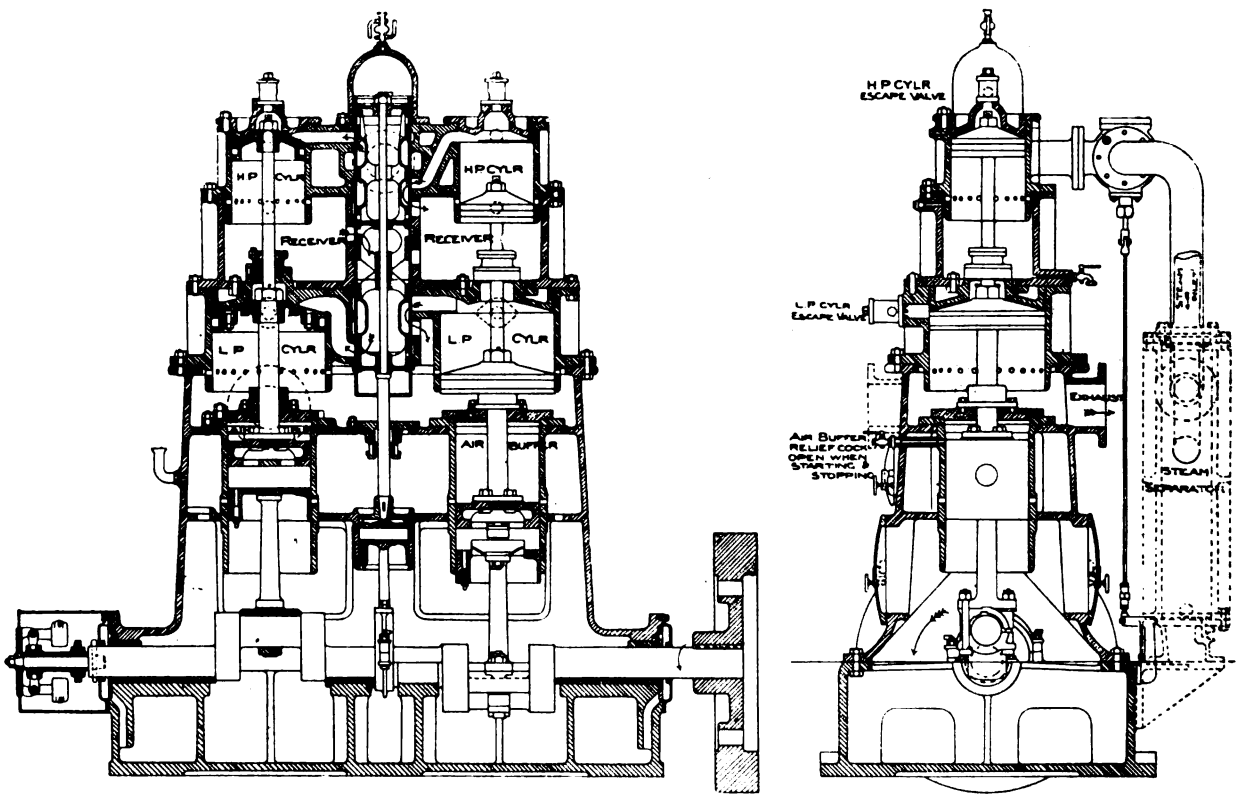


FIG. 6.

Fig. 7 shows an engine made by a local firm, Messrs. Mirlees, Watson, and Yaryan Company, Limited. Steam, after passing the throttle valve on the right and up the dotted pipe, enters the space, A, and when the valve rises enters the space above the high-pressure piston. From thence it exhausts into the receiver space, marked R. This space is almost five times the capacity of the high-pressure cylinder, and extends both before and behind the valve chamber, as shown, and envelopes the high-pressure cylinder for about three-quarters of its circumference. The valve is shown admitting steam from the receiver space to the top of the low-pressure cylinder. From thence on the up stroke it is transferred to the underside of the piston, which corresponds to the transfer chamber of the Willans.

* Paper read before Glasgow Technical College Scientific Society.

Digitized by Google

On the next down stroke the steam passes to exhaust. This engine has, therefore, not only the outside but also the inside of its high-pressure cylinder exposed to receiver steam, which is rather bad practice. The receiver space is very large, and as it is beyond the control of the governor, it tends to produce unsteady governing. The first engine had a much smaller receiver, but it was found that the

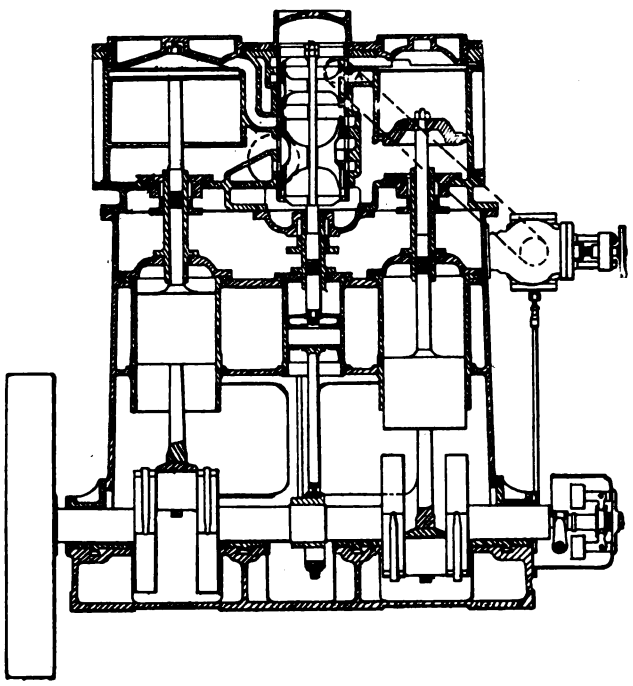


FIG. 7

descending high-pressure piston compressed the receiver steam above the terminal pressure in the high-pressure cylinder, and thus formed a toe to the diagram. Each buffer has very light reciprocating parts attached to it compared to the Willans, etc., so that high speeds can be obtained. This engine illustrated very well the difficulties attending air packing, for packings which held in steam very easily would not, when applied to the air buffer, keep air in at all. The long sleeve shown in the illustration was one of the attempts to overcome this difficulty, but it, too, was discarded. It will be noticed that the air-buffer cylinder, cover, sleeve, and the gland in the steam-cylinders must all be in line with each other and the cylinder. This, as a matter of practice, is rather difficult to attain, and even if right when cold, the steam, by heating up the cylinders, threw the centre lines further apart in the cylinders than in the bed-plate. The line of valves in the first engines had no air buffer, but of course this had to be added, the only curious point being that the wear had taken place at the sides and not at the top and bottom. Messrs. Mirlees's engine, although very well made, was not, I believe, very economical, using rather over than under 24lb. per indicated horse-power, but I have no exact figures on that point.

A more recent engine is one by Reavell and Co., Ipswich (Fig. 8). Steam enters by the left-hand passage shown, and envelopes the entire cylinder, passing up to the small ports (marked A) at the top, passes through these, down the central tube, and enters the high-pressure cylinder by the passages marked C. It is soon cut off, however, and, expanding during the rest of the stroke, exhausts on the up stroke through E and G to the underside of the piston; at half stroke the valve between the upper and lower side of the piston is closed, and steam expands on the underside and is compressed to boiler pressure on the upper side of the piston. This action takes up all the momentum of the parts at normal loads, but at light loads it is forced to rely on two air buffers on the two piston rods. The valve motion is somewhat peculiar; the central tube does not move at all, but the valve moves up and down by means of a bellcrank driven by a link from between the double connecting rod. This saves eccentric room, and gives an extra good valve motion, moving very rapidly when opening and closing, and remaining almost stationary when full open or shut. The makers claim a very high economy, but it is difficult to see why it should be so, the steam cycle being practically midway between a single cylinder cutting off at one-fifth of the stroke and that of an ordinary compound. On account of the central tube, this cycle takes place in a cylinder which has a very large proportion of wall surface to cylinder volume. An explanation of the economy may be found in the fact that the makers do not include the water condensed in the steam-jacket in their steam consumption, but claim that it merely corresponds to the steam separator in other engines. I do not think this is a fair conclusion. The separator in the Willans engine takes the water from the steam before it reaches the engine, and is more useful to prevent an accumulation of water from getting into the cylinders after stoppages, etc., than in actually drying the steam in most cases. Willans found that the amount collected in the separator was so small that it was not worth collecting. On the other hand, by covering his cylinders with a large steam-jacket the results were very different. To quote Captain Sankey, who

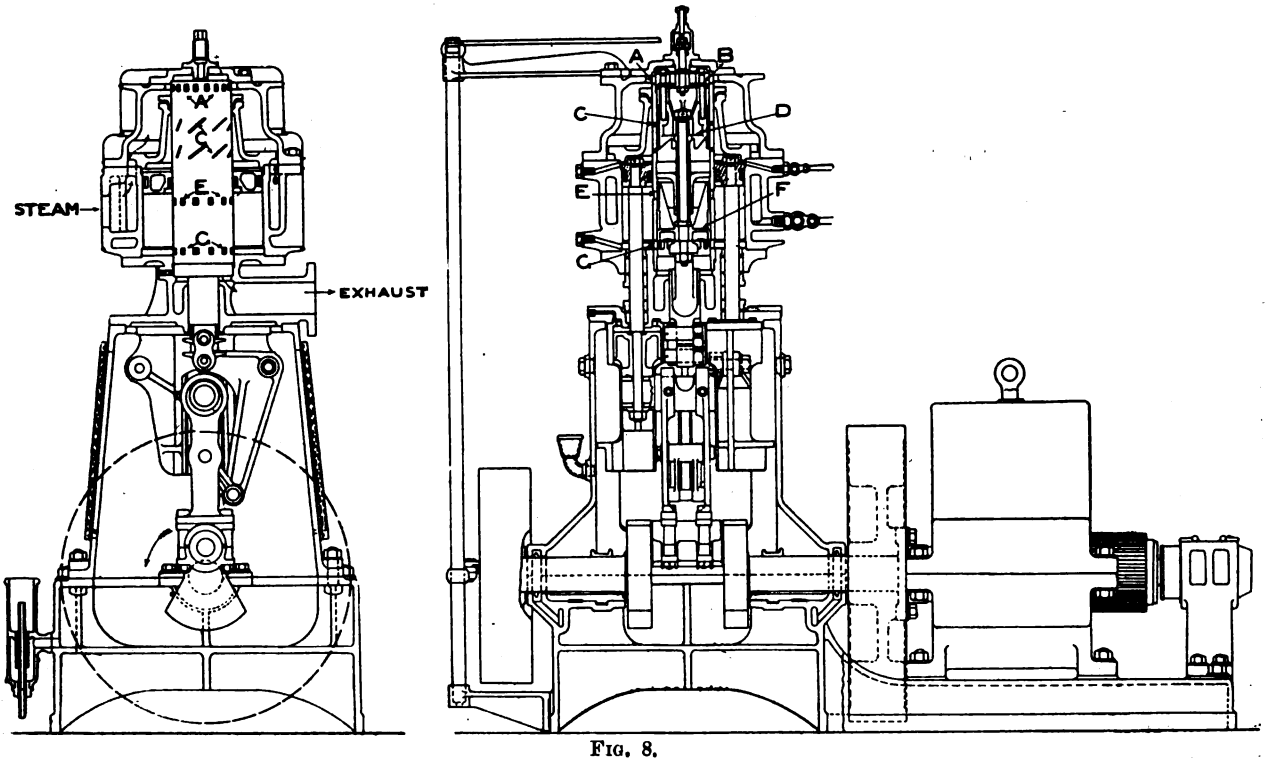


FIG. 8.

Digitized by Google

finished Mr. Willans's paper after he died: "The condensation in this jacket was, of course, enormous, 25 per cent. of steam going through the engine; so the only lesson to be learned was as to the saving in the steam actually passing through the engine."

(To be continued.)

CONNECTING SERVICE CABLES.

It will be remembered that at the recent meeting of the Municipal Electrical Engineers at Huddersfield, the question of the actual cost of making connections between the mains and the consumer's wires was specially referred to in Mr. Wilkinson's paper on "The Distribution of Electricity." The high cost of these service connections is a serious matter in all electrical undertakings, and especially in those cases in which the consumer takes only a few lights. Mr. Wilkinson referred to the fact that service joint-boxes for a triple-concentric cable cost from £2 to £3. 5s. In the discussion on this paper, Mr. Leonard Andrews, the engineer to the Hastings Corporation, stated that he had for some time been using a joint-box which cost only £1, and that one jointer was able to connect as many as eight or ten services in a day. This statement was received with a certain amount of incredulity, but Mr. Andrews has followed the matter up, and now has forwarded us the photographs, which we reproduce herewith, to show the general design of this joint-box, and how it is possible to get the number of joints referred to above made in so short a time. Of

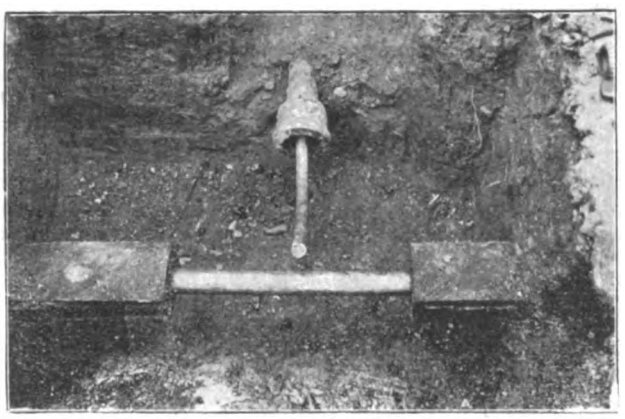


FIG. 1.

these illustrations, Fig. 1 shows the service and main as it was left by the labourers ready for the jointer. Fig. 2 is a photo of the joint exactly 15 minutes after the jointer had commenced work upon it. It will be seen that 3in. or 4in. of the outer insulation has been cut away from both

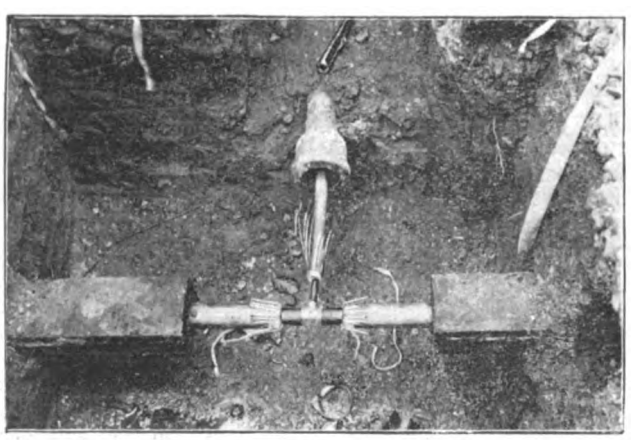


FIG. 2.

cables; the outer conductor of the triple has been cut and splayed back, about 1in. of the insulation between the outer and intermediate conductors has also been cut away, and the inner conductor of the concentric service has been sweated on to the intermediate conductor. Fig. 2A shows the joint in the same stage, except that one of the half clips, used for completing the outer circuit, has been placed in position. The clearance between the inner and outer conductors is here shown. This clearance is filled up when the joint is completed with melted wax or other highly insulating compound. The other half of the conducting clip is shown on the right-hand side of the

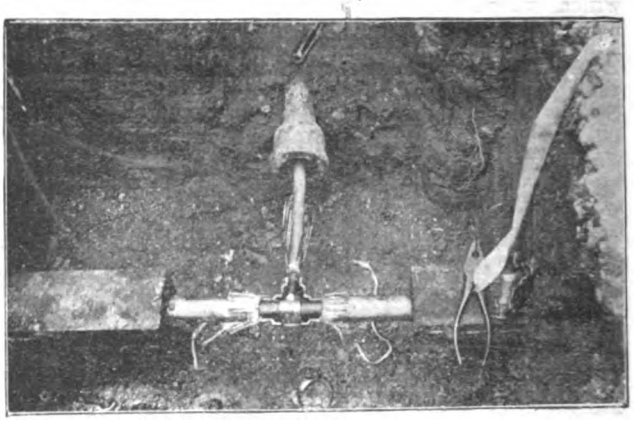


FIG. 2A.

pit in Figs. 2 and 2A. Fig. 3 shows the joint 12 minutes after the photo shown by Fig. 2A was taken. Here it will be seen the outer conductors of each of the cables has been bound and sweated on to the outer conducting clip, and the bottom half of the exterior cast-iron box has been placed in position. The final photo (Fig. 4), taken

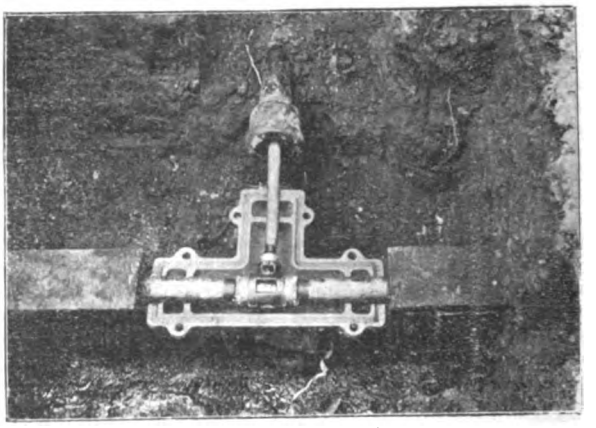


FIG. 3.

6½ minutes later, shows the completed joint with the top half of the cast-iron box bolted into position, and the whole of the space inside the clips and between the clips and the outer box filled with melted wax. The total time taken in making this particular joint

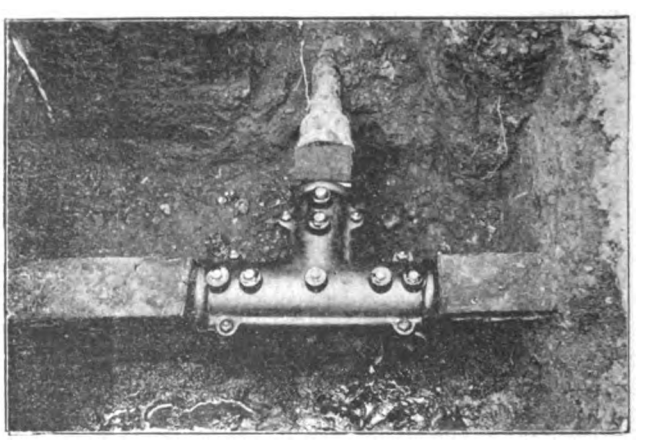


FIG. 4.

from start to finish was just 33½ minutes. Mr. Andrews justly asks if this is not a record for making a service connection. The joint-box, which is illustrated above, is the invention of Mr. J. Glass, the mains foreman of the Hastings Corporation. It has been exclusively used on the Hastings mains during the past 12 months. The insula-

Digitized by Google

tion resistance of a completed joint is usually several hundred megohms, and it will stand a pressure of over 10,000 volts without showing any signs of breaking down. The conductivity of the cable is practically unaffected by a number of joints being taken off in a comparatively short length, as all the joints are soldered, added to which, where services can be taken off the outer and neutral conductors, the neutral conductor is the only one cut. The practice at Hastings is to joint small consumers' services on to the outer and neutral conductors, and large consumers' on to the inner and neutral; by this means the system is balanced by about one inner connection to every four or five outer connections. The process of jointing a service on to the inner conductor is practically the same as that shown by the photographs, the only difference being that an additional pair of half clips are used for connecting up the outer conductor, which in this case has to be cut asunder to enable the inner conductor of the concentric to be jointed on to the inner of the triple. As the completed joint takes up very much less room than an ordinary joint-box, a joint can be made in positions where it would be quite impossible to use an ordinary joint-box. It will be noted that the clearance between the conductors is not in any way dependent upon the skill of the joiner, but is fixed by the branches of the clips resting on the insulation of the cables. These clips are drilled out to fit cables for which they are intended to be used. There are many other useful points about this joint which will be apparent to those using it.

GENERAL ELECTRIC COMPANY, LIMITED.

This company, which for years has been building up its business, is at last about to give the public a chance of sharing in its financial success. The prospectus of the company to be reorganised is now before us, and it will be issued to the public next week. The facts in this prospectus are a good indication of the enormous growth of the concern, which was started in 1880 as Messrs. G. Binswanger and Co. The present directors (Mr. G. Byng, Mr. M. Byng, and Mr. H. Hirst) have been personally responsible for the progress made, while Mr. A. Eckstein has taken in hand the manufacturing side and perfected the productions, both as regards the accuracy of the finish and also in economy. Thus at the present time the valuation of the assets of the company is as follows: freehold land, buildings, plant, and machinery, £140,317; plant and machinery on leasehold property, £21,274; stock-in-trade, £184,843. 15s. 7d.; investments (which produced last year £2,060), £24,640. 18s. 10d.; book debts (guaranteed by the vendor company), cash in hand and at banks, £212,958. 12s. 2d.; goodwill and patents (out of which the vendor company pay all expenses of formation), £92,104. 14s.—£676,139. 0s. 7d.; less debts and liabilities on March 31, 1900, and the profits for the year ended March 31, 1900, reserved to the vendors, £176,139. 0s. 7d.—total, £500,000 (net purchase money). The company will have a capital of £800,000, but at present the following only will be issued. Of these the vendors take £50,000 of the debenture stock, £70,000 of the preference shares, and all the ordinary shares (£250,000, all as fully paid) as purchase money, and about £130,000 in cash.

Now as regards the past profits, Messrs. Edwin Guthrie and Co. report that these were for the year ended March 31, 1898, £51,546. 10s. 7d.; March 31, 1899, £57,034. 3s. 9d.; and for March 31, 1900, £76,804. 12s. 5d.—a total of £185,385. 6s. 9l.; being an average of £61,795. 2s. 3d. per annum over the three years. The foregoing profits are sufficient to pay the interest upon the proposed issue of debenture stock 7½ times over, and after payment of that interest the residue is sufficient to pay the dividend on the proposed issue of £250,000 of preference shares more than four times over.

It is well to note, also, that some £132,841 of the present issue is to be used for the extension of works and for additional working capital. The issue is not underwritten, and the company will remain under the direction of the old directors, who have achieved such a success in the past. Thus, while the present issue is large, it cannot in the light of the above figures be considered at all speculative, and it should attract that class of investors who look for a regular return. We do not doubt but that the business firms of electrical engineers connected with the General Electric Company will take a large share in the new company.

Our Volunteers.—We notice in the list of officers returning home the name of Major Crompton, who left the Cape on Oct. 3 on the ss. "Saxon," homeward bound.

LIGHT RAILWAYS.

The Light Railway Commissioners held an enquiry at the Town Hall, Durham, on the 10th inst.

A largely-attended meeting in support of the Witney, Burford, and Andoversford light railway scheme was held at the Boys' Board School, Burford, on Saturday last. After some discussion the following resolution was carried: "That this meeting of the inhabitants and ratepayers of Burford and district have learned with great satisfaction that the Oxfordshire County Council have resolved to advance £15,000 towards the proposed Witney, Burford, and Andoversford light railway, and trust that the Gloucester County Council will make a like advance at their meeting in October next, and that a copy of this resolution be forwarded to the clerk of the Gloucestershire County Council."

At the Halifax Town Hall on the 8th inst. the Light Railway Commissioners held an enquiry into the light railway which it is proposed to construct from Greetland to Dean Head. There was practically no opposition to the scheme. The scheme provided for two small branch lines to serve quarry traffic, and a branch line connecting the railway with the Calder and Hebble Navigation. The total estimated cost of the undertaking, exclusive of equipment, was £61,117. 14s. The application was that the capital at present should be £55,000 in £1 shares, with the usual limit of £18,000 for borrowing powers. After hearing other evidence, the Chairman said that, subject to the agreements that had been arrived at, they would be pleased to recommend the Board of Trade to grant the order.

The work in connection with the Isle of Axholme light railway is fast proceeding. On Wednesday a party of directors travelled in saloon carriage along the newly-made line from Goole to Crowle. After inspecting the cutting operations through the pit hills, they were conveyed by carriage to Haxey, where they inspected the important work of cutting and banking at Burnham. They returned in the evening, and were highly satisfied with the progress made.

The Light Railway Commissioners held an enquiry at Harrogate on the 9th inst. into the construction of a light railway in the Nidd Valley from Pateley Bridge to Lofthouse.

It is stated that the Commissioners will shortly hold an enquiry into the proposed Jarrow electric tramways.

An offer from Messrs. Leslie and Co. to construct a tramway from Bolton to Cadshaw Bridge, and asking for an interview with the Corporation in regard to the extension of its tramway from the present terminus to Cadshaw Bridge, is being considered by the Parliamentary Committee of the Darwen Corporation.

FORTHCOMING EVENTS.

FRIDAY, OCT 12.

Electro-Harmonic Society.—At St. James's Hall Restaurant, first smoking concert of season.

FRIDAY, OCT. 19.

Institution of Mechanical Engineers.—At 8 p.m., at Institution House, Storey's gate, first monthly meeting. Paper on "Observations on an Improved Glass Revealer for Studying Condensation in Steam Engines and Rendering the Effects Visible," by Mr. Bryan Donkin.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

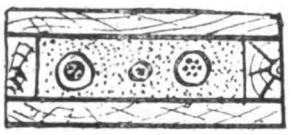
QUESTIONS.

[The following question comes from Brisbane.—ED. *E.E.*]

315. I am in charge of a few miles of underground cable in this city, and I have recently experienced great trouble with them, and would like to ask whether any of your readers have had a similar experience and found the remedy. Our supply is on the three-wire continuous-

Digitized by Google

current system, 220 volts between the outers; the mains are all singles, lead-covered, paper-insulated, laid in tarred sand, protected by hardwood boxing (as shown in sketch).



At every street corner we have 12 cables meeting in a box, and they are all bonded together by a copper wire soldered to the lead sheathing. At each customer's service box hey are also bonded, and in many cases earthed to water-pipe or earth-plate. The lead sheathing has been badly eaten away in certain blocks, but the recent trouble has arisen in those places where the cables are good, on feeders which have no services on them, and which appear quite perfect, except just where the fault has developed and burnt a hole in the sheathing, the lead around the fault being a dark-blue colour and free from any sign of corrosion, whereas all the previous faults were in cables that were so damaged that the paper was visible in spots through the holes eaten by some chemical action. This chemical action seems to be confined to certain blocks in the city, whereas the mysterious faults have occurred in back streets where the cables have hitherto been perfect and still look perfect. It is a curious thing that all these mysterious faults have occurred since the erection of our new switchboard with its quick-break switches, and since we have used the compounding on the balancer machines. The balancers are steam-driven, and were shut down once by a reversal of the current, so they were run as shunt machines until lately. With the new board they run safely with the compound.—W. JOHN YOUNG.

316. Describe the necessaries in construction of a multipolar continuous-current dynamo, in order to obtain sparkless commutation with a fixed position of lead for all loads.

ANSWERS.

Question No. 309.—Explain, with sketches, all the connections of a balancer-booster on the three-wire direct-current system where the booster is used for battery charging.

Answer to No. 309 (*awarded 7s. 6d.*).—The accompanying sketches (Figs. 1 and 2) show the arrangements of balancer-booster sets adopted in generating stations, the one in Fig. 1 being the most usual. The connections explain themselves, and it only remains to describe the functions of the several apparatus. The balancer has been brought into general use in connection with the three-wire system, as it dispenses with a number of small generators, admitting of the substitution of half the number of generators with double the voltage. These are placed across the outers, having no direct connection with the middle wire. Higher efficiency is thus obtained, and it renders the duties of manipulation and regulation easier all round, besides securing economy in steam connections, etc. The duty of the balancer is to supply the "out of balance" current between the two sides of the system, and to keep the pressures constant and equal at the feeding points. It consists essentially of two armatures in series, joined with the outside terminals to the outers and their point of junction to the middle wire. These two armatures are generally run in separate fields with their shafts rigidly coupled together, or the set may be steam-driven, in which case a machine is put each side of the engine and the starting switch dispensed with. (In the diagram of connections, Fig. 1, the set is a motor-driven one.) The excitation is obtained by means of shunt fields, which, it will be noticed, receive their current from the opposite side of the system from that in which its armature is running. This ensures better automatic regulation, for the following reasons: When the demands for current on the two sides are equal, the balancer runs simply as two motors in series. Supposing that the negative side be now more heavily loaded than the positive, the E.M.F. on the negative side drops, while that on the positive increases. As the shunts are reversed, this causes the field, and consequently the E.M.F. of the machine on the positive side, to drop, and it consequently commences running as a motor, driving the

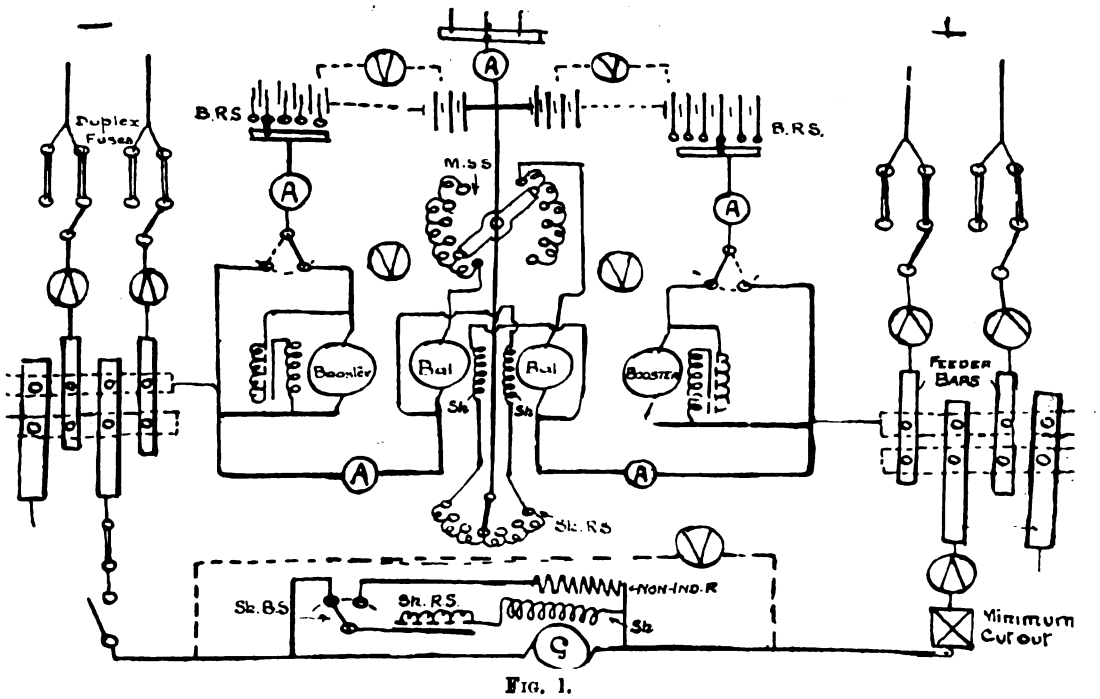


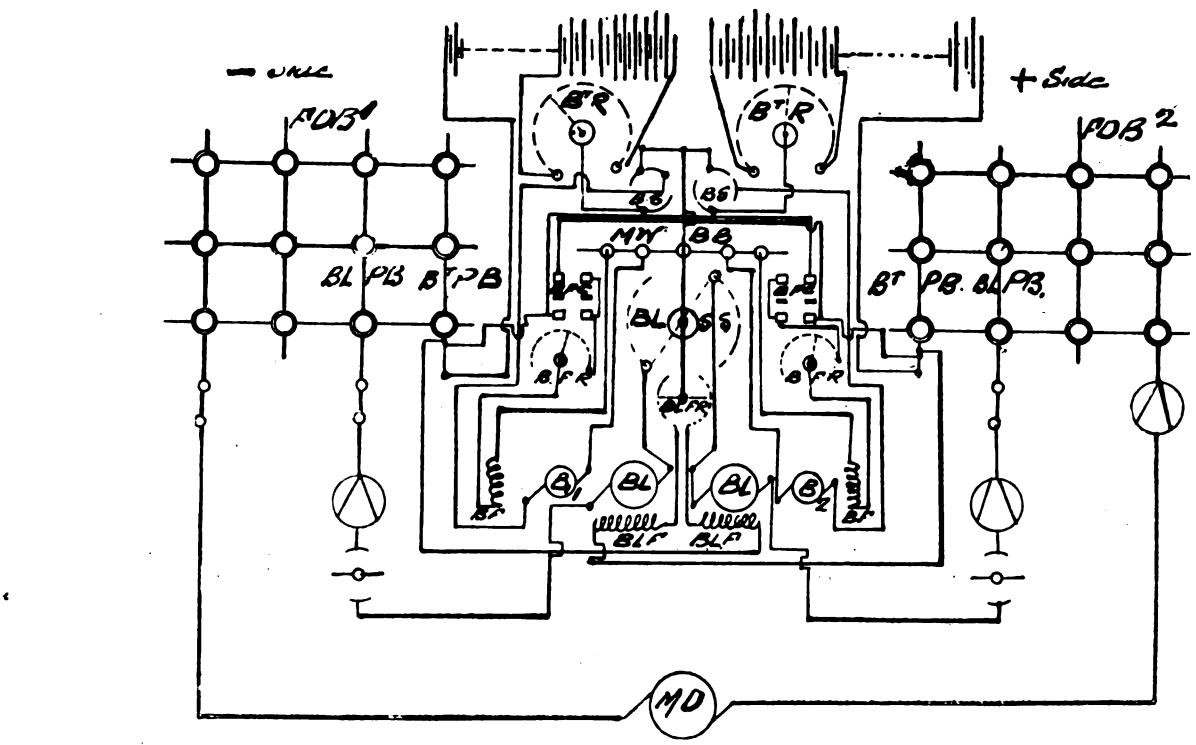
FIG. 1.

armature on the negative side now as a generator supplying the "out-of-balance" current. The addition of a few series turns wound to have cumulative effect enhances automatic regulation. With the same inequality of load the motor field would be still further weakened, enabling the set to sooner regain equilibrium and the more rigidly to maintain it. Care must, however, be taken to put few enough turns on for the machines still to have a slightly drooping characteristic. Should they be overcompounded, the generator, in the case of an "out of balance," gives out too great a current for the required pressure, and this, in conjunction with the greatly weakened motor field, may pull the set up, burn the fuses out, and also interrupt the supply if there is not another balancer running or a battery serving the same purpose. When the only balancing set on a system is at the generating station, and the feeding points are, say, a mile away, further regulation becomes necessary, as it is at the distributing mains the pressures have to be kept equal. To accomplish this on an "out-of-balance" load, a great difference of voltage between the two sides at the station is often necessary, owing to the greater drop in one of the outers and also the drop on the middle wire, which is generally smaller in cross-section. This drop in the middle wire is rather important, as it assists the lightly-loaded side and operates against the other. This feature is commented upon in

Digitized by Google

p. 139 of "Central-Station Electric Supply," by Gay and Graman, and is rightly urged as one of the objections to a balancer consisting of one core having two windings and running in the same field. It will be obvious that regulation by variation of the field is impossible, and is only obtained by means of the somewhat clumsy arrangement of putting cells in series when required. The further regulation mentioned above is effected by means of one rheostat connected as shown. By moving the lever one way resistance is cut out of, say, the generator field, and consequently puts resistance into the motor field. The motor speeds up, and the generator E.M.F. is further raised.

The relative advantages and disadvantages of steam and motor driven balancers respectively are exclusively considered in the answers to Question No. 225 of this series It is desirable in any case that the characteristics of the two machines should be identical. Where there are motor-driven balancers, the boosters, of which there are generally two, are coupled on their shaft ends, making in all four machines on practically one shaft. The booster armature is connected as shown; one pole to the 'bus bars and one contact of a two-way switch, and the other pole to the other contact. The lever of the switch is connected to the arm of the battery-regulating switch. When it is necessary to charge the battery, the switch is turned so as to include the booster armature in its circuit, and the field is adjusted to generate the E.M.F. over and above that of the mains which is required to charge the whole battery. Where the voltage is 460 across the outers, the booster should be able to supply the requisite current at any voltage between 10 and 100. A point in the design of the booster which is important to keep in mind is that they are required to give out the full charging current with a very weak field (at the beginning of charge). Under these circumstances sparkless collection is difficult to achieve. With the somewhat ingenious arrangement shown in Fig. 2, and used at the Gloucester station, a description of which appeared in the *Electrical Engineer* for July 20, one booster may be done away with. The main battery is charged direct from the mains, and the regulating cells only are charged by the booster. The arms of the charge and discharge switch are so constructed that it is impossible for the charge arm to pass beyond that of discharge, which would reverse some of the regulating cells. The switches in the sketch are in the position ready for charging, and all the connections not shown would be similar to those in Fig 1.—E. J. EVANS.



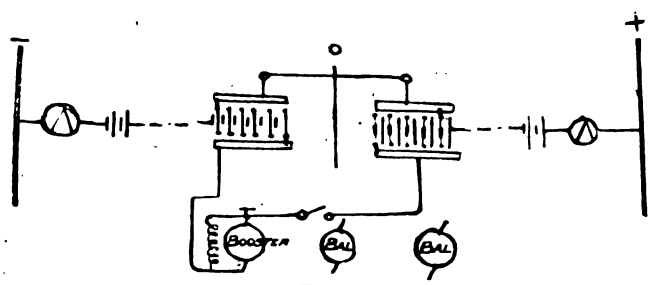


FIG. 2.

Answer to No. 309 (*awarded* 7*s.* 6*d.*).—The term "balancer booster" is generally given to a combination of two balancers and two boosters rigidly coupled together in line, but having their electrical connections coupled to their respective circuits. The balancers usually consist of a pair of generators built as far as possible alike, and having their characteristic curves coinciding so that when running together they may behave alike. Two sets of field magnets are, of course, used, with two armatures and a pair of commutators. In the diagram given, B L is a balancer, coupled one on each side of the three-wire system or the main 'bus bars by means of a plug bar on the outer sides, and direct to the middle wire on the inner sides, a double starting switch, B L S S, being coupled as shown, so that the machines may be brought up to speed gradually. In some instances the outers of the balancers are connected to one 'bus bar only, generally the "common 'bus," but by having a plug bar to each machine, as with the main dynamo, M D, the balancers can then be run on any one of the 'bus bars, and also any particular feeder or feeders. The fields, B L F, are shown cross-connected, the principle of which needs no explanation, as such has been frequently described in these columns. B L F R is a resistance so connected to the middle wire and the balancer field coils, so that a little regulation can be got by moving the switch clockwise or anti-clockwise, thus weakening one and strengthening the other field. The usual field-breaking switch and absorbing coil finds its place in each of the field circuits, but for the sake of clearness is left out of the sketch.

The boosters, as pointed out above, being two in number, should be constructed alike, the amount of "boost" depending, of course, upon the number of extra cells to be charged, but it may be said to vary between 10 to 100 volts for the average station. B_1 in the sketch is the booster for the negative battery, and B_2 for the positive battery. B F denotes the fields in each case, and B F R the shunt regulator, the fields being, of course, shunt wound.

Digitized by Google

In accordance with modern practice, a special change-over field switch, B F C, is shown. This permits the booster field to be reversed, so that instead of the booster standing idle it may be used to help the battery to discharge at a higher pressure when required, and the combination of advantages to be derived will easily be seen from a study of the diagram. B S is the usual booster switch, which is used to put the battery on the main bars and neutral wire, or in circuit with the booster for charging. In some cases a battery emergency switch is used in each battery circuit, but that remains a matter of choice, in the present case the battery fuses being left out for clearness. In the present case the booster is in the diagram arranged to be worked in between the middle wire and cells on each of their respective sides, but in some cases, particularly the earlier systems, the boosters were coupled between the outer bars and the cells. The writer thinks it is, perhaps, an advantage to have the former method, as it is possible then to arrange the balancer booster switch gear all on the middle-wire panel, and so have the controlling of both sets near at hand. Bt P B is the battery plug bar in each case, an addition, perhaps, when compared with other switchboards, but well worth the extra cost when fitted, as it can be brought in to reduce the booster load by plugging on to the 'bus bar working at the higher pressure. F D B^1 and F D B^2 are feeder plug bars, Bt R battery regulator. In order that the diagram may appear as clear as possible, several of the voltmeters and ampere-meters and keys have been omitted, but their positions need no describing to the average reader of this paper.—A. H.

Answer to No. 309 (*awarded* 5*s.*).—The practice at present in vogue in connection with balance-booster sets has, in common with all other electrical practice, been gradually arrived at, and it is only natural that great diversity is found, even with plants being at present laid down, as to the methods employed. The out-of-balance current on the two sides of the three-wire system was first compensated for by the use of steam-driven generating sets, wound for a voltage equal to half that existing between the outers; but as it is generally admitted that this resulted in a loss of economy, particularly on light loads (owing to the necessity of running more than one machine), the practice has gradually given place to that of connecting two dynamos (or motors, as one pleases to call them), with their armatures rigidly coupled together, in series across the supply mains, the middle point being connected to the middle or neutral wire of the system. The practice, too, which was, and even now is in some cases, adopted of using separate motors or steam-driven boosters for supplementing the line voltage when charging the batteries is on the wane, and one generally finds now, in new stations, the armature or armatures of the booster mechanically coupled to the balancing set, for by this means the reserve of power which generally there exists, on light loads is turned to good account.

Fig. 1 shows a plan of connections for such a combination, and for the sake of clearness only absolutely necessary connections have been put in, and the ammeters in the balancer and booster circuits and the booster voltmeter have been omitted. In the first place, the two balancer armatures, B A_1 and B A_2, run as a double motor between the outers, and, in common with other motors, require a starting resistance which can be cut out of circuit gradually as the motor attains its proper speed—such a starting resistance is shown by B S R. The middle point is connected to the neutral wire of the system, N W, and half the resistance is on either side in series with the armature circuit of B A_1 and B A_2 respectively; these halves are simultaneously reduced by the motion of the resistance arm. B F_1 and B F_2 are the balancer fields, in this case connected together through a resistance, R, across the outers—other methods of connection will be referred to later. An arm connected to N W slides over contacts in connection with this resistance; when in the middle position an equal resistance is inserted between N W and either field, but by moving the arm either way the resistance is decreased on that side and increased on the other simultaneously. The reason for so doing is that if one half of the system is more heavily loaded than the other, that half of the balancer tends to act as a dynamo, and if the resistance arm is moved, cutting out resistance on the dynamo side, the field is strengthened on that side and the voltage raised, and at the same time the motor field is weakened by increased resistance in circuit, and the armature tends to increase its speed to make up for the drop in back E.M.F. caused by this weakening of field. This increase in speed still further helps the dynamo side to cope with its load.

K_1 and K_2 are two booster armatures, which each have one terminal connected respectively to the + and − mains and the other terminals to the throw-over switches, T O S_1 and T O S_2, so that K_1 and K_2 are each in

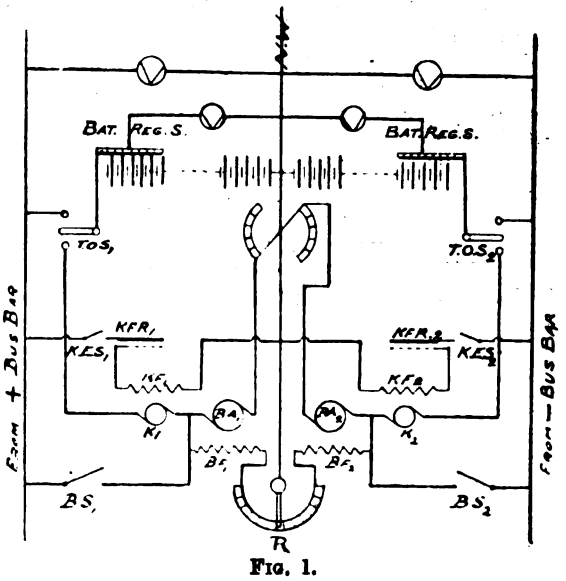


Fig. 1.

series, starting from N W, with one-half of the system, and therefore these contacts of T O S_1 and T O S_2 acquire a difference of potential from the neutral wire equal to that of half of the system + the booster voltage. The battery is connected by its middle point to N W, and its extreme ends are joined through a battery-regulating switch to the top contacts of T O S_1 and T O S_2. When the switch arms are in connection with these top contacts, the battery is in parallel with the mains, but when on the lower contacts, it is connected to the mains through the booster, and the excess voltage thus derived at its terminals causes it to commence charging. K F_1 and K F_2 are the booster fields connected, not across the booster terminals, but between the middle and outer wire in each half, for by so connecting, a much steadier field is obtained than would otherwise be the case. In series with these fields are large

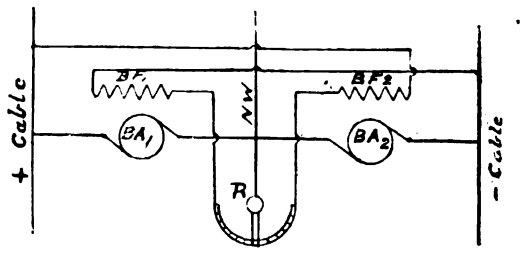


Fig. 2.

shunt resistances, K F R_1 and K F R_2 (owing to the large range of voltage generally required—viz, 40 to 125 volts), and special field switches, K F S_1 and K F S_2, which, when breaking the circuit, short-circuit the field coils through a non-inductive resistance, and thus reduce the instantaneous rise of voltage due to self induction in the coils. Space will not permit to give particulars of these switches, of which many forms exist. Such is about the simplest system of connections for a booster-balancer set; now to come to some variations that exist in practice.

Several methods are in vogue for connecting up the balancer fields: (1) To connect the two fields in series across the outers without any middle-wire connection; this gives a steady field, but does not permit of independent regulation. (2) Each field connected across the armature circuit, with a separate resistance in series with each

Digitized by Google

field. (3) Each field connected across the terminals of the other armature, as shown in Fig. 2. This makes the set to a certain extent self-regulating, as a heavy load on one side strengthens the field on that side and weakens it on the other. It is well to have an adjustable resistance, however, as in figure. Sometimes the booster fields are connected in series across the outers with one resistance in circuit, and there are cases in which only one booster armature is employed. In some stations connections exist so that each booster may be employed to charge either half of the cells. Balancers, too, may be found having the two windings on one armature and a commutator at each end, but difficulties in regulation have been the means of causing this system to drop out of fashion, in spite of its lower first cost.

Enough, however, has, I think, been said to give a general idea of the systems in vogue of connecting up balancer boosters.—W. G. MURRIN.

Question No. 310.—Describe a method of determining the current (with a certain temperature rise, say, 100deg. F.) which can be carried by high-resistance wires, such as platinoid, rheostene, tinned iron wire, etc., when used for resistance coils, and when their specific resistance is not known.

Best Answer to No. 310 (*awarded* 10*s.*).—The specific resistance of any of these materials could, of course, be readily obtained from a measurement of the resistance of a short length of the wire by a Wheatstone's bridge or other method, but, even knowing this, it would not be safe, if accurate results are required, to predict the temperature rise from any general rule, as so much depends on the actual arrangement of the wire in the resistance frame and the amount of ventilation. It is much better to make an experiment. A length of the wire under consideration of any convenient diameter should be wound up into a spiral of about the same form as will be used in the resistance (say, a 1in. diameter spiral with four or five turns to the inch if of No. 12 wire, or a ½in. diameter spiral with seven or eight spirals per inch if of No. 18 gauge or thereabouts). This should be placed in a ventilated frame more or less like the proper resistance frame. A current should then be passed through it, and the final temperature rise noted by means of a thermometer suspended in the centre of the spiral. The test should be repeated with two or three different currents, some giving temperature rises below 100deg. F., and some above it. A curve can then be drawn connecting temperature rise and current, and the exact current for 100deg. F. rise with that wire can then be read off. The result thus obtained can then be used for the determination of the correct current for other wires of the same material but of different diameters, so long as the general arrangements of the resistance frame remain unchanged. For let A be the current which, by experiment, gives the required temperature rise with a wire of diameter D, and a the unknown current, which will give the same rise with a wire of diameter d. Then the watts lost in a given length of the first wire are $\propto \frac{A^2}{D^2}$ (since the resistance of the wire is proportional to $\frac{1}{D^2}$).

The cooling surface of this length of wire is $\propto$ D. $\therefore$ the watts per square inch or the temperature rise $\propto \frac{A^2}{D^2} \div D$, or $\propto \frac{A^2}{D^3}$, or, say $= K \frac{A^2}{D^3}$; where K is a constant depending on the specific resistance of the wire and on the amount of ventilation.

In the same way the temperature rise of the second wire $= K \frac{a^2}{d^3}$. $\therefore$ for the same temperature rise in both $K \frac{A^2}{D^3} = K \frac{a^2}{d^3}$ or $a = A \frac{d^{\frac{3}{2}}}{D^{\frac{3}{2}}}$, or the currents for a given temperature rise are proportional to the $\frac{3}{2}$ powers of the diameters, which is the well-known rule for the heating of bare well-ventilated wires.—Q.

Answer to No. 310 (*awarded* 5*s.*).—The temperature of a body is in a certain sense the measure of the equilibrium of supply of heat to a body and the dissipation of this heat. When the rate of supply is exactly equal to the rate of dissipation, the temperature of the body remains constant. In the case of a resistance coil the supply of heat is produced by the action of a current passing through the wire, and is proportional to the square of the current multiplied by the resistance of the wire. The heat thus produced is dissipated by conduction and convection, and the rate of dissipation varies. In the case of coils enclosed in fireproof cement, the dissipation is wholly effected by conduction through the cement, and the temperatures obtained are high. In the case of spirals of wire hanging in air, the heat is almost entirely carried away by the convection of air currents. The rate of dissipation in the latter case varies according as the coils are closely shielded or are exposed to strong draughts. It can be seen, therefore, that a given current will produce different intensities of heat (temperatures) in the same wire under the different conditions enumerated above.

We should here clear up two essential points. The heat developed in the resistance wire $= k \cdot C^2 R$, where k is a constant. But the resistance of a wire $= \frac{l \rho}{a}$, where l = length of wire, ρ = specific resistance, a = sectional area of wire (all in suitable units).

$$\therefore \text{heat developed} = k \cdot C^2 \frac{l \rho}{a}.$$

Now, the heat dissipated is proportional to $m s (t_1 - t_2)$, where m = mass of wire, s = its specific heat, t_1 = mean temperature of wire (the temperature of a wire varies from centre to circumference), t_2 = temperature of substance immediately surrounding the wire. But m varies as $l \times a$: so that when a constant temperature is obtained in the wire (*i.e*, heat generated = heat dissipated) we have that $C^2 \frac{l \rho}{a} = y \cdot l\, a\, s\, (t_1 - t_2)$, where y is another constant, or

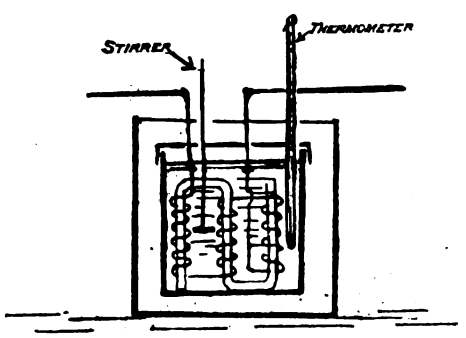
$$C^2 \rho = y\, a^2\, s\, (t_1 - t_2), \text{ or } \frac{c^2}{a^2} = \frac{y\, s\, (t_1 - t_2)}{\rho}$$

$$\therefore t_1 - t_2 = \frac{\rho}{y\, s} \cdot \left(\frac{c}{a}\right)^2$$

$$= x \cdot \left(\frac{c}{a}\right)^2$$

where $x = \frac{\rho}{y\, s}$ = constant. But by hypothesis t_2 is invariable when the coil has been in use a little time, and we are endeavouring to so design our resistance that t_1 is also constant. $\therefore t_1 - t_2$ is constant, and $\therefore \left(\frac{c}{a}\right)^2 = \frac{x}{t_1 - t_2} = K$, where K is a factor determined by experiment. $\therefore \frac{c}{a} = \sqrt{K}$, and $\frac{c}{a}$ is the current density in the wire. Therefore, we learn that (1) the heating effect is independent of the length of the wire (provided that the whole length of the wire is equally exposed); (2) we can determine the above factor by experiment on one specimen, and by using this can readily determine the size of wire necessary to carry any current.

It is a fairly simple matter to determine this constant in the case where the wire is surrounded by a material which conducts heat badly. A piece of the wire (preferably of small diameter) of length, say 24in. (in order to prevent

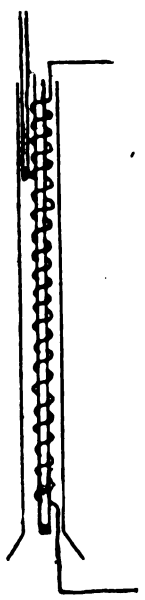


any cooling action at the ends of the wire having a great effect), is coiled round a glass rod, which rod is suitably bent to go inside a small tin or copper pan, somewhat as shown. The wire is soldered at both ends to thick insulated copper leads making circuit with a set of resistance coils

Digitized by Google

(for regulating current), an accurate ammeter, and some cells (preferably a secondary battery) in series. The pan is filled with paraffin oil above the level of the coils, and is covered by a lid having holes in it for (*a*) a stirrer to agitate the oil, (*b*) a thermometer (Fahrenheit in this case), (*c*) the insulated leads. This pan is placed in a large tin packed loosely with cotton wool or silicate cotton. As much as possible of the same substance is placed on the top of the tin. A current is passed and adjusted by the resistance until the thermometer remains steady at the required temperature of 100deg. F., the oil being constantly stirred. A certain time is necessary for the oil to heat up. Once the temperature is attained the current should be kept as steady as possible for, say, a quarter of an hour, and its mean value taken on the galvanometer. The wire should now be unwound from the rod and carefully calipered with a micrometer (or mil) gauge in several places and the mean diameter found. The area is easily determined from this and the current density obtained, from which we get our factor.

The method for determining the factor for coils in air is not so accurate, but as in practice the conditions vary so much, it is sufficiently exact for use. A long glass tube is



wound with the wire under test and connected up as before, and the arrangement placed inside another vertical tube, preferably coned outwards at the bottom. The passage of the current heats the coil and this expands the air in the tube, causing a gentle draught up the outer tube, a condition approximating to practice. If now a thermometer be placed at the top of the tube, it will encounter air which is sensibly at the same heat as the wire, having passed along its whole length. The rest of the experiment is as before.—J. A. S.

Answer to No. 310 (*awarded* 5*s.*).—The simlpest method of determining the carrying capacity of any resistance wire for a definite temperature rise is to pass a gradually-increasing current through the wire until the latter reaches the temperature of boiling water. It is easy to tell when this temperature has been reached by touching the wire with a wetted splinter or needle, and noting whether the water immediately boils off. This method can be applied with considerable accuracy to large sizes of wire, and from these results reliable figures can be calculated for the smaller sizes from the formula $C \propto d^{\frac{3}{2}}$, where C = current, and d = diameter of wire. Suppose, for instance, we want to know how much current a wire ·018in. diameter will carry with a temperature rise of 100deg. F. We take a thick wire, say ·116in. diameter, of the same material, and find that a current of 20 amperes heats it to boiling point from atmospheric temperature 72deg. F., corresponding to a temperature rise of 140deg. F. Then the current to heat our ·116in. wire 100deg. F. will be $20 \times \sqrt{\frac{100}{140}}$ = 17 amperes; therefore the current which will heat our ·018in. diameter wire 100 degrees F. will be $17 \times \left(\frac{\cdot 018}{\cdot 116}\right)^{\frac{3}{2}} = 1$ ampere. In the practical design of resistances several other considerations have to be taken into account, such as the nearness to each other of the spirals, the direction of the ventilating currents of air, etc. DISPAR.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Varna.—The Municipality invite tenders for the lighting of the town by electricity for 40 years by Oct. 15 (concession).

Bermondsey.—The Vestry invite tenders for the erection of steam dynamos, etc. Tenders by Oct. 15. Details in our advertisement columns.

Paris.—The Postal and Telegraph Department, rue de Grenelle, No. 103, invite tenders for a number of telephone apparatus. Tenders by Oct. 16.

Sunderland.—The Corporation invite tenders for 24 car bodies and electrical equipment. Tenders by Oct. 15. Details in our advertisement columns.

Maidstone.—The Corporation invite tenders for a surface condenser and feed pumps. Tenders by Oct. 16. Details in our advertisement columns.

London County Council.—The Council invite tenders for the supply, for one year from Jan. 1 next, of engineers' goods and electrical stores. Tenders by Oct. 29.

Santiago.—Offers are invited for the laying down and working of a telephone system in Santiago de Compostela, in the province of Coruna, Spain. Tenders by Oct. 19.

Palma.—The Municipality of this town, in the province of Baleares, Spain, invite tenders for the installation and maintenance of 60 arc lamps. Tenders by Oct. 30.

Cortegana.—Offers are invited for the installation of electric lighting and the working of same for five years in this town, in the province of Huelva, Spain. Tenders by Oct. 19.

Whitechapel.—The Electrical Committee invite tenders for the supply of a hand-driven overhead travelling crane for their new electricity supply station. Tenders by Oct. 23. Details in our advertisement columns.

Whitehaven.—The Water and Lighting Committee of the Corporation invite tenders for the supply and erection of a switchboard at their electric lighting station. Tenders by Oct. 13. Details in our advertisement columns.

Aberdeen.—The Tramways Committee invite tenders for the manufacture and supply of 25 electrical tramcars, and equipments for six horse cars, about to be converted. Tenders by Oct. 17. Details in our advertisement columns.

Cardiff.—Tenders are invited for slow-speed vertical engines, slow-speed generators, boilers, and economisers. Specifications, etc., may be obtained from Mr. A. Ellis, M.I.E.E., Old Post Office-buildings, Cardiff. Tenders by Oct. 23.

Grantown-on-Spey.—The Commissioners of the burgh invite tenders from electric light companies to supply electric light for public and private consumption within the burgh. Tenders by Nov. 6. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for (1) cables for connecting up plant; (2) transformer connecting bars. Specification, etc., can be obtained on application to Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Oct. 13.

Bradford.—The Corporation invite tenders for the construction and erection of a 30-ton electric travelling crane for their new electricity works, Valley-road, to operate on a 500-volt direct-current circuit. Tenders by Oct. 25. Details in our advertisement columns.

Cienfuegos (Cuba).—Tenders are invited for a service of public electric lighting for the above town. Intending contractors can present their estimates and state their conditions until Oct. 26. All enquiries and tenders should be addressed to the Secretary's Office in Cienfuegos, Cuba.

Ayr.—The Corporation invite tenders for supply and delivery of steel tramway rails and fishplates for the work required in connection with the proposed tramways. Specification, etc., may be obtained from Mr. J. Young, C.E., town surveyor, Town Buildings. Tenders by Oct. 12.

London, N.E.—The Acme Wood Flooring Company, Limited invite tenders for the electric lighting (Section 1—wiring) of their mill premises at Victoria Park, N.E. Specification, etc., may be obtained from Messrs. Taylor and Field, 14, Victoria-street, Westminster. Tenders by Oct. 13.

Dartford.—The Urban District Council invite tenders for the erection of an electric light station at Dartford, in accordance with drawings and specifications prepared by their architects. Specifications may be seen at the office of Messrs. Hesketh and Stokes, 110, Cheapside, E.C. Tenders by Oct. 20.

Digitized by Google

Glasgow.—The Corporation invite tenders for the supply of 1,000, 2,000, or 3,000 tons steel straight track rails; 100, 200, or 300 tons steel curved rails; 50, 100, or 150 tons steel fishplates. Specifications, etc., can be obtained from Mr. John Young, general manager, 88, Renfield-street, Glasgow. Tenders by Oct. 23.

Aberdeen.—The Town Council invite tenders for the supply of materials and the construction of works in connection with the laying down of the permanent way of new electric tramways. Specifications, etc., may be obtained on application to Mr. Wm. Dyack, M.I.C.E., engineer, Town House, Aberdeen. Tenders by Oct. 18.

Whitechapel.—The Board of Works invite tenders for erection of a chimney shaft and the construction of economiser chambers, flues, and cableways at the new electrical supply station yard, Osborne-street, Whitechapel, E. Drawings may be seen at the office of Mr. M. W. Jameson, engineer and surveyor to the Board. Tenders by Oct. 16.

London (City).—The Streets Committee of the Corporation invite tenders for the hiring of a mechanically-driven dust-cart for collecting and removing the dust, trade refuse, and street sweepings from the City to the Corporation's depôt at Lett's Wharf, Commercial-road, Lambeth, S.E. Tenders by Nov. 10. Details in our advertisement columns.

Kendal.—The Corporation invite tenders for building engine-house, boiler-house, accumulator-house, chimney shaft, offices, etc., in connection with the electric lighting station to be erected at the gasworks, Kendal. Specification, etc., may be seen at the office of the engineer, Mr. T. N. Ritson, A.M.I.C.E., Gas Offices, Parkside-road, Kendal. Tenders by Oct. 29.

India.—The Secretary of State for India in Council is prepared to receive tenders for the supply of a complete electrical installation for supplying power to a factory from a waterfall about three miles distant from factory. The generator will be required to develop about 500 kw., and the installation is to include complete plant of generators, line, transformers, cables, motors, etc. Conditions, etc., may be obtained from the Director, General Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office by 2 p.m. on Oct. 16.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Alteerig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

RESULTS OF TENDERS:

Stockport.—The Council have accepted the tender of Messrs. Dick, Kerr, and Co. for 20 top-seat cars, at £675 each.

Bedford.—The Electric Lighting Committee have accepted the tender of Mr. W. Laughton for building a sub station on the Silver-street Market Hill, at £33. 10s.

Newcastle.—The Council have accepted the contract of the National Construction Company for the supplying and laying of conduits for the additional new tramways at scheduled prices.

Tunbridge Wells.—The tender of Mr. J. Jenkins, Swansea, has been accepted in connection with the erection of chimney shaft, 180ft. in height, at the central electric light station, at £3,835. 2s. 4d.

Rochdale.—The Guardians have accepted the tender of the Edison and Swan United Electric Light Company, Manchester, for the supply of 3,000 yards of tubing and 6,000 yards of wire for an electric light installation at the new workhouse infirmary.

Middleton and Castleton (Lancs.).—The British Electric Traction Company have accepted the tender of G. Freeman and Sons, of Hollinwood, Oldham, at £38,781, for the construction of light railways in Middleton and Castleton, near Manchester (length in all about seven miles).

Bangor.—The Lighting Committee have accepted the tender of Patterson and Harford, at £56. 10s., to supply and fix the necessary fittings required at the electric supply station. The offer of Messrs. Verity to exchange the present testing set for an Evershed ohm-meter at an additional cost of £5. 5s. has been accepted.

War Office.—The War Office have accepted the tender of Pritchetts and Gold, Feltham, Middlesex, for supplying and fixing a battery and stands for each of the three Spithead Forts. There will be 33 cells at the Spitbank Fort and 44 at both Horsesand and Noman's Land Forts, and in all cases the boxes will be of lead-lined teak.

Worksop.—The Electric Lighting Committee have placed the order for the generating plant, balancers, and boosters required for the new electricity works with Witting Bros., Limited, 49, Cannon-street, E.C. The steam dynamos will be three in number, each consisting of a multipolar dynamo of Witting's standard pattern direct coupled to a high speed Scott and Mountain engine.

Grays.—The Urban District Council have accepted the following tenders with regard to the electric light scheme: Messrs. Danks, boilers, £2 325; British Schuckert Company, steam dynamos, £2 147. 10s.; Messrs. Green, economiser, £241. 10s.; General Electric Company, switchboards, £628. 15s.; D.P. Battery Company, battery, £836. 1s.; Messrs. Carrick and Ritchie, crane, £95. 10s.; Messrs. Callender, cables, £3,545; electric light buildings, £4,174; engineering and road work, £1,005. 14s.—total, $15,000.

Worthing.—The Corporation have received the following tenders for supply of electric lighting plant:

Contract No. 1.—Steam dynamos.

Allen and Co.	£3 371	0	0
British Westinghouse Company	3,310	0	0
British Westinghouse Company (alternative)	3,490	0	0
British Schuckert Company	3 158	0	0
British Schuckert Company (alternative)	3,190	0	0
British Schuckert Company (alternative)	3,422	0	0
Bruce Peebles	3,402	0	0
Bruce Peebles (alternative)	3,405	0	0
Bruce Peebles (alternative)	3,490	0	0
Bruce Peebles (alternative)	3,654	0	0
Brush Electrical Company	3,600	0	0
Brush Electrical Company (alternative)	4,500	0	0
Clarke, Chapman, and Co.	3,664	0	0
Crompton and Co.	3,225	0	0
Crompton and Co. (alternative)	3,487	0	0
Crompton and Co. (alternative)	3,633	0	0
Dudgeon and Co.	2,995	0	0
Electrical Construction Company, Limited	3,432	0	0
Electrical Construction Company, Limited (alternative).	3,614	0	0
Electrical Construction Company, Limited (alternative).	3,956	0	0
Elcotrical Company, Limited	3,225	0	0
Electrical Company, Limited (alternative)	3 230	0	0
Electrical Company, Limited (alternative)	3,420	0	0
General Electric Company	2 890	0	0
General Electric Company (alternative)	3 408	0	0
Holmes and Co.	3,000	0	0
Holmes and Co. (alternative)	3,300	0	0
Holmes and Co. (alternative)	3,400	0	0
Holmes and Co. (alternative)	3,500	0	0
Jackson and Co.	3,470	0	0
Jackson and Co. (alternative)	3,590	0	0
Jackson and Co. (alternative)	3,730	0	0
Johnson and Phillips	3,090	0	0
Johnson and Phillips (alternative)	3,110	0	0
Johnson and Phillips (alternative)	3,640	0	0
Lancashire Dynamo and Motor Company	3,054	0	0
Lancashire Dynamo and Motor Company (alternative)	3,102	0	0
Lancashire Dynamo and Motor Company (alternative)	3,230	0	0
Lancashire Dynamo and Motor Company (alternative)	3,332	0	0
Mavor and Coulson	2 836	15	0
Mather and Platt	3,100	0	0
Mather and Platt (alternative)	3 415	0	0
Mather and Platt (alternative)	3,475	0	0
Parsons and Co. (turbines)	2,818	0	0
Parker and Co.	3,270	0	0
Parker and Co. (alternative)	3,488	0	0
Parker and Co. (alternative)	3,669	0	0
Reavell and Co.	2,772	0	0
Reavell and Co. (alternative)	2 858	0	0
Rosling and Appleby	3,466	0	0
Selby Bigge and Co.	3,650	0	0
Scott and Mountain (accepted)	2,850	0	0
Laurence, Scott, and Co.	2,932	0	0
Laurence, Scott, and Co. (alternative)	2 952	0	0
Laurence, Scott, and Co. (alternative)	3,203	0	0
Laurence, Scott, and Co. (alternative)	3,205	0	0
Laurence, Scott, and Co. (alternative)	3 285	0	0
Laurence, Scott, and Co. (alternative)	3,459	0	0
Laurence, Scott, and Co. (alternative)	3 800	0	0
Siemens Bros. and Co.	3,821	0	0
Siemens Bros. and Co. (alternative)	3 895	0	0
Siemens Bros. and Co. (alternative)	4,063	0	0
Thames Ironworks	2,750	0	0
Thames Ironworks (alternative)	3,181	0	0
Thames Ironworks (alternative)	3,357	0	0
Westminster Engineering Company	3,176	0	0
Westminster Engineering Company (alternative)	3,502	0	0

Contract No. 2.—Boilers, &c.

Danks and Co. (accepted)	1,130	0	0
Davey, Paxman, and Co.	1,500	0	0
J. Fraser and Son	1,330	0	0
J. Fraser and Son (alternative)	1,900	0	0
Fraser and Fraser	1,627	0	0
Taylor and Sons	1,580	0	0
Tinkers, Limited	1,975	0	0

Contract No. 3.—Steam-pipes, condensing plant, &c.

Alton and Co.	2,2 9	0	0
Babcock and Wilcox	2,252	0	0
Blackwell and Co. (accepted)	1.731	15	0
Crompton and Co.	2 627	0	0
Rosser and Russell	2,756	10	0
J. Spencer and Co.	2,247	0	0

Contract No. 4.—Manhole covers.

Bird and Co.	475	16	6
Callender's Cable and Construction Company (accepted)	501	3	0
Haley and Co.	586	19	0
Mackenzie Bros.	573	15	0
Watson, Gow, and Co., Limited	521	7	6
Western Electric Company	951	10	0

Contract No. 5.—Arc lamp posts.

Allan, sen., and Son	1,874	4	0
Bradley	1,585	0	0
Crompton and Co.	2,010	5	0
General Electric Company	2,347	15	0
Haley and Co.	2,075	10	0

Digitized by Google

Kershaw	1,622	0	0
Law	1,567	0	0
Lucy	1,883	0	0
Mackenzie (accepted)	1 353	5	0
McDowall, Steven, and Co.	1,786	0	0
Rowland, Carr, and Co.	1,631	9	0
Western Electric Company	1,952	0	0

Contract No. 6.—Stoneware casings.

Albion Clay Company (accepted)	2,102	3	6
Doulton and Co.	2 102	3	6
Western Electric Company	2,298	0	0

Contract No. 7.—Cable work.

British Insulated Wire Company	6,156	14	10
Callender's Cable Company (accepted)	5 967	15	3
Glover and Co.	7 059	0	0
Henley's Telegraph Company	6,189	2	2
Siemens and Co.	6 991	8	8
St. Helen's Cable Company	5,870	0	0
Telegraph Manufacturing Company, Limited	9 093	4	3
Western Electric Company	6,406	10	5

Contract No. 8.—Arc lamps.

British Schuckert Company	765	0	0
Brockie, Pell, and Co.	1,143	16	8
Crompton and Co.	1,166	0	0
Electrical Company, Limited	692	0	0
General Electric Company	1,140	0	0
Gilbert Arc Lamp Company	954	5	0
Johnson and Phillips	1 324	0	0
Oliver and Co.	850	17	0
Western Electric Company	1,324	0	0
Westminster Engineering Company	1,149	0	0

Contract No. 9.—Storage batteries.

Chloride Electrical Storage Syndicate	2,145	0	0
D P. Battery Company	1,386	0	0
Eclipse Brass and Copper Company (accepted)	984	4	0
Electrical Power Storage Company	1,973	0	0
Hart Accumulator Company	1,535	0	0
Tudor Accumulator Company	1,860	0	0

Contract No. 11.—Boosters, &c.

British Westinghouse	1,016	0	0
British Schuckert Company	976	0	0
Bruce Peebles	995	0	0
Brush Electrical Engineering Company	959	0	0
Crompton and Co.	1 177	0	0
Dulgeon and Co.	543	10	0
Electrical Company, Limited	982	0	0
General Electric Company	850	0	0
Holmes and Co.	1,040	0	0
Laurence, Scott, and Co. (accepted)	710	0	0
Lancashire Dynamo and Motor Company	888	0	0
Mavor and Coulson	912	15	0
Parker and Co.	1,047	0	0
Roeling, Appleby, and Co.	980	0	0
Siemens and Co.	1 469	0	0
Thames Ironworks	955	0	0

Contract No. 12.—Economiser.

Carter and Son	385	0	0
Green and Co.	390	10	0
Lowcock, Limited (accepted)	372	10	0
Roberts Bros.	390	0	0

Contract No. 13.—Travelling crane.

J. Carrick and Son	211	0	0
Carrick and Ritchie (accepted)	165	0	0
Chatterls Engineering Company	167	0	0
Higginbottom and Mannock	176	0	0
Larmuth and Co.	230	0	0
Measures and Co.	300	0	0
Pickerings, Limited	229	15	0
Southgate Engineering Company	244	10	0
Spencer and Co.	256	0	0
Whitley and Co.	371	0	0

Note.—Tenders for Contract No. 8 not yet decided.

BUSINESS NOTES.

TRACTION.

Bury. — Messrs. Lacey, Clirehugh, and Sillar have been appointed consulting engineers for tramway purposes.

Falkirk.—The Town Council have appointed a committee to draft an agreement with the electric tramway company.

Lowestoft.—We understand that the Corporation have engaged Mr. Walter Beer to prepare plans, etc., for the Corporation's tramway scheme.

Folkestone.—The Town Council on Wednesday decided to apply for parliamentary powers to construct electric tramways, at an estimated cost of £93,000.

Plymouth.—The possibility of extending the Lipson tramway round into the Alexandra-road will be considered by the Tramways Committee at their next meeting.

Dundee.—The electric system on the Lochee tramway route is now practically completed, and a trial run was made on Saturday, when everything was found to work smoothly.

Wigan.—We understand that the first line of track of the electric tramways will be opened in the first week of December.

Turton.—The Tramways Committee of the Bolton Corporation have resolved not to make any offer to the Turton District Council with reference to the proposed tramways in their district.

Lincoln.—The City Council have made a grant of 100 guineas to Mr. Vesey Brown, electrical engineer, for his services in connection with the Lincoln Corporation (Tramways) Act, 1900.

Eccles.—The Town Council have resolved to promote a Bill in the ensuing session of Parliament for doubling and altering the existing tramlines in the borough for electric traction purposes, etc.

Erdington.—At the next meeting of the District Council a resolution will be proposed affirming the advantage of constructing at once a system of tramways properly equipped on an up-to-date system.

Darwen.—Five of the new cars have already been delivered. The Council have promised to give the application of Hoddlesdon with reference to tramways being laid to that place their closest attention.

Liverpool.—The tramway extension debate at the City Council on Wednesday was without definite result. The Irish Nationalist members refused to vote, and thus the statutory number of 78 votes could not be obtained.

Redcar.—The Redcar Urban Council, having decided to institute power for electric light, have now been advised to have electric trams in the town, either for the convenience of visitors or for inter-communication between Redcar and Saltburn.

Leeds.—The receipts from the city tramways last month yielded £16 674. 5s. 6d., as compared with £10,263. 19s. 1d. in September last year. The Dewsbury-road section, recently opened, contributed £1,108. 12s. 4d. and the new Beeston-hill section over £500.

Watering of Tramways.—The legality of watering tramway lines will shortly be tested by the National Cyclists' Union, who are under the impression that excessive watering is a nuisance for which tramway authorities have no justification under their Act of Parliament.

Audenshaw.—At a recent special meeting of the Council a formal resolution was passed requiring the Manchester Carriage Company to sell to the Council so much of the tramway undertaking as authorised by the Manchester Suburban Act, and upon terms specified in the Act.

Shipley.—The Bradford Tramways Committee intend to recommend the Corporation to extend their tramways to Dumb Mill, Frizinghall, and to run through Shipley and Windhill to Thackley, and also along the Otley-road, Shipley, in the direction of Charlestown, and Tong Park, Baildon.

Birkdale.—Notice is to be served upon the Southport Tramway Company requiring that company to sell to the Birkdale Urban District Council so much of their undertaking authorised by the Southport Tramways Order, 1872, as is situate in the said urban district, upon the terms specified in the said section.

Aberdeen.—The Tramways Committee have under consideration the question of converting the Constitution street baths into tramway sheds, and a report as to the cost of such a scheme is to be obtained. Mr. Bell and Mr. Moonie have taken steps to immediately procure cow-catchers to be put in front of the fenders on the cars.

Chester.—The Town Council on Wednesday resolved to apply to Parliament for an Act empowering them to take over the Chester tramway undertaking and to adapt it for mechanical traction, and to extend the system beyond the borough boundaries. The price to be paid by the Council to the tramway company is £18,300, plus the rolling-stock at a valuation.

Lee.—At a recent meeting of the Lee Vestry a resolution was proposed to the effect that the Vestry regretted to find that the Lee Board of Works had expended public money in actively opposing the light railway scheme of the London County Council from New Cross to Eltham, which the Vestry believed would have proved a great public boon and a sound and profitable investment of public funds. A long discussion ensued, and finally, on a division, eight voted for the resolution and 12 against.

Birmingham.—Work has been commenced at Bournbrook upon the equipment of the Bristol-road tramway as an overhead system. The rails are being bonded together, and the poles are being laid by the edge of the pathway ready for erection. The work of laying the electric cable will be undertaken by the Electric Supply Committee, and the Public Works Committee will have the supervision of the reconstruction of the lines in Bristol-street and the Horse Fair, where the use of the centre poles necessitates a wider space between the two sets of metals than at present exists.—*Birmingham Daily Post.*

Lewisham.—A letter from the London County Council with reference to the proposed tramway from Camberwell green to Forest Hill is being considered by the Works Committee. The London County Council are asking whether, upon a reconsideration of the whole subject, the District Board of Works could see their way to give their consent to the construction of the tramway along the portion of the thoroughfare within their district, and to contribute one-third of the net cost of the necessary street-widening in Lewisham. It appears that the districts through which the greater portion of the line passes have refused to contribute.

Glasgow.—The Tramways Committee have confirmed their previous decision in the matter of that part of the tramways report which had been referred back to them, and arranged that Messrs. Macartney, M'Elroy, and Co. should proceed at once with the erection of the overhead work for the tramway exten-

Digitized by Google

sions in Alexandra-parade, Cumbernauld-road, Keppochhill-road, and Great Western-road, and that the Lorraine Steel Company should proceed with their contract for the special track work, which is mainly for crossings. The proposal to apply for parliamentary powers to extend the tramways to Cambuslang, Renfrew, Clydebank, and Bishopbriggs has been adopted by the Council.

Traction Trucks.—We are glad to observe that English manufacturers are commencing active operations in the manufacturing of tramway materials. The Brush Electrical Engineering Company, Limited, have now taken up the manufacture of traction trucks at their Falcon Works, Loughborough, Leicestershire. They make three standard types, which cover the general needs of electric traction in this direction—namely, the four-wheel single type, the four-wheel bogie type, and the maximum traction type. A special shop has been erected and equipped under the control of Mr. E. E. Cook, an engineer who has had long and successful experience in this branch of manufacture in the United States.

Hampton Wick.—The District Council have adopted a number of recommendations of the Highway and Lighting Committee with regard to certain options which the Council have power to take under the recent Act of the London United Tramways. The paving from the railway station to Kingston Bridge is to be constructed of Jarrah wood blocks, and before the tramways are commenced notices will be issued to the owners and occupiers of houses along the route pointing out the desirability of renewing their service pipes from the water company's mains before the wood paving is laid, as the expense afterwards would be considerable, and that the attention of the gas company be also called to the matter.

London United Tramways.—The local authorities in Middlesex and Surrey have received notice of the company's intention to apply in the next session of Parliament for powers to construct additional tramways, including 23 miles of lines in Surrey, 20 miles in Middlesex, and 20 miles in the county of London. The existing system, under this scheme, will be extended to Fulham, Marylebone, St. Pancras, Putney, Willesden, Southall, and Sunbury. A new street and new bridge are included in the Richmond extensions. A number of lines are to give intercommunication between different parts of Kingston, Putney Hill, Surbiton, Tolworth, Hook, Long Ditton, Thames Ditton, Esher and Hampton Court, Brentford and Ealing, Twickenham and Kempton Park, Putney and Richmond, Hounslow and Cranford, etc.

Strikes.—There is, or was, a dispute between the Oldham, Ashton, and Hyde Electric Tramway Company and their employés. About 80 went out on strike, and the company were obliged to run a reduced service of cars in the daytime with the assistance of imported non-society drivers and conductors. The strike originated with the dismissal of a number of men who were on the maximum wage list without what was thought a satisfactory reason. The strikers have an organised system of picketing, and they have induced many men brought into Ashton to take service on "a new route" to return to their homes. Free labour was supplied fairly plentifully through a Manchester agency.—Last week all the men, numbering 500, employed at the electric car works, Hadley, near Wellington, Salop, recently removed from Birkenhead, came out on strike. The men have left their work to support 40 others who have been locked out during the past fortnight for objecting to the employment of unskilled workmen on certain machines at an alleged loss.

Stirling.—At the last County Council meeting, the committee appointed to enquire into the application for the consent of the Council to the construction of an electric tramway on a circular route between Falkirk, Carron, Stenhousemuir, and Camelon, reported the terms on which they were prepared to give their consent to the undertaking. First, the company to pay to the Council an annual wayleave of £40 per mile of route within the area of their jurisdiction, and to maintain the road between the rails and to the extent of 18in. on each side; or, second, to pay the Council at the rate of £72 per mile per annum, the Council maintaining the roadway, with the exception of the tramway rails and their supports. In any event the company at their own expense will construct the roadway with setts between the rails and on each side. Clauses were also inserted for the purchase of the undertaking by the Town and County Councils on certain conditions at the expiration of 25 years and other subsequent periods. It was stated that the line was a single one, with crossing places and that there was sufficient room on the roads for other traffic. The only difficulty was the canal bridges, and these were outside the county. The matter was left in the committee's hands.

East Ham.—The electrical engineer and the surveyor reported at the last meeting of the Urban District Council that the total extras in connection with the tramway track recently constructed by Dick, Kerr, and Co. were £1 682. 9s. 2d., which was due to the substitution of wood paving for tarred macadam, additional granite pitching, removal of gas and water mains, and the work in connection with the East Ham railway bridge, and which were not included in the contract. Also that an estimate had been received from the electrical engineer and the surveyor, together with the tender of Dick, Kerr, and Co., for the extension of the tramway track from the Denmark Arms, along the Barking-road to the Barking boundary, and from the north metropolitan sewer embankment to Cyprus-place, and the committee, having fully considered the same, recommended that the tender of Dick, Kerr, and Co. be accepted, subject to their agreeing to construct the portion of track across the Great Eastern Railway (Beckton line) after the sanction therefor has been received from the Board of Trade. The electrical engineer reported that the whole of the first consignment of cables had been laid, completing Forest-drive, Station-road, and Carlyle-road. He had tested about 6,500 yards of distribution cable, in the presence of a committee and councillors, to their satisfaction, at Messrs. Callender's works, and this was now on its way from the works to Romford-road, where it would be laid as soon as it arrived. The laying of the conduits for the lighting feeder cables at Plashet-grove was being proceeded with The whole of the tramways poles in High-street South and Barking-road had been erected, and the erection of poles in High-street North would be proceeded with at once.—*West Ham Guardian.*

Colonial.—We are indebted to the well-informed *New South Wales Railway Budget* for the following summaries: The Hon. J. L. Stirling moved the second reading of the Electric Tramways (Private) Bill (No. 1) in the Legislative Council of South Australia on July 11. During a lengthy speech, the hon. member stated that the object of the Bill was to attain the necessary powers to abolish the antiquated system of horse traction, and substitute the modern system of electricity. These powers were asked for by the Westinghouse and the Callender Companies, who had jointly secured the right to purchase 60 miles out of the 70 miles of the Adelaide and Suburban Tramways. To provide the city and suburbs with the intended conveniences, the companies claimed that it will be necessary to incur an initial expenditure for the purchase of the existing lines of nearly £400,000; and a further expenditure for the work proposed by this Bill, about another £400,000, which did not include the conversion of the whole of the lines. A sum of £8,000 had been paid to the Government as a guarantee that the work would be proceeded with. It was not proposed to make this a foreign company, as an opportunity was to be offered to the shareholders of the present companies to reinvest their money in the new concern. The debate was adjourned until July 17, and on the 18th the second reading was carried, and referred to a select committee.—Mr. W. Gentry Bingham, representative of the Electric Tramways Company, recently returned to Auckland to take up the work in connection with the Auckland electric tramways scheme. He states that the work of constructing the tramways will be put in hand as soon as ever the negotiations with the suburban authorities are completed. The equipment of the city lines will be undertaken without delay, and he considered it would be a great advantage to all parties if matters could be satisfactorily settled with the suburban bodies, so as to enable the completion of the scheme in one contract. The points at issue, with the exception of those raised by Newmarket, Mr. Bingham considered of minor importance, and, considering the sympathetic spirit in which he had always been met by the local bodies, he had every hope of being able to adjust them satisfactorily.—Several proposals for the construction of private railways are now before the Queensland Legislature. The Callide Coal Syndicate Railway Bill was read the first time in the Assembly on July 25. The company asks for power to construct and maintain a line of railway and branch lines to connect its land with Gladstone Harbour. The line is to be constructed within three years from the date of the passing of the Act, and is to be 75 miles in length; no branch line, however, is to be more than 10 miles long. The gauge is not to be less than 2ft.; the rails are to be of steel, and weigh not less than 35lb. to the yard. The Government is to convey over the public railways all material for the construction of the line at the rate of ½d. per ton per mile.

LIGHTING AND GENERAL.

Morley.—Several electric light cables are about to be extended.

Lytham.—The electric lighting scheme has been abandoned for the present.

Canterbury.—Further extension of the electric light works has become necessary.

Sudbury.—Application is to be made shortly for a loan for electric lighting works.

West Bromwich.—The report upon the free wiring, extracts of which appeared in our last issue, has been adopted.

Accrington.—The engineer's last report shows that there have already been received 33 applications, equivalent to 1,460 16-c.p. lamps.

Reuter's Telegram Co.—The directors announce an interim dividend at the rate of 5 per cent. per annum for the half-year ended June 30.

Watford.—Major Cardew is engaged in making a report upon electric lighting works and additional plant required by the Urban District Council.

Wireless Telegraphy.—The "St. George" cruiser has been fitted at Portsmouth with masthead semaphore and wireless telegraphy apparatus.

Shoreditch.—The insurance of the electricity and dust destructor works has been placed in the hands of the Fine Art and General Insurance Company.

Farnham.—A committee of the whole Council have considered the question of the provisional order for electric lighting, and the clerk is to make certain enquiries.

Bedford.—The public lighting of Devon-road with electric lamps is to be completed, and the cable extended so that 2 and 4, Peel-street may be supplied with electric light.

Molesey.—The Council have consulted Mr. Albion T. Snell with reference to the proposal of the Edmundson Electricity Corporation for supplying the district with electric current.

Digitized by Google

The Galveston Disaster.—The Western Union Telegraph Company announces that telegraphic communication with Mexico and South America *vid* Galveston is now completely restored.

Direct United States Cable Co.—The directors announce an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum, for the quarter ended 30th ult., payable 26th inst.

Sale of Plant.—We beg to refer to an announcement which appears in another column for particulars of a sale of an electric installation by Messrs Galloways, Limited, Knott Mill Ironworks, Manchester.

Wicklow. — A letter from Mr. S. J. Warden-Stevens, A.M.I.E.E., of London, stating that he would prepare a report for the application of an order, etc., is before the Managing Committee of the Urban District Council.

Moffat.—Mr. W. J. Forman, electrical engineer, St. Leonards, Moffat, who is of opinion that an electric lighting scheme could be carried out with profit to the burgh for about £2,500 (water power being utilised), has been asked to prepare plans.

Brierley Hill.—The Midland Electric Corporation are progressing with the laying of the electric cables. They have given notice of intention to break up Bank-street, Dudley-street, High-street, Brettell-lane, Mount-pleasant, and other streets.

Pickering.—The question of making an application to the Board of Trade for an order to establish works for supplying electricity to the urban district was again discussed at the last Council meeting. Finally the matter was again deferred.

Stafford.—It is reported that about 80 acres of land have been bought near Stafford for the purpose of erecting large electrical works close to the main line of the London and North-Western Railway, and that when completed these works will employ over 1,000 people.

Beckenham. Judging from the progress of the works, it is expected that current can be supplied from the middle of November. The wiring rules have been adopted, with the proviso that 1s. 6d. per 8 c.p. lamp per annum be taken as the minimum payment for wiring.

Stratford-on-Avon.—The Town Council intend to oppose the application to the Board of Trade by the United Electric Light and Traction Company for a provisional order, the Council having decided to apply themselves for such provisional order to supply electricity within the borough.

Chefoo-Tientsin Cable.—The cable which was laid between Chefoo and Tsintau for account of the German Government was opened for the transmission of messages on Oct. 4. The territory of Kiao Chau is thus joined to the international cable system. No change will be made in existing rates.

Falkirk.—A special meeting of the Town Council is being called, on a month's notice, in terms of the Electric Lighting Acts, for the purpose of considering and, if so decided, of resolving to make an application to the Board of Trade for a provisional order for electric lighting.

Eccles.—There are now 8,044 lamps connected with the generating station, and the supply of the electric light last week was the highest on record. The Council have confirmed the appointment of Mr. H. W. Angus, late chief assistant to the Bolton Corporation, as their electrical engineer.

Bournemouth.—We understand that the Town Council have written to the National Telephone Company informing them that the Council are considering the propriety of applying to the Postmaster General for a license, and ask them if they are prepared to reduce their charges in Bournemouth.

St. George (Hanover-square).—A special meeting of the Vestry was held yesterday to receive and consider the report of the special committee of Vestry *re* electric lighting, recommending that the agreement between the Vestry and the Westminster Electric Supply Corporation be approved and sealed.

Banbury.—At the quarterly meeting of the Town Council, the question was raised whether the electric lighting scheme was progressing or otherwise. It was known that a company secured the provisional order some years ago, but no one seemed to have any further information about the point. The time limit must be nearly expired.

Oriental Telephone and Electric Co.—The directors have declared an interim dividend of 2½ per cent (being at the rate of 5 per cent. per annum) on the paid-up capital of the Company, free of income tax, payable to those shareholders whose names were on the register at Oct. 10. The warrants will be posted 31st inst.

Dudley.—Mr. H. Percy Boulnois, M.I.C.E., has held an enquiry into the application of the Town Council to borrow £10,000 for the purpose of defraying the cost of the free wiring of houses and business premises for electric lighting. It is proposed to charge 6d. per unit for the first two hours' consumption per day, and 1½d. per unit afterwards.

Consett.—The Urban District Council have adopted a recommendation to illuminate the streets by electricity and to provide a refuse destructor. The Council have also sanctioned, subject to certain conditions, the proposed application of the Northern Counties Electrical Supply Company for a provisional order in respect of the urban district.

Airdrie.—Draft agreements from the Scottish House-to-House Electric Company relating to the proposed transfer of the provisional order obtained by the Town Council for supplying electric light in the burgh, and also providing for the lighting of the street lamps and supply to private houses, etc., are under consideration by the Town Council.

Removal.—The old-established firm of Johnstone, Benjamin, and Co., late of Wenlock-road, City-road, have removed their offices and works to Crown Electric Works, Ascham street, Kentish Town, N.W., near to Midland Railway Station, where they have installed an entirely new plant for the manufacture of electric light cables in order to cope with an increasing business.

Meltham.—In consequence of a letter from Mr. A. H. Gibbings, M.I.E.E., consulting electrical engineer, Bradford, stating that a proposal was on foot for the forming of a joint electric lighting scheme for the districts of Slaithwaite, Linthwaite, Marsden, and Holmfirth, the Urban District Council have appointed a small deputation to confer with the representatives from the other Councils.

Appointments Vacant.—The Corporation of Motherwell invite applications for the appointment of burgh electrical engineer.—The electricity department of the Leyton District Council require a shift engineer. Full particulars of these vacancies appear in our advertisement columns.—The Corporation of Southampton require the services of a mains superintendent, at an annual salary of £150.—The Tramway Committee of the Manchester Corporation require the services of a lady superintendent for their ticket and cash counting department.

New Swindon.—Application is to be made to the Local Government Board for power to borrow £31,000 for carrying out the first portion of the electric light scheme for the town. That sum is £800 in excess of the engineer's estimate, and includes the purchase of all the engines and machinery necessary for both light and traction and the laying of the whole of the cables throughout the town. The steam dynamos will cost about £6,000, and the Council will advertise for three steam dynamos, as recommended by Mr. Lacey, so as to ensure early delivery.

Stock Exchange.—The Stock Exchange Committee have appointed Oct. 17 as a special settling day for St. James's and Pall Mall Electric Light Company's £150,000 3½ per cent debenture stock. The committee have also ordered the St. James's and Pall Mall Electric Light Company's £151,000 3½ per cent. debenture stock, and the Western Telegraph's Company's £348,777 4 per cent. debenture stock, to be quoted in the official list. The committee have further been asked to allow Folkestone Electricity Supply Company's 10,000 ordinary shares of £5 each, fully paid, Nos. 1 to 10,000 (renewed application), to be quoted in the same list.

Hornsey.—At the last meeting of the District Council a letter was read from the Board of Trade approving of the system upon which the Electric Lighting Committee propose to work. The Highways Committee reported having had before them a letter received from the Board of Trade enclosing a copy of Colonel Yorke's report on his inspection of the Highgate hill tramway, and also a copy of a letter received from Messrs. Weekes and Co., instructed by the tramway company, as to the cost of repairing the roadway, and stating that the Board of Trade had consented to the use of cable traction on the tramway for six months from Sept. 12

Paisley.—The Town Council have received a report from Mr. J. Balderston Whyte, C.A., relative to the financial condition of the electric lighting works, stating that the capital expenditure till date is £94 832. 15s. 1d., after allowing a margin of £500 for contingencies or £14 832. 15s. 1d. in excess of the present borrowing powers. No allowance has, however, been made to cover the cost of laying additional mains and connections. He adds that he is informed that the three engines supplied by Ferranti, Limited, are to be removed, and two engines are to be supplied of equal capacity, without further expense to the Corporation. A further report on the subject, including a tabulated statement of the original estimates showing additions to each department since these were accepted, and whether these additions were necessary or for ornamental works, will be prepared.

London Gazette.—A receiving order has been made out *re* W. Haines, 261, Bury New-road, Whitefield, Lancashire, on debtors' petition. The first meeting in the estate of the above will be held on Oct. 16 at the official receiver's office, Exchange-street, Bolton, at 11 a.m., and the public examination on Oct. 23 at the Court House, Mawdsley-street, Bolton, at 3 p.m.—The first meeting in the estate of T. W. Greaves and W. G. Randall (lately trading as T. W. Greaves and Co., 230, East India Dock-road, E) will be held on Oct. 18, at 1 p.m., at Bankruptcy-buildings, Carey-street, W.C., and the public examination on Nov. 15, at 11.30 a.m., at Bankruptcy-buildings, Carey-street, W.C.—A first and final dividend of 2s. 5½d. per £ has been declared *re* B. Symmons (trading as B. Symmons and Co.), 2, North-street, Quadrant, Brighton, payable at the offices of Ward and Wilding, 17, North-street, Brighton, from Oct. 11.

Sunderland. — The Lighting Committee's report, the first portion of which recommended the recision of the minute passed by the Council as to inviting competitive designs for a new electric lighting station in Hylton-road has been adopted. It was explained that Mr. Snell, the electrical engineer, had himself prepared a plan for the erection of a station, which was so satisfactory, and which seemed to meet all requirements, that the committee had considered that the Council need not be put to the expense of engaging an architect. The Council on Wednesday authorised the committee to borrow £73,035 with which to construct the new electric lighting supply station at Hylton-road, carry out extensions of mains, and other purposes. It has also been decided that, except on special contracts, customers should have the option of being charged according to the maximum demand system, or at a uniform rate of 5d. per unit with a scale of discounts, the rental of meters also being reduced in proportion.

Digitized by Google

Hastings.—Electric light mains are to be laid in the undermentioned roads: Linton-road, estimated cost £208; St. Saviour's-road, £251; Sedlescomb-road, £295; Sedlescomb-road (high-tension main), £120; St. Matthew's-gardens, £140; Boscobel-road, £135—total, £1,149. Application is to be made to the Local Government Board for sanction to the borrowing of the total estimated cost of the work.

Ashton.—A presentation of plate has been made to Mr. Vincent, the chief engineer, who has just returned from his holidays, and also his honeymoon, he having been married during his leave of absence. Mr. Bruton, first assistant engineer, formally made the presentation, which was seconded by Mr. Markland, second assistant engineer, and most heartily endorsed by the whole of the staff present, to the number of 20.

Cardiff.—The gas company are going to raise their price. The Corporation propose to issue circulars with a view of making the electric light much more popular as an illuminant, setting out the advantages of this particular light. The consideration of the report from Mr. Appelbee upon the arrangement of the electrical staff has been deferred. The Chairman stated at last week's meeting that everything was proceeding smoothly at the electricity works.

Much Woolton.—A draft agreement with the National Telephone Company for laying underground cables in the district was submitted to the District Council last week, also a letter regretting the company's inability to agree to certain clauses inserted by the Council. It was resolved that negotiations cease, and that the clerk be instructed to ascertain from the Bristol Corporation the terms upon which the Telephone Company are permitted to lay cables under the roads in their district.

Islington.—The Vestry having decided to light Hornsey-road and Drayton-park with electric arc lamps, it is considered advantageous to continue the lamps from Hornsey-road along Benwell-road to Drayton-park. The engineer's estimate for the work is £1,450, and we understand that the work of laying and erecting conduits, cables, four arc lamps, columns, etc., included in the estimate, will be carried out after the usual consent to the borrowing of the necessary funds has been received from the London County Council, and that a loan is to be raised for the purpose.

Worcester.—A resolution concerning the supply of electricity to churches and chapels led to an animated discussion at the last City Council meeting. The Chairman of the Electricity Committee, in moving 'That the Council be recommended, as from Sept. 29 next, to fix the price for current supplied to churches and chapels at 5d per unit, on the understanding that as far as possible the current is not used during the time of the highest load, between 5 and 7 p.m.," said the transaction was a purely business one, the object of the committee being to increase the users of the electric current on Sunday. The resolution was lost.

Bury St Edmunds.—Sanction has been obtained to the borrowing of £800 for the purpose of public electric lighting, provided no part of the loan be employed in providing incandescent lamps. The engineer is taking steps to procure the necessary cable and lamps for public street-lighting. Two five-ampere arc lamps are to be fixed at the waterworks yard, each having an illuminating power of 500 candles. Below the arc lamps, two small incandescent brackets will be placed for the purpose of lighting the yard when only a small amount of light is required. The cost of lamps and wiring is estimated at £15. 10s., and the annual cost of lighting at £5.

Crook.—Messrs. Pease and Partners, Limited, are taking steps for the laying down of an electric installation. The Council have accepted their offer of 35s. per lamp for public lighting, the firm taking all the expense of the initial cost. Most of the lamps are to be 32 c.p. Apart from the occasional renewal of the lamps and the cost of cleaning, the charge of 35s. will cover the entire expense per lamp. The district to be lighted is Institute-terrace, White Lea square, Billy-hill, the whole of the houses on the hill top up to the junction by the Stanley Church. Messrs. Pease and Partners will place their generating station at the general shops.

Bermondsey.—A tablet is to be placed in the chimney shaft at the electric lighting station, bearing the following inscription: "This stone was laid by Thomas Cox, chairman of the Electric Lighting Committee, September, 1900. Committee: J. B. Anderson C. E. Barber, A. Burton. H. Gardiner, G. H. W. Grace, W. J. Hollies, J. Manser, G. W. Marner, J. R. Martin, G. W. Mitchell, J. J. Paice, H. C. Rogers, H. A. Rye, G. Simpson, T. Taylor, H. Walker, N. Wells, J. H. Wilkinson, Felix T. Pridmore, J.P. (chairman Bermondsey Vestry). Kincaid, Waller, and Manville, engineers. Hughes and Stirling, builders. Fredk. Ryall, clerk to the Vestry.

St. Marylebone.—At a meeting of the Vestry yesterday a report was submitted by Advisory Special Electric Lighting Committee recommending that the Vestry withhold their consent to the execution of the works referred to in the notice from the Metropolitan Electric Supply Company of their intention to lay a low-tension armoured main along the east side of Edgware road, from north side of Seymour-street to south side of Bryanston-street; from No. 84 to south side of Upper Berkeley-street; and from north side of Burwood-place to north side of Nutford-place, crossing at north side of Seymour-street, south side of Upper Berkeley-street, and north side of Burwood-place.

Middlesbrough.—At a recent meeting of the Electric Lighting Committee of the Corporation, Mr. Hammond, the consulting engineer, laid a plan before the committee showing the positions of 40 suggested lamps in the Market-place, South-street, Sussex-street, Linthorpe-road, Newport-road, Corporation-road, and Albert-road, which would do away with 147 existing lamps. The gas lighting costs £782. 0s. 8d., and 40 lamps, with half of their number turned out at 12 o'clock at night, at a charge of £20 per lamp, would cost £800 per annum, which was practically the same. The committee decided to make such an offer to the Watch Committee. Mr. Clayton, clerk of the works, was appointed as resident engineer.

A Find.—The following story has been going the rounds of the Press: "A conductor on the Venetian electric trams named Nicola Cicchino has just had a great stroke of luck. In July, 1898, he found in the Via San Lorenzo a draft for £10,700 on the Marseilles Land Bank, payable to bearer in gold. It was signed 'Attanasio.' Cicchino deposited the cheque with the authorities, awaiting the appearance of the owner to claim his legal 10 per cent. The owner, however, has never appeared, and a few days since Niccola received an official notification that the cheque, having never been claimed, was now by law his property." It is, however, not stated whether the cheque has not been stopped at the bank, nor whether there were any funds to meet it.

London County Council.—The first meeting of the Council after the summer recess was held on Tuesday at the County Hall, Spring gardens. Upon the recommendation of the Finance Committee it was agreed to lend the Islington Vestry £3,187 for the purchase of electric light meters, and the Battersea Vestry £5,145 for arc lamps and standards. The Fire Brigade Committee recommended that the tender of Mr. F. J. Coleby to maintain for three years after the expiration of the current contract the electric bells belonging to the fire brigade and the telephone installation at the chief station be accepted, the price to be paid being £315 per annum for the number of bells existing on Oct. 3, 1900; and that no additional charge be made for the use of the combined bell and electric light call switches at any station.

Birkenhead.—That portion of the corporate estate entrusted to the Gas, Water, and Electrical Committee was inspected on Saturday by the members of the Council entrusted with its control, and as their guests were also the chairman of other committees and leading officials. At the electrical generating station in Bentinck-street was made obvious the rapid development of this branch of the department. An engine of 500 h.p. had got to work for the first time, and at the back of the works was found rapidly springing to completion the new stations for supplying energy for the electrical tramways. Mr. Bates and Mr. Shallcross accompanied the party over the works, lucidly explaining a somewhat complicated branch, and later at Flaybrick-hill they conducted the company through the new generating station now supplying Noctorum and Bidston with the electric light. At the conclusion of the inspection, dinner was served at Flaybrick-hill waterworks, and at which Alderman H. Bloor presided. The usual toasts were proposed and duly honoured.

Lowestoft.—The last report of the Electric Lighting Committee states that, in reference to Mr. Hawtayne's report on the cost of a complete system of public lighting by electricity of the borough, instructions were given to Mr. Hawtayne as to the revision thereof (in conjunction with the borough surveyor), he to submit his revised scheme to a further meeting of the committee. Mr. Hawtayne was also requested to report to the committee as to the substitution of electric motive power for the gas-engines now in use at the pumping station. The surveyor was directed to furnish to the committee a complete report upon the number of public lamps in the borough, and the cost of public lighting by gas, to be considered in connection with Mr. Hawtayne's revised report on public electric lighting. Thirty-six applications have been received for the post of resident electrical engineer. The demand for electricity is proceeding very satisfactorily. There are now 2,271 private premises wired and fitted up, and it is expected that the lighting of the borough will be an accomplished fact by the middle of December.

Sunbury.—The District Council have adopted a report of the General Purposes Committee on the draft order submitted by the Twickenham and Teddington Electric Supply Company stating that (1) the Council were empowered by the order to carry out, at the expense of the company, the works of excavating and reinstating the roads and footways necessary for the undertaking, but the committee do not recommend that the Council take advantage of this provision. (2) The order provides that the company shall, within two years from the date thereof, lay sufficient mains in part of the district to be defined in the order and called "the compulsory area." The committee recommended that the compulsory area for this district be the lighting district, and that the company be requested to insert a provision to this effect in the provisional order. (3) The committee also considered as to the terms of the order with respect to purchase by the respective local authorities, the price of electricity, and other provisions general to the whole of the urban districts included in the order, and they recommended that the clerk write to the other local authorities concerned, to ascertain whether they wish to obtain any amendments of or alterations in the general clauses of the provisional order, and decided to defer further reports until the receipt of the answers to the enquiry.

Stroud (Gloucestershire).—A special meeting of the Urban District Council was held last week to consider the desirability of applying for a provisional order for the electric lighting of the district. It was stated that a private company was about to apply for power to light the district, and if the Council obtained a provisional order now they would protect their own rights. Mr. English thought the question to be decided now was whether they wanted the electric light or not. The Chairman said they might

Digitized by Google

obtain the powers now, and take action in the future. It was further said that to light the town of Stroud they would require a minimum of 5,000 incandescent lamps at a cost of not less than £3 per lamp. Probably they would require 10,000 lamps, so that they would have a capital expenditure of £30,000. That was a large sum for Stroud, practically equal to the whole of their assessable value. Other speakers were strongly in favour of the introduction of electric light. It was urged that they could protect themselves, and begin work for an expenditure of £150 or so; it would not be thrown away, and they would have the right to carry on the work when circumstances were more favourable. The tradespeople in the town were practically unanimous in favour of the electric light. The ratepayers of Stroud were greatly dissatisfied with the present lighting of the town. The meeting was adjourned for a fortnight for the purpose of further considering the matter.

Colchester.—The Electric Light Works Committee recently met at the electricity station, and inspected it and the plant, and expressed their satisfaction with the general condition thereof. The new engine at the time of inspection was running at 240 h.p., and 3,100 lamps were being supplied with current. The new boiler will shortly be ready for delivery. The recent temporary partial failure in the supply of current arose through a loss of steam in the early part of the evening, which could not be recovered owing to the fact that one boiler only was available, the No. 2 boiler being under repair (recaulking), and the intended No. 3 boiler not yet delivered. The partial failure was remedied within a comparatively short time, and no similar one is apprehended. From the minutes adopted last week we gather that Messrs. Siemens Bros. and Co. wrote that if the whole order for the 1½ miles of new feeder cable for the Sobraon and Goojerat barracks be given at once, they will adhere to their original quotation of 9s. per yard. The chairman reported that in the circumstances he deemed it prudent to order the cable, and his action was confirmed. The surveyor was requested to report upon the question of the committee bearing part of the additional cost to be incurred by the Roads and Drainage Committee in laying slabs in the pavements in certain streets so as to facilitate the laying of cables thereunder whenever needful. The electrical engineer submitted applications from three owners of premises in Maidenburgh-street for current for a 2-h.p. motor, and a total number of 36 16-c.p. lamps, and stated that the cost of laying a cable 150 yards long would be £54. 7s. 6d. It was resolved that, subject to the Council's approval, the cable be laid, the committee being fully satisfied that the demand for energy is sufficient to justify the expenditure. It was also resolved that three prepayment (slot) meters be purchased at £3. 10s. each.

Price-List.—We have received from the Sunbeam Lamp Company, of Gateshead-on-Tyne, an abridged edition of their catalogue of Sunbeam lamps. The book is very neatly got up, and is thumb-indexed, so that one can open it at any particular place. It will be found very useful to carry in the pocket for reference when ordering lamps, and in this way possesses a great advantage over a full catalogue. Amongst the reasons put forward as to why Sunbeam lamps should be used in England is, we are pleased to note, that they are made in England, by English workpeople, of English material, and with British capital. The lamps have, we learn, been adopted for the Houses of Parliament, and also by the Admiralty, General Post Office, etc.—We have also received a pamphlet setting forth the advantages of the Renewable Electric Lamp Company's goods. This company, whose offices are in City-road, make their lamps with a rather long neck to the bulb, and when a filament becomes burnt out the glass neck of the bulb is cut and a new filament inserted, the lamp being closed and exhausted in the ordinary way, and it is then fit for use again. It is interesting to note that the price for the renewal of a lamp is just half of its original cost, this being a great saving where many lamps are used.—Mr. G. Braulik has also sent us an illustrated sheet dealing with the patent arc lamp couplings, of which he makes a speciality. These patent couplings prevent the untidy appearance which loose wires give to an arc lamp. The coupling has also the advantage that when a lamp is pulled down for recarboning it is cut out of circuit, and there is thus no danger of shock. The price charged for these couplings is 35s. each.—We have received also a card from Messrs. Johnson and Phillips setting forth the sizes, weights, resistances, etc., of their electric supply main cables. These range from conductors of ·05 square inch section to one square inch.

Bradford.—At the meeting of the Town Council on Tuesday the following report, for which we are indebted to the *Bradford Observer*, was adopted: "Mr. T. H. Shaw, chairman of the Electricity Committee, moved the minutes of that committee, and in doing so read the report of the work of the electricity department during the half-year ended on June 30 last. He stated that the total income for the half-year was £17,723. 9s. 5d., as compared with the corresponding period in the preceding year of £13,256. 12s. 11½d., or an increased income of £4,466. 16s. 5½d. The total expenditure for the half-year (including interest and sinking fund) was £16,751. 1s. 3½d., as against £11,523. 10s. 4d. for the corresponding period of the preceding year. The net profit for the half-year, therefore, was £972. 8s. 1½d., as against £1,733. 2s. 7½d., being a decrease of £760. 14s. 6d. on the corresponding period of the preceding year. The number of consumers was 1,178 as against 965, or an increase on last year of 22 per cent. The total number of units consumed was 1,449,409, against 996,807, or an increase of 45 per cent. (irrespective of current supplied for public lamps). The total profit since the opening of the electricity works (in September, 1890) to June 30, 1900, after paying interest and sinking fund, amounted to £26,986. 0s. 6½d., and the total amount written off for depreciation has been £14,372. 17s., leaving the sum of £12 613. 3s. 6½d. to be appropriated as the Council might direct. The trade profit—that is the profit before charging interest and sinking fund—for the half-year ended June 30, 1900, worked out to £3. 7s. 2d. per cent. on a capital outlay of £241,838. 8s. 11d., and the net profit—i.e., after charging interest and sinking fund—shows a percentage of 8s. on the same outlay. Taking the June half year and the preceding December half-year together, the trade profit amounted to £18,186. 14s. 1d., representing £7. 10s. 5d. per cent. on the capital outlay. The net profit for the same half-years amounted to £4,369. 13s. 10½d., and represented £1. 16s. 2d. per cent. on the capital outlay.

COMPANIES' MEETINGS AND REPORTS.

NEWCASTLE ELECTRIC SUPPLY.

An extraordinary general meeting of the Newcastle-upon-Tyne Electric Supply Company, Limited, was held on Oct. 4 at the offices of the Company, 50, New Bridge-street, Newcastle.

Alderman T. G. Gibson presided, and moved the adoption of a resolution to change an article in the Company's articles of association so as to empower the directors from time to time, and at any time, to appoint any shareholder to be a director, but so that the total number of directors shall not at any time exceed 12. He said two sites had been secured on the riverside at Wallsend. Of course, they could not take advantage of those two sites without agreeing with the Wallsend Urban District Council and the Wallsend Gas Company, but they had been able to make satisfactory arrangements with both of those bodies, and they now had power by Act of Parliament to build for the supply of electric energy for lighting and power for the district described in the map. The sites were advantageous for the purpose, being well situated for the Gosforth district and the east end of the town.

Dr. Mers seconded the resolution, and it was unanimously agreed to.

The **Chairman** said the directors at the present time had had the subject of tramways under consideration. It was in connection with the Newcastle trams, and would cover the country between Newcastle and North Shields. With this object in view they had formed a private syndicate to apply to Parliament for the necessary powers. He asked the Company's approval of the appointment of Sir Lindsay Wood and Mr. J. H. Noble as additional directors.

Sir Riley Lord moved the approval of the Company, and **Mr. Monorieff** seconded.

NEW ST. HELENS AND DISTRICT TRAMWAYS.

The first annual meeting of the shareholders in the new St. Helens and District Tramways Company, Limited, was held at the Law Association Rooms, Cook-street, Liverpool, on Oct. 8.

Mr. John A. Willox, M.P., who presided, shortly reviewed the object and work of the Company. The Company was formed to take over the business of the old company who had worked the tramways of St. Helens with steam haulage, and also to acquire from the Corporation of St. Helens the working of the new and extended system of electrical tramways which they were constructing. The Corporation undertook to lay down the rails and the electrical equipment and to supply the motive power, while the new Company was to provide the rolling-stock and the staff for working on the lines. At the outset the Company was at some disadvantage financially, as it had to pay rent, but was not in a position to recoup itself by the revenue arising from traffic. Seven months after the Company came into existence their first electric section was opened—namely, that between St. Helens and Prescot. Since then other sections had been opened, and the work was being pressed forward vigorously. At the date of the report, June 30, only about one-half of the tramway system had been completed, but since then other sections had been finished and opened, and they hoped that in a comparatively short time fully 20 miles of rails would be available. The delays at St. Helens might no doubt have arisen from unavoidable causes, but the result had been rather hard on the Company. They had been paying rent, providing rolling-stock, and incurring all the charges of administration, and had not been able to recoup themselves by the receipts from traffic. Now they might look with confidence to the whole system being brought into working order and producing a favourable revenue within a reasonable time. They had such an abundant stock of cars already on hand that they were in a position to commence the service whenever the lines were ready for use, therefore there would be no delay on their part in utilising the lines. The cars had given entire satisfaction to the travelling public, and the service had been maintained on all the routes with regularity. It was only right to give a word of praise to the Corporation for the excellence of their supply of power, which had been adequate and uninterrupted, and the efficiency of the Company's service had been largely due to this fact. The receipts on the various sections now in use were large and progressive, and realised the expectation of the directors. They might, therefore, look with confidence to the future, both as to the carrying power of the Company and the profit on the business. An important factor would probably be the South Lancashire Tramway Company. Parliament had sanctioned the construction of an elaborate system of electric tramways in the populous

Digitized by Google

district between Liverpool and Manchester for passenger and goods traffic. The St. Helens tramways would be an essential link in this important network of cheap locomotion, and it would be the policy of the Board to encourage its development, knowing that it would be advantageous to the public and to the Company. They had assumed no financial obligations in relation to the South Lancashire scheme, but they would be glad to handle any traffic which it might bring them, and to facilitate its development in any reasonable way.

Councillor H. Martin, J.P., seconded the motion, which was adopted without discussion.

Alderman Lloyd Higginbottom (Manchester), the retiring director, was unanimously re-elected, as were also the auditors, Messrs. Chalmers, Wade, and Co., of Liverpool.

On the motion of **Councillor Martin**, and seconded by **Mr. J. Atherton**, the chairman was thanked for presiding and for the manner in which he had conducted the business of the Company.

TYPEWRITING TELEGRAPH.

The first ordinary general meeting of this Corporation was held at Winchester House, Old Broad-street, on Oct. 4.

Sir James Fergusson, chairman of the Company, presided, and said that that was the first (or statutory) meeting since the incorporation of the Company, and the financial position was that 26,800 shares had been taken up and allotted, making available £15,000 clear for the development of the business of the Company. That would be quite sufficient, because they did not require a great deal of capital to carry on the business, as the General Post Office and the National Telephone Company were very large customers with them, and paid for the instruments as they acquired them. Negotiations were in progress for the sale of certain of the patent rights, including those for America, Germany, South Africa, France, and Scandinavia, the profit in respect to which would come entirely to this Company, because they had acquired the whole of the patent rights. Enquiries were being received for installations, which would be fitted as fast as the instruments could be supplied. Contracts with the General Post Office and the National Telephone Company were being completed, and would in all probability be sealed immediately. He had confidence as to the success of the extremely clever invention which the Company possessed, and he had been approached to take the position of chairman, he being a director of the National Telephone Company, which was one of their chief customers. He hoped and believed that profitable results would accrue to the shareholders from their investment in the undertaking.

Mr. Crouch asked whether the total subscribed was 26,800 shares and the working capital £15,000.

The **Chairman** said that was the amount of the subscription; as the shareholders would be aware, a portion of the purchase money was paid in shares. The total number of shares issued was 71,000, leaving a balance unallotted of 29,000.

Mr. Crouch said that he presumed, therefore, that they would have to pay dividend on the 71,000 shares, and he would like to know whether it was contemplated to begin to do so soon.

The **Chairman** said not before the expiry of six months.

Mr. John A. Sillars, chairman of the vending company, said that his company's rights had been perfectly satisfied, and he had to congratulate the shareholders.

Mr. Mordey, the Company's consulting engineer, gave a technical description of the machine owned by the Company, and pointed out that it could be used in conjunction with the telephone, and that it had the advantage of setting down in writing the essentials of a telephone message, and, moreover, an additional advantage was that messages in foreign languages could be recorded in plain writing.

A vote of thanks to the chairman closed the meeting.

PROVISIONAL PATENTS, 1900.

October 1.

17379. **Improvements relating to electric meters.** Henry Harris Lake, 45 Southampton-buildings, Chancery-lane, London. (Société pour L'Exploitation des Compteurs Electriques Rettener et Cie., Switzerland.)

17399. **Improvements in or relating to electric arc lamps.** Charles Oliver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

October 2.

17437. **Improvements in telegraphones.** Edward C. Paramore, 111, Hatton-garden, London. (Complete specification.)

17453. **Improvements in and relating to electric perforating and recording machines.** George Howlett Davis, 77, Chancery-lane, London. (Complete specification.)

17467. **Improvements relating to telephone switchboards.** Henrik Tore Cedergren and Askar Kahr, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17475 **Improvements in and relating to the manufacture of substances similar to indiarubber.** Carl Adolp Resen Steenstrup, 322 High Holborn, London. (Complete specification.)

17479. **Improvements in automatic releasing mechanisms for phonographs and the like.** Julius Wall, 6, Lord-street, Liverpool.

17487. **Improvements in dynamo-electric machines and motors and in means for regulating the same.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

17489. **Improved electrical apparatus for automatically playing violins and the like instruments.** Arthur Douglas Douglass and Norman Collins, 53, Chancery-lane, London.

17490. **Improvements in the manufacture of secondary battery plates.** Berthold Kuettner, 37, Chancery-lane, London.

17496. **Improvements in and relating to ceiling roses and terminals for electrical lamps and power installations.** Hugo Hirst and Henry Bevis, 165, Queen Victoria-street, London.

October 3.

17507. **Improvements relating to electric lanterns to be fixed on the top of posts.** Harold Faraday Proctor, City Electrical Engineer's Office, Temple Backs, Bristol.

17514. **Improvements in electric switches.** Edward Woodrowe Cowan and William Pancras Hamlyn, Springfield-lane, Salford, Manchester.

17549. **Improvements in electrically operating signal bells and apparatus for that purpose.** Paul Millington Jerrard, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17568. **Improvements in or relating to prepayment mechanism for electric meters.** Thomas Herbert Minshall, 322, High Holborn, London.

17575. **Improvements in electric converters.** Frederic de Mare, 72, Cannon-street, London.

October 4.

17598. **Improvements relating to lanterns for gas or oil lighting to be placed on the top of posts for street lighting or the like.** Harold Faraday Proctor, City Electrical Engineer's Office, Temple Backs, Bristol.

17635. **Apparatus for automatically turning on gas should the current fail in a place electrically illuminated.** George Calvert and Reginald Morrell, 166, Fleet-street, London.

17642. **A new or improved instrument for measuring direct or alternating currents and potential differences.** William du Bois Duddell, Norfolk House, Norfolk-street, Strand, London.

October 5.

17670. **An improved method of combining a telephone with a system of electric bells.** Herbert Alexander and Archibald Duncan Hunter, 28, New Bridge-street, London. (Complete specification.)

17675. **Improvements in systems of electrical distribution.** Charles Ira Young, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 6, 1900, being date of application in United States.)

17694. **Improvements in or relating to the attachment of arc lamps to their weather-hoods or supports.** Charles Oliver, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London.

October 6.

17715. **Improvements in torpedo steering, an appliance to permit of wireless telegraphic influence being received by submerged torpedoes for steering or other purposes.** Cecil John Varicas, 27, Avenue-road, Weymouth.

17722 **Improvements in or in connection with electric light fittings.** Clarence Metcalfe Stead and Frederick Scott, 30, Park-row, Leeds.

17723. **An improved fitting for incandescent electric lights.** Clarence Metcalfe Stead and Frederick Scott, 30, Park-row, Leeds.

17724 **Improvements in dynamo-electric generators.** Cyril Talworth Batchelor, 104, Colmore-row, Birmingham. (John George Herbert Batchelor, Brazil.) (Complete specification.)

17757. **Improvements in and relating to electrode plates.** William Phillips Thompson, 322, High Holborn, London. (The Akkumulatoren und Elektricitats-Werke Aktien Gesellschafo, vormals W. A. Boese und Co., Germany.) (Complete specification.)

17765. **An improvement in connecting the glow bodies of incandescent electric lamps to the leading-in wires.** Paul Scharf, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

17773. **Improvements in alternating-current electric generators.** Sebastian Ziani de Ferranti, Hollinwood, Lancashire.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Oct. 27.

1899.

15895. **Magnetic compasses.** Haddan. (Heit.)

19785. **Electro-chemical process for cleaning metal surfaces.** Vereinigte Elektricitäts Actien-Gesellschaft and Klandy,

Digitized by Google

19793. Electro-plating and burnishing of certain articles and apparatus to be used therein. Round and Round.

19867. Telegraphic apparatus. Crehore and Squier.

20216. Receiving apparatus for high-speed telegraphy. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

20346. Manufacture of incandescing electric lamps. Voelker.

20390. Apparatus for automatically connecting any two of a number of electric circuits branching from a central station. Cerebotani.

20877. Manufacture of reflecting opalescent surfaces for electric lamps or glass reflectors. Improved Electric Glow Lamp Company, Limited, and Barnes.

21079. Time indicators for use in connection with a telephonic service. Sutherland.

22143. Electrical accumulators. Lugard.

23054. Coupling appliances for the electrical conductors of electrical railway and tramway vehicles. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

23154. Electrical indicator. Eckstein and Coates.

23319. Electrical measuring instruments. Atkinson.

23371. Switches, specially applicable to switches for electro-motors and the like. Sloan and Barnes.

23413. Construction of dynamo-electric machines. Robinson and Sankey.

23960. Electric switch or governor. Cros.

1900.

1617. Carbon contacts for electrical switches and the like. Reichwald. (Firm of Fried. Krupp.

10688. Telephonic fire-alarms and other similar call systems. Wells and Brown.

11486. Electrical equipment of railway vehicles for the purposes of lighting, heating, and ventilation. Zehden.

11557. Ballast resistances and cut-outs for Nernst lamps. Potter.

11558. Systems of lighting by Nernst or like electric lamps. Wurts.

11559. Starting apparatus and cut-outs for Nernst and like electric lamps. Wurts, Potter, and Hanks.

11597. Flexible conduits for electrical conductors. Osburn.

12009. Apparatus for receiving and recording messages. Lake. (Gordon.)

12783. Art of reducing attenuation of electrical waves and apparatus therefor. (Pupin.) (Date applied for under International Convention, Dec. 14, 1899.)

13005. Storage battery electrode. MacRae and MacRae.

13729. Methods of operating dynamo-electric machines. British Thomson-Houston Company, Limited. (Berg.)

14212 Electric furnace. Boult. (Union Carbide Company.)

14367. Collectors for use in overhead systems of electric traction and the like. de Kandó.

15381. Thermal electric cut-outs. British Thomson-Houston Company, Limited. (Emmet.)

15717. Electric railways working on the closed-conduit system. Dion.

TRAFFIC RETURNS.

Line.	Returns for week Ending		1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
			£	£	£	£	£
Aberdeen Corp'rat'n	Oct.	8	—	—	—	—	—
Birmingham Trams.	,,	6	4,570	4,321	+ 249c	174,560	166,014
Blackburn Corp'rat'n	,,	8	—	—	—	—	—
Blackpool Corporatn.	,,	4	673	432	+ 241	25,146	18,657
Blackpool-Fleetwood	,,	8	407	422	- 15	18,070	17,958
Bradford City Trams	,,	7	547	374	+ 173	14,037	11,002
Bristol Tramways Co.	,,	6	3,305	2,943	+ 362	—	—
Carlisle Tr'mw'ys Co	,,	8	—	—	—	— f	—
Central London Ry.	,,	6	5,103	—	—	47,510e	—
City & South London	,,	7	1,616	1,019	+ 597	21,237e	13 204
Cork E. T. and L. Co.	,,	4	458	390	+ 68	16.625	15,240
Dover Tramways ...	,,	6	224	202	+ 22	8.458	8,075
Dublin & Lucan E.R	,,	6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	,,	5	3.623	1,885	+1,738	—	—
Dublin S.D. Electric	,,	5	836	720	+ 116	—	—
Glasgow Corporation	,,	6	9,441	9,229	+ 212	—	—
Halifax Corporation	,,	8	—	—	—	—	—
Hull Corporat'n E.S.	,,	6	1,276	—	—	33,857a	—
Liverpool Corporat'n	Sept.	29b	8.920	7,047	+2,873	305 057	267,421
Liverpool Overhead	Oct.	7	1,592	1,462	+ 130	24.272c	23,079
St. Helens Tramways.	,,	3	609	363	+ 246	—	—
Sheffield Corporation	,,	7	2,591	—	—	—	—
Southampton Trams	,,	8	—	—	—	—	—
Swansea Tramways..	,,	5	447	263	+ 184	7,093	4,462

a Since April 1. b Partly electrical. c Since Jan. 1. e From July 30. f From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	⅝ ¾
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	5	—	10½-10¾
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6¼
—— 5 per cent. Mortgage Debentures	100	—	98-102
British Electric Works, Ordinary, 50,001-96,000	1	—	⅞-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	1-1⅛
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	—	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	102-104
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-13½
—— 5 per cent. Pref.	5	—	5-5¼
Crompton and Co.	2	—	2⅜ 4½
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	2	—	1¾-2⅛
—— 5 per cent. Debentures	5	—	5¼-4¾
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Certs.	70	..	96-100 xd
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2⅜-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-13½
—— 4½ per cent. Preference	5	—	5-5¼
—— 4½ per cent. Debentures	100	—	108-113
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½-21½
—— 4 per cent. Debentures	100	—	99-102 xd
Telegraph Construction and Maintenance	12	—	84-88
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5-5½ xd
Willans and Robinson, Ordinary, 1-30,000	5	—	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-30,000	5	—	6-6¼
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-5¾
Chelsea Electricity Supply	5	—	6¼-7¼
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	8¼-9¼
—— 6 per cent. Cumulative Pref.	10	—	12½-13½
—— 5 per cent. Debenture Stock	100	..	124-129
County of London and Brush Provincial, Ordinary	10	—	8¼-9¼
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	107-110
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¼-5
—— 4½ per cent. First Mort. Deb.	100	—	100-103
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	2	—	1¾ 2¼
—— 6 per cent. Pref.	5	—	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-102
Metropolitan, Ordinary	10	—	13 14
—— 4½ per cent. First Mortgage Debenture Stock	100	—	111-114
—— 3½ per cent. Mortgage Debenture, Red	100	—	97-100
Notting Hill Electric Lighting	10	—	14¼-15¼
Oriental, 1879	1	..	1¾-1¾
—— £5 Shares	5	—	7¼-7¾
—— £4½ Shares, New	4½	..	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	103-105 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	95-98
South London, Ordinary	2	..	2-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	..	8-9
Westminster, Ordinary	5	..	12-13
—— 80,001-109,437	5	—	11-12
Electric Railways.—			
Central London, Ordinary	10	..	10¼-10¾
—— Pref. Half-Shares	5	..	5-5¼
—— " deferred	5	..	5-5¼
City and South London, Consolidated Ordinary	100	..	58-61
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— " " " '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13¼
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	..	101-103 xd
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10¼
British Electric Traction, Ordinary	10	..	13¼-14¼
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
—— " " " 1900	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¾-5 xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	3¾-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	104-107
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9¾-10¼
New General Traction, Ordinary	5	—	3¾-3¾
—— 6 per cent. Cum. Pref.	5	—	4¾-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	18-19
—— 5 per cent. Cum. Pref.	10	..	10¼-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9¾-10¼
—— 4½ per cent. Debenture Stock	100	—	104-107
Telephones.—			
National Telephone, Ordinary	5	—	4¼-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5¼-6¼
—— 3½ per cent. Deb. Stock, Red.	100	—	97-100
Oriental Telephone and Electric Company	1	—	¾-1¼

Digitized by Google

NOTES.

Glasgow and West of Scotland Technical College Society.—The opening meeting of the session of this society is to be held to-morrow (Saturday) in the large hall, 38, Bath-street, Glasgow, when the president, Mr. David Home Morton, will deliver his inaugural address on "The Standardisation of Machinery." This is a subject which is very interesting to all engineers, and the opening meeting should for this reason be well attended.

Institution of Junior Engineers.—The annual general meeting of this institution is to be held next Friday, Oct. 26, at the Westminster Palace Hotel. This meeting opens the session 1900-1901. On Saturday a visit to the London Hydraulic Power Company's station has been arranged. Sir Lowthian Bell, Bart, F.R.S., of Northallerton, has, we are informed, been elected president of this institution, in succession to the Hon. C. A. Parsons, F.R.S., of Newcastle-upon-Tyne.

Electrical Apparatus in Brazil.—A gentleman bearing the high-sounding name of Dr. Olympio De Assis, of Minas, Brazil, has written, stating that in his town some electric railway lines are to be constructed, and he requests manufacturers of electrical apparatus and of other kinds of street railway material to let him have price-lists, catalogues, and any other information they may care to supply. The request was originally sent to American firms, but there should also be a chance of some of our English firms securing contracts, if these latter are worth having.

Compensation.—A subject which has not been much in evidence lately is now again to receive attention, this being the question of the compensation to be paid to the church authorities of St. Mary Woolnoth with respect to the City and South London extension to Moorgate-street. The company, it will be remembered, made use of the church during the construction of the line, and a claim is now being made for rent. The case is to be heard before Mr. Robt. Vigers at the Surveyors' Institution, and the *City Press* considers that the amount of compensation awarded will amount to several thousand pounds.

The Alaskan Cable.—The laying of the cable from St. Michael to Unalakleik, Alaska, has been seriously hindered by the cable ship "Orizaba," which was engaged in laying it, stranding upon a rock, which was apparently uncharted. The ship stranded on the afternoon of Sept. 20, and is probably still aground. Vessels have been sent to the rescue of the steamer, and they will probably take off the crew and the cable material and apparatus. The master of the "Orizaba" is of the opinion that the ship can be saved, but the mishap will prevent the completion of the Behring Sea cable this year. The total length of the cable when finished will be 187 miles, of which five had been paid out at the time of the accident.

Clapham Junction.—There are, we learn, improvements about to be effected at Clapham Junction, amongst which figures an electrical indicator denoting the platforms from which the trains are to start. This improvement, if carried out, will, we are sure, save a large amount of the time and energy which is now wasted by passengers at that station in hurrying from one platform to another asking which their train goes from. Every railway official tells one a different platform, and the subway in the station is frequently crowded with people trying to catch a train which apparently goes from two or three platforms at the same time. However, let us hope that with the advent of the electrical indicator this waste of time and energy will be prevented.

Society of Model Engineers.—The monthly meeting of the Society of Model Engineers took place on Tuesday, Oct. 9, in the Memorial Hall, Farringdon-street, E.C., about 50 members and friends being present. The Chairman drew attention to the new curved portion of track made by Messrs. Burnham and Orford, and the tool and buffer box constructed by Mr. H. S. Boorman. The formal business terminated at 8 o'clock, after which the trials of locomotives took place over the new extended track. The next meeting of the society, to be held on Thursday, Nov. 8, will be the annual general meeting, when will take place the election of new officers for the next session and other business.

St. Marylebone Lighting.—The Metropolitan Electric Supply Company do not seem entirely to have got rid of the obstruction which the St. Marylebone Vestry have offered to their works. Thus we notice that the Advisory Special Electric Lighting Committee of the Vestry have recommended that the Vestry shall withhold their consent to the execution of works referred to in a notice from the Metropolitan Electric Supply Company of their intention to lay a low-tension armoured main along certain roads in St. Marylebone. The refusal to consent to the laying is apparently only an outcome of the old quarrel existing between the company and Vestry. It is a pity that a body of men chosen to look after the interests of the public and a parish should put aside these interests in order to indulge in petty spite, which would appear to be the case in this instance.

The Central London Railway.—The directors of the Central London Railway are not, it would appear, slow in learning a lesson, and the recent unfortunate accident has already produced its results. Thus, one theory as to how the unfortunate man, Field, met his death was that he was knocked off the train whilst endeavouring to look through the windows at the side to see if anyone was smoking in the non-smoking compartment. The directors have now taken measures to prevent an accident again occurring from such circumstances, and are placing in the doors which shut in the carriages glass in the upper panels instead of the wood previously used. It is thus possible in the trains which are fitted with glass to look from one end of the train to the other. Apart from questions of safety, the glass panels with the neat monogram in the centre tend to improve the appearance of the carriages.

Victorian Water Power. — The question of the utilisation of the waterfalls in Victoria for the generation of electrical energy having been raised, Mr. Jas. Stirling, the Government geologist, has in his report for March given a list of the waterfalls which have come under the notice of the officers of the Geological Survey. The list gives the name of the falls, the locality in which they are situated, and the height of the fall. The fall having the greatest drop is the Yarra Fall, which has a drop of about 1,000ft. The next highest fall is one on the Dondangadale River, which drops some 400ft. The height of the other falls ranges between 300ft. and 28ft. Some of the streams are liable to cease running during very hot periods, but the majority of the streams are perennial. Several of the water-supply weirs could, we learn, well be used to store water for the generation of electricity, and one of them—the Goulburn weir—actually is used to generate electricity for lighting purposes.

Fuel Gas.—The *Trade Journals' Review*, in its issue for Oct. 5, has a leader dealing with fuel gas and its use for driving various plants. Our contemporary goes on to

Digitized by Google

explain that fuel gas is not illuminating gas, and speaks of its great use for driving small electrical plants. The fuel gas spoken of is producer gas, which is said to contain 80 per cent. of the heat energy of the coal consumed. A producer gas plant can be installed for about the same cost as a steam plant of the same capacity, and its performance is said to be better than that of steam. Tests are stated to have shown that the same result can be obtained with producer gas with half the amount of coal required for steam plants, the coal also being of an inferior quality. Our contemporary, however, while not doubting that the power gas will replace steam in a very large number of cases, does not go to the extreme of stating that the steam-engine will become defunct, but thinks that steam must for many years hold its own in certain circumstances, such as ship propulsion, etc. The real trouble with the use of fuel or power gas appears to be with the maintenance of the gas-engines and plant.

Electromobiles in France.—We gather from the French Press that the Touring Club of France is compiling a card of electric stations in that country at which electromobiles can be charged, and has sent to private persons owning electrical installations a number of questions as to the nature of the current produced by their machines, whether continuous or alternating. If the current is alternating, whether they have transformers to obtain continuous current? If the voltage is continuous, what is the voltage? They also ask if the owners are willing to sell their current for recharging electromobile accumulators, and how many amperes they are willing to dispose of, and at what hours? It is also asked if ampere and volt meters are available, and also if the owners of the plants possess suitable rheostats? This card, when finished, should be of great service to the electromobile tourist in France, as it is not possible in all cases to obtain a supply from a public authority or electric lighting company, and many of the manufacturers possessing an installation for their work would no doubt be pleased to sell a small amount of their current at a reasonable rate.

Street Obstruction.—The laying of the Post Office telephones is proceeding, but it would hardly be right to say rapidly. The work of laying mains in London is not easy, but one might hope that in the streets of the City, where the traffic is very heavy, some effort would be made to hurry on the work and cause as little inconvenience as possible. This, however, does not appear to be the view of those responsible for laying these telephone lines, and the consequence is that all the busiest thoroughfares in the City are torn up, and work is proceeded with in a very leisurely fashion. We are informed, for instance, that there is no night work done, such as there should be in a place where a great number of vehicles are continually passing. The city engineer recently reported to the Court of Common Council that he had endeavoured, without success, to make the Post Office employ men on night work, and thus hurry on the operations. The Common Council have therefore again appealed to the Post Office on the matter, and we learn that the matter is now under consideration. While this is so, we suppose that workers in the City are to lose their time and suffer great inconvenience.

The Coal Strike in the States.—It will be remembered that at the time of the lamentable coal strike among the Welsh miners there was, in consequence, a large number of prosecutions in London on account of the smoke nuisance. We now note from the columns of the *Electrical Review* of New York that that city has experienced the same inconvenience in consequence of the coal strike in the States. Our contemporary's remarks on the subject are as follows: "Even to the casual observer it was evident that a coal strike was in progress last week, when the formerly smokeless city of New York became covered with dense clouds of black smoke, shot upward from a thousand chimneys that have done their work unnoticed for years past. New York has enjoyed a practically smokeless atmosphere for several years, and when it is considered that it is the largest manufacturing city in the United States, and that the enormous total of steam power developed in it requires the daily consumption of vast quantities of coal, it will readily be understood what a difference is made when pitchy and smoky bituminous coal is substituted for the almost smokeless fuel that has been lately in use. At this writing the prospects for the immediate ending of the strike seem excellent, and if for no other reason than that we desire to see the sun again, and emerge from the murky atmosphere of the last few days, this consummation is one that we all devoutly wish for." We see no note, however, to the effect that the various industrial undertakings in the city of New York are being persecuted because they are not able at once to make their chimneys smokeless, in spite of the fact that coal such as the furnaces were designed to burn cannot be obtained.

Jointing.—A patent has recently been granted to Mr. W. F. Barber, of Wilkesbane, U.S.A., for a metallic cement, which, he claims, acts as a solder, and does not require heating. Thus the wires are twisted, or mechanically secured together, and the cement is then applied. The cement consists of an amalgam, with a little binding material added, the mass having about the consistency of putty. When in mass the cement does not harden except at the surface, where a thin crust is formed. When worked between the fingers the mass becomes soft, and can then be applied to the wires. The amalgam is stated to consist of four parts of zinc, two of tin, two of copper, two of cadmium, four of bismuth, two of lead, one of antimony, and eight of mercury. The solid metals are granulated and melted together, after which the mercury is added, the mass being stirred at the same time. When cool the mass is pulverised in a mortar, and a binding material, consisting of liquid glucose and silicate of soda, is thoroughly mixed with the metals. The cement thus formed when in bulk will not harden, and may easily be worked between the fingers, but when spread out upon a joint it not only adheres to it, but hardens in from 12 to 24 hours. The cement may be applied to the wires without any previous application of acid, and by amalgamating with the conductors it forms as perfect an electrical union as could be formed by the application of solder without the inconvenience attending the application of the latter. The application of the cement prevents oxidation of the wires. The above details must be amplified by others concerning the resistance and endurance of the joints made before any valuable opinion can be formed of the method.

Wanted Electrical Comforts.—That electricity could be used to a very much larger extent than at present for the comfort of human beings will not be denied. Mr. R. S. Hale, in commenting on this fact in the *Electrical World*, mentions a few of the ways in which he would increase his comfort by the use of electricity. In the first instance he refers to the lighting of a house, and advocates a system of three-point wiring, in which the lights can be turned on or off from various places as may be convenient. This system, though apparently little used in America, is very common in England, many large houses and other buildings being fitted in this way. The author also mentions the lighting of the stairs on one floor of a building only, switching on or off at the bottom or top of each staircase. For bedroom lighting he states he has a switch at the door by which he turns

Digitized by Google

on the lights before entering the room, and also another switch close to the bed by which he can turn the lights on or off as occasion requires without getting up to do so. Another arrangement which finds favour in his eyes is an electric bed warmer, by means of which and the help of a pendant switch he warms his bed when he feels cold. For stair-lighting he recommends the use of push switches, it being easier with these for a servant to switch stair-lights on and off when carrying a tray or other article. The author thinks an electric lamp should be placed in every cupboard and wardrobe, by which means the dropping of grease from a candle on to the clothes may be avoided. The extra cost of the fittings of which he speaks would, he states, not add 25 per cent. to the cost of wiring a house, and would add 10 per cent. to the comfort.

Bacterial Light.—Speaking of the uses which are now being found for various micro-organisms, the *Lancet* mentions as a thing to be cultivated that kind of bacteria which emits a phosphorescent light. The phosphorescent microbe, it states, if properly fed, will grow and multiply enormously, emitting during its development a strange phosphorescent light. In the past this light has been looked upon as indicating phosphorus in the neighbourhood, but in a large number of cases it is not due to any chemical change, but to countless micro-organisms. In the case of the phosphorescence of the sea this is so, and in this case the phosphorescence is best when the sea is disturbed and the maximum of light is emitted from the crest of a short rapid wave, or in the foam produced by the water striking the shore. The light in this instance may be intensified by the addition of a combustible foodstuff, such as sugar, the light being caused by the oxidation of the bacteria, and if oxygen be excluded the light is at once quenched. The glow seen upon stale sea fish is said to be also due to these organisms and not to phosphorus, and it is possible to cultivate the phosphorescent bacteria so as to obtain a strongly phosphorescent fluid. This may be done by placing the flesh of fresh haddocks or herrings in a 2 to 3 per cent. solution of common salt and keeping it at a low temperature, say 7deg. above freezing, and it will then be found in a few days that not only the fish but the liquid give off a pale greenish light, which becomes more brilliant if sugar be added. The *Lancet* says, however, that it is not possible to say whether the culture can ever be carried to such a pitch that the vessel containing it can be used as a street lamp or as a Chinese lantern at garden parties.

The Strike on the Ashton Tramway.—With respect to the strike of tramway employés which recently took place on the Oldham, Ashton, and Hyde Electric Tramways the directors have issued a statement to the effect that, owing to the falling off in traffic following the conclusion of the fairs which are held in the district on Sept. 3, 12 motormen and conductors were given one week's notice to leave, but while working out their notice four of the 12 men were re-engaged to fill vacancies which had occurred during the week, so that on Sept. 10 eight men left the company's service. There is, it is stated, no truth whatever that the dismissal of the eight men was due to their being members of the union. With reference to the statement that the company dismiss men when they are in receipt of the maximum wage, the company point out that of the eight men two only were in receipt of the maximum wage, the remaining six being in receipt either of the minimum or intermediate wage. The present position is that 74 of the employés are on strike, 15 have remained with the company, and 61 new men have joined the service of the company, making a total staff at present of 76. For the service of cars the company are desirous of running during the ensuing month or two about 100 men are required, and the 24 vacancies are being gradually filled. In a letter which the chairman of the company has addressed to the local Press, it is clearly stated that the company has no wish whatever to interfere with the right of the men to join the union. The directors also are willing to reinstate the men now on strike to fill the vacancies in the order in which they apply, and have instructed the superintendent to give preference to the men of good character, and to reinstate them at the same rate of pay which they were receiving prior to the strike. The only point at issue is the number of men to be employed to do the work of the company, and of this the directors must, of course, be the sole judges.

A Closed-Conduit Traction System. — In the issue for Sept. 19 of the *Electrical Review* of New York we notice a description of a system, invented by Mr. L. M. Machan, for operating a closed conduit for electric tramways. The top of the conduit is made of iron, forming practically a third rail in the streets. This third rail is divided up into sections, which are successively energised by the car passing over them. The length of the section is about one-fourth that of the car. At intervals of 4ft. are placed contact-making receptacles, which consist of a porcelain cell containing an aluminium cup. The cup is partly filled with mercury, and in this is immersed the stem of a rivet-shaped contact-making device, which is adapted to be attracted upward against the under surface of the working conductor when the latter is magnetised. Attached to the car is a pair of electromagnets, hinged to which for convenience are the collectors. These magnets are energised by a storage battery of small size on the car. The magnetic effects produced by these two magnets on the third rail are expected to lift up the plungers described above, and it is claimed that the system is novel. We are surprised that the editor of our contemporary allows such a claim to appear in his columns. The system is a reproduction of one of the crudest systems of closed-conduit working, and we make bold to say that the inventor has not tried it on a large scale with apparatus made as illustrated in our contemporary. The eddy currents produced in the body of the third rail, if sufficient lines of force are to go through it to attract the plunger, would be very great indeed; and although the magnets might be energised with a small storage battery, they would give rise to a very great waste of power in this way. In fact, we doubt if with high speeds it would be possible to work at all as proposed. Unfortunately, in these days it is so much easier to write a description for a technical paper than to carry out the practical work necessary to prove the truth of what is written. In this case, however, the system can be rejected on theoretical grounds.

New Incandescent Lamp. — A new process of manufacturing incandescent lamps is now in operation in the Paris Exhibition. The process consists in producing the vacuum by the absorption of the gases by certain chemical substances which have been previously introduced into it. In this Malignani process, as it is called, a partial vacuum is first obtained in the bulbs by an air-pump; to absorb the remaining gases red phosphorus is stated by the *Scientific American* to be the compound generally used, and it is formed into a somewhat liquid paste, which is introduced by means of a piece of cotton on the end of a wire into the tube by which the bulb is exhausted, and the walls of the tube are coated with the paste. A vacuum is first made by the air-pump, and it is found that at a low pressure many of the gases will be absorbed by the compound used, especially oxygen, hydrogen, nitrogen, and the

Digitized by Google

hydrocarbon gases; the latter are most easily absorbed, and are in consequence used in practice. After the partial vacuum has been reached, the hydrocarbon gases are introduced into the bulb to displace the air; the pump is operated for half a minute while a current is sent into the filament, which brings it to dull redness. When the vacuum is made as nearly complete as possible by the air-pump, a stronger current is passed through the filament, and the outside of the bulb heated by a small gas furnace placed below it. When the vacuum has reached a certain point, a light-blue discharge appears at the positive pole, which increases, and eventually fills nearly the whole of the bulb; at this point the lamp is separated from the pump by melting off and closing the tube. The chemical product on the walls of the tube is then heated, and it absorbs the remaining portion of the gases; at this point the discharge appears to fill the whole of the lamp, having a light-blue appearance. Upon heating the lamp for a few moments, the discharge disappears, and the vacuum is complete. The glass tube is then removed from the bulb by melting off in a blow-pipe flame. The advantages claimed for this lamp are that the vacuum is better, the operation is more rapid, and it does away with the inconvenience of using mercury pumps.

Institution of Electrical Engineers.—We have received the list of meetings of the Institution which are to take place during the coming session. The opening meeting is fixed for Thursday, Nov. 8, at 8 p m., when the premiums for papers read in 1899-1900 awarded will be presented, and the president, Prof. J. Perry, M.E, D.Sc., F.R.S., will deliver his inaugural address. As usual, there are two meetings set down for each month, the last being on the annual general meeting, which is to be held on May 23. The total number of meetings set down on the list is 14. We have also received a card giving the arrangements for the meetings of the local sections. These sections are formed, as announced last session, at Birmingham, Dublin, Glasgow, Manchester, and Newcastle-on-Tyne. Of these, the Birmingham section has not yet been properly constituted, and in consequence the arrangements have not yet been settled. At Dublin, however, the session will open on Nov. 22, and a meeting will be held each month at the rooms of the Royal Dublin Society. The hon. secretary for this section is Mr. F. Gill, Telephone-buildings, Dublin. At Glasgow, where considerable progress was made in the past session, Mr. E. G. Tidd acts as hon. secretary, his offices being at 25, Gordon-street, Glasgow. Here, again, seven meetings, beginning on Nov. 14, will be held, the rooms of the Institution of Engineers and Shipbuilders at 207, Bath-street, Glasgow, being used for the purpose. The Manchester section will hold two meetings each in November, February, and March, and one meeting each in December, January, April, and May, the opening meeting taking place on Nov. 13. The place of meeting will be the Owens College, Manchester, Mr. E. W. Cowan, Springfield-lane, Salford, acting as hon. secretary. At Newcastle the session begins on Nov. 12, but finishes on March 25. There are, however, between these dates to be 11 meetings. Mr. J. F. C. Snell, of the Sunderland Corporation electricity works, has consented to act as hon. secretary, and the section is to meet at the College of Science, Newcastle-on-Tyne, if possible. A footnote on the card informs us that the dates are subject to alteration, if necessary.

Railway Power Transmission.—On Sept. 18 Mr. A. H. Armstrong read a paper before the Street Railway Association of the City of New York on the above subject, in which some useful conclusions are drawn as to the advantages of the various systems of distributing power for railway work. The available systems he classes as five in number. The first of these is the ordinary 500-volt direct-current supply. The next system employs series-wound direct-current boosters in the feeders from a 500-volt station. The third system is a three-wire one, using the track as neutral. The fourth is an alternate-current distribution, with sub-stations containing step-down transformers or rotary converters. The last system mentioned by the author employs alternate-current induction motors on the cars with the same system of distribution, with the exception that the rotary converters can be dispensed with. For tramway undertakings covering comparatively small areas the first two systems are undoubtedly the best. The author goes on to state that where larger systems of tramways are required, the local conditions must largely determine whether it is better to employ the direct-current supply with boosters or the alternate-current supply with sub-stations containing rotary converters. When, however, suburban roads have to be operated with great lengths of track, heavy cars, and high speeds, it will be found that the alternate-current supply with sub-stations and rotary converters is more economical than to build a number of small direct-current stations at various parts of the roads. When, on the other hand, the existing steam railways for suburban work and trunk lines have to be supplied, with a comparatively unfrequent service of heavy trains, the author considers that the induction motor has several advantages. For instance, it saves the large labour account which is caused by the running of machinery in sub-stations employing rotary converters, and it provides by means of the induction motors a fixed speed to trains independent of grade and line voltage. When, even with these trunk lines, the service becomes more frequent, he considers that it may still be advantageous to reconvert into direct current. The final conclusion of the whole matter is that no hard-and-fast rule can be made, but that each system must be considered on its own merits.

International Association of Municipal Electricians. — At the fifth annual convention of this association, held in Pittsburgh, U.S.A, from Sept. 25 to 28, Mr. J. L. Morgan, formerly city electrician of Kansas, read a humorous communication, in which, according to the *American Electrician*, he said he was no longer an active member of the association, as the office of city electrician had been abolished some six months before. Referring to some of the conditions under which the city electrician labours, Mr. Morgan said that "his employers consist chiefly of the mayor and a city council, or probably the city council and a mayor. Characteristic curves of the mayor may be more or less easily plotted, but no one can foretell the vagaries of the city council." The ethics of the profession, he continued, demand that dignity should be omnipresent, but dignity and aldermen are strangers. "In vain you attempt to discuss with an alderman plans which you have for bettering the electrical condition of the city, or money that you have saved by the elimination of electrolytic electrolysis. The alderman dismisses such a proposition with a gesture, and brings you down to earth with a jar by telling you that he has a friend whose door bell doesn't work, or that his electric light meter is working overtime. If he doesn't want a door bell fixed or a meter shunted, he probably wants a city telephone placed in his hall, or a city arc lamp in his parlour, or perhaps he only wants his gasolene stove repaired. When the influential member introduces you to his brother-in-law, and confides to you that he is to be your chief or sole assistant, that he is a first-class Kalsominer,

Digitized by Google

and in a few days will learn to be a good electrician, you must cheerfully accept this as an axiomatic proposition; never show the slightest annoyance; if you don't like him, take him out and connect him up with the alternating-current primaries. This is not crime, but philanthropy. Endorse unreservedly any and every proposition advanced by any member at any time or at any place. It is also wise to express an eagerness to personally assault any person, not a councilman, who has the slightest views opposed to those of the aforesaid member." Speaking in a more serious vein, Mr. Morgan advocated State control as a remedy for the more or less grotesque conditions pertaining to municipal systems, contemplating the appointment of a chief electrician who would have deputies to supervise the work, not only in large towns, but in small ones as well. This arrangement, he pointed out, would also remedy the existing defect that small cities and towns have practically no expert protection.

The Pan-American Exhibition.—Our American contemporaries, in most of their recent issues, have something to say respecting the Pan-American exposition, the buildings for which are now in a well forward state of construction. The electricity building is 500ft. long and 150ft. wide, but has an exhibition space of only 25,000 square feet owing to architectural work. In the north-west corner is to be placed a 5,000-h.p. transformer plant, consisting of 19 250-kw. General Electric air-blast transformers, which will transform the Niagara Falls Company's polyphase current at 11,000 volts down to 1,800 volts for distribution. Other step-down transformers will also be used in the buildings. In addition to the 5,000 h.p. from the Niagara Falls Company, an auxiliary power-house is to be located in the grounds for lighting the large number of arc lamps with which the exposition will be lighted Prof. G. F. Sever, who is superintending the electrical exhibits, has issued an announcement setting forth that electricity is to be used in lighting the grounds and buildings of the exhibition, it being the most convenient and adaptable system of lighting. He states that probably all the buildings will be outlined in incandescent lamps, and also the electric tower, which will be a central figure. There are also to be many novel and interesting electric fountains, and displays with combined water and electric effects. In order to carry out the suggested schemes over 200,000 incandescent lamps are to be utilised, and in order to get the best effects arc lights will be confined exclusively to the borders of the grounds. The illumination of the aisles and interiors of the buildings is, however, to be done by arc lamps. The electrical and mechanical buildings are to be placed close together, in order that clear comparisons may be made. It is proposed to make the electrical section of this exposition unique. Previously, electrical exhibits at expositions have been largely confined to large spaces filled by individual exhibitors, so as to demonstrate the amplitude of their resources, but for the Pan-American exposition each manufacturer is invited to contribute only such articles as may be considered really novel or of interest, thus making the exhibit a collective one, rather than one exclusively composed of individual commercial exhibits. Another important factor which has necessitated a selective exposition in this particular instance, is the small amount of exhibition space as compared with the area occupied by the buildings. The exhibits will therefore be divided into two groups—the collective exhibit, which will consist of retrospective exhibits of historical interest, illustrative models or practical contrasts showing the advances in the art; and the commercial exhibit, which will be composed of those exhibits possessing distinctive merit, whether this consists in workmanship, novelty, or useful applications. The exhibits are to be classified into 12 different sections, and it is intended to place commercial and operative exhibits together in one part of the building, the historical exhibits and models being in another portion. The cost for floor-space in the building is to be from 4s. 2d. to 6s. 3d. per square feet.

Institution of Civil Engineers.—The eighty-second session of this institution will open on Nov. 6, at 8 p.m., when the president, Mr. Jas. Mansergh, will deliver his inaugural address and distribute awards for papers read in the past session. Mr. J. H. T. Tudsbery, the secretary of the institution, has sent us a list of subjects upon which papers are invited, and also a copy of the rules for the admission of students. There are some 83 subjects set forth upon which original papers are invited, and amongst these we notice in the railway section: the increase of speed in express travelling; the application of machinery in large railway goods yards and sheds and street railways, having reference to different systems of traction—viz., steam, cable conduit, electric trolley, electric rail contact, electric conduit, and electric storage battery. In the machinery section papers are invited on: turbines; the most suitable steam-power equipments and the size of units for electric light stations; the theory and development of the compound steam-turbine; methods of testing the lubricating values of oils, grease, etc.; and methods of removing moisture from steam, and of reducing losses by radiation from steam-pipes. In mining and metallurgy papers are asked for on: mechanical appliances for coal getting; the manufacture and use of steel for electromagnetic purposes; and the extraction of metals from their ores by electrolytic processes. There are 10 suggestions put forth as to electrical subjects, these being: the use of electric energy in working mines; the utilisation of electric energy for heating purposes; the application of electricity to traction on roads and tramways; the first cost and economy of operation of electric traction on railways with heavy trains; the utilisation of electric lighting plant during hours of small demand; the use of electric motors for driving machines in textile factories and in engineering workshops; the use of electrical machinery for lighting and for the transmission of power in warships and in the mercantile marine; the regulation of electric pressure in large lighting circuits as carried out at the engine, the dynamo, or the exciter; the progress of telegraphy and telephony at home and abroad; the electrolytic action of return currents in electrical tramways on gas and water mains, and the best means of providing against electrical disturbances. Amongst the premiums which the institution awards for papers read at the institution, the first is the Telford Fund, which produces £235 annually, and is expended in annual premiums under the direction of the council. The Manby Donation is also given for an annual premium for papers read. The Miller Fund provides for a scholarship, which is awarded each year, and is tenable for three years, the scholarship not exceeding £40 in value. The Howard Bequest provides for a prize or medal, which is presented once in five years, for a paper on "The Uses or Properties of Iron," or for some new and valuable process relating thereto. The Crampton Bequest provides a prize or medal for the author of the best paper on "The Construction, Ventilation, and Working of Tunnels of Considerable Length." The James Forrest Medal is annually presented to the student contributing the best paper in that class. The James Prescott Joule Medal is given every third year to a student for the best paper presented on an engineering subject, preference being given to one dealing with the transformation of energy.

Digitized by Google

LIVERPOOL ELECTRIC LIGHTING.

Mr. A. Bromley Holmes was born at Derby, June 8, 1849, and educated at Repton School, near Burton-on-Trent. In 1868 he commenced pupilage under Mr. A. Buchanan, of Messrs. Andrew Handyside and Co., engineers, at Derby, and was subsequently for seven years in the employment of that firm. In 1881 he commenced business as consulting engineer in Liverpool in partnership with Mr. J. C. Vaudrey, and was managing engineer for the Liverpool Electric Supply Company, Limited, from its formation in the year 1883 till its purchase by the Corporation of Liverpool in 1896. On July 1, 1896, he was appointed city electrical engineer by the Corporation of Liverpool. Mr. Holmes was elected a member of the Institution of Civil Engineers in 1888, and is a member of the Institution of Electrical Engineers.

Through the courtesy of Mr. A. Bromley Holmes, the city electrical engineer of Liverpool, we are able to give a few particulars of the new electric light stations which have recently been put to work in that city. It was on his advice in 1898 that the Corporation determined to provide amply for the rapidly increasing demand for electrical energy. This demand even as far as electric lighting only is concerned has increased in a remarkable way in Liverpool, but the introduction of electric traction for the tramways has given a still further demand, which only prompt forethought could have enabled the Corporation electrical department to meet. It was accordingly decided to build two new large power stations. In Fig. 1 we give a general map of Liverpool, in which the positions of these two stations can be seen. The one is at Lister Drive, and the other at Pumpfields, in Vauxhall-road, which is nearer the docks. As will be seen by the scale, the actual distance between these two stations is about 2½ miles, and the heart of Liverpool is between the two. The Pumpfield station, in which the photographs given below were taken, is built on the Leeds and Liverpool Canal; the other station, at Lister Drive, adjoins the London and North-Western Railway. The architecture of the two stations is practically the same, as is also the arrangement of the various departments. This arrangement is shown in Fig. 2, and in section in Fig. 3. These two illustrations were prepared from the actual drawing used for the Lister Drive station, in which the coal is obtained by railway instead of by water. These buildings were designed by Mr. Thomas Shelmerdine, the Liverpool Corporation surveyor, and the buildings were erected by Messrs. Morrison and Sons, of Liverpool. It will be seen that the arrangement of the station is such that the plant is divided up into four sections, each of which can be worked quite independently of the others. Each of these sections contains seven boilers, with an economiser in the main flue which leads to the chimney, and three steam dynamos with their accessories. The size of these steam dynamos is practically 800 kw., so that the ultimate output of each station will be, without spares, 9,600 kw. The engine-rooms in each station are made some 247ft. long and 50ft. wide, while the boiler-rooms at either side of the engine-room are 53ft. wide. The external appearance of these buildings can be seen from Fig. 4, which is the front elevation of the Pumpfield station, while Fig. 5 shows the back elevation of the same works. In this last illustration the arrangement adopted for getting coal into the works can be seen. This consists of an horizontal canvas belt near the canal, which is seen in the foreground, which delivers the fuel on to an inclined conveyor belt, which delivers it into the bunkers over the mechanical stokers. The space between the canal and the station can be used for storing fuel, but the bunkers and coal stores over the boilers hold a very large supply.

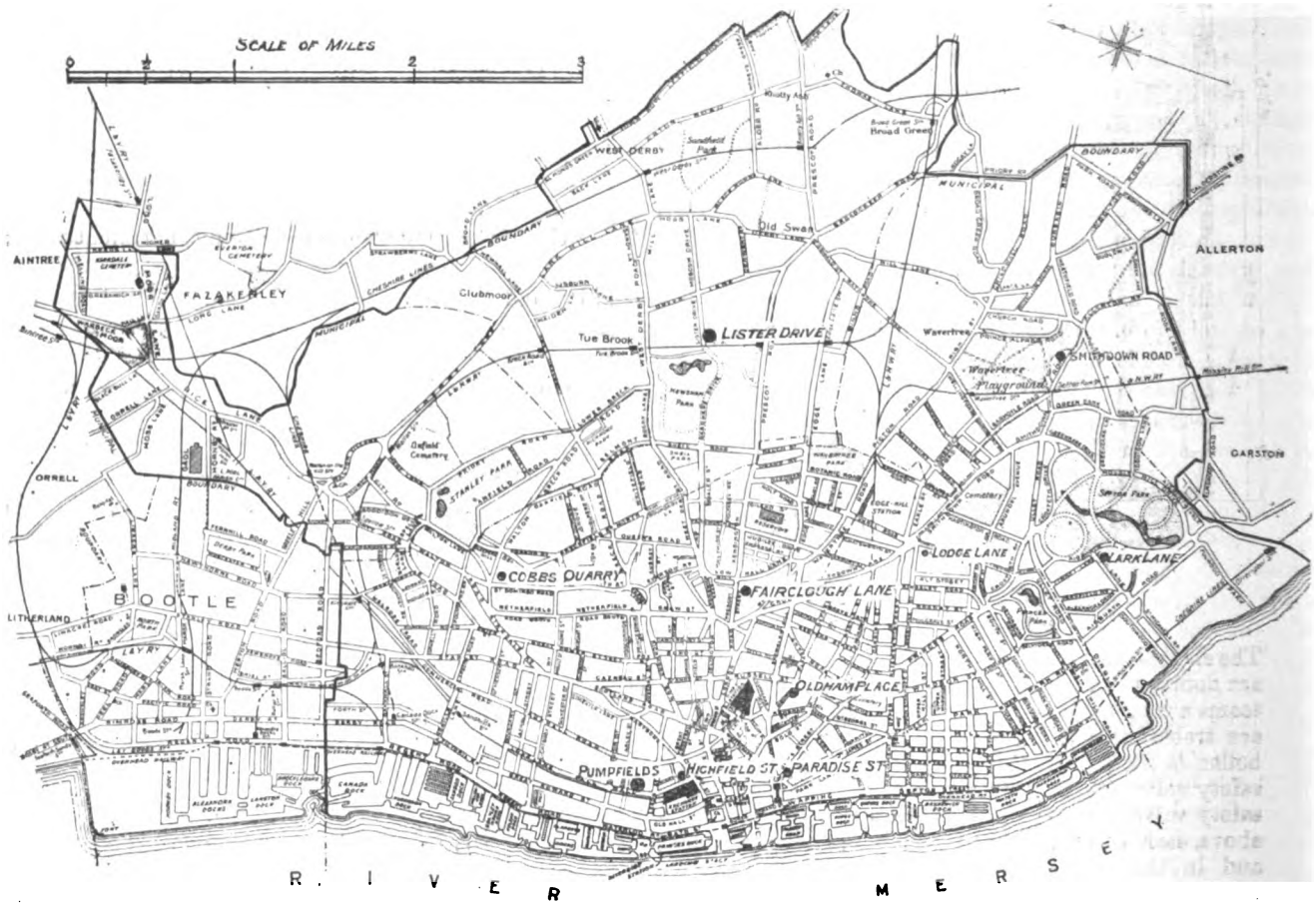


FIG. 1.—Map of Liverpool, showing the positions of the Electric Supply Stations of the Corporation.

Digitized by Google

At the Lister Drive station a railway siding is provided on each side of the works, from which the coal can be delivered into the wrought-iron storage chambers over the mechanical stokers. The arrangement at this station can be seen in Fig. 3. The ashes from the mechanical stokers are also raised by elevators on to a platform, from which they can be delivered either into railway trucks or into carts for removal. The mechanical stokers in use at these works can be seen in Fig. 6. These stokers are of the Vicars type, and it will be noticed that the hoppers are well cased in, so that the stokehole should be easily kept clean and free from dust. The stokers, elevators, and conveyors, as well as the scrapers of the economisers, are driven by motors.

The boilers at the Pumpfield station were supplied by Messrs. Tetlow Bros., of Hollinwood, and at Lister Drive by Messrs. Galloways, Limited, of Manchester. They are of the Lancashire type, 30ft. long and 8ft. diameter, flues 3ft. 2in. diameter, each fitted with five Galloway tubes.

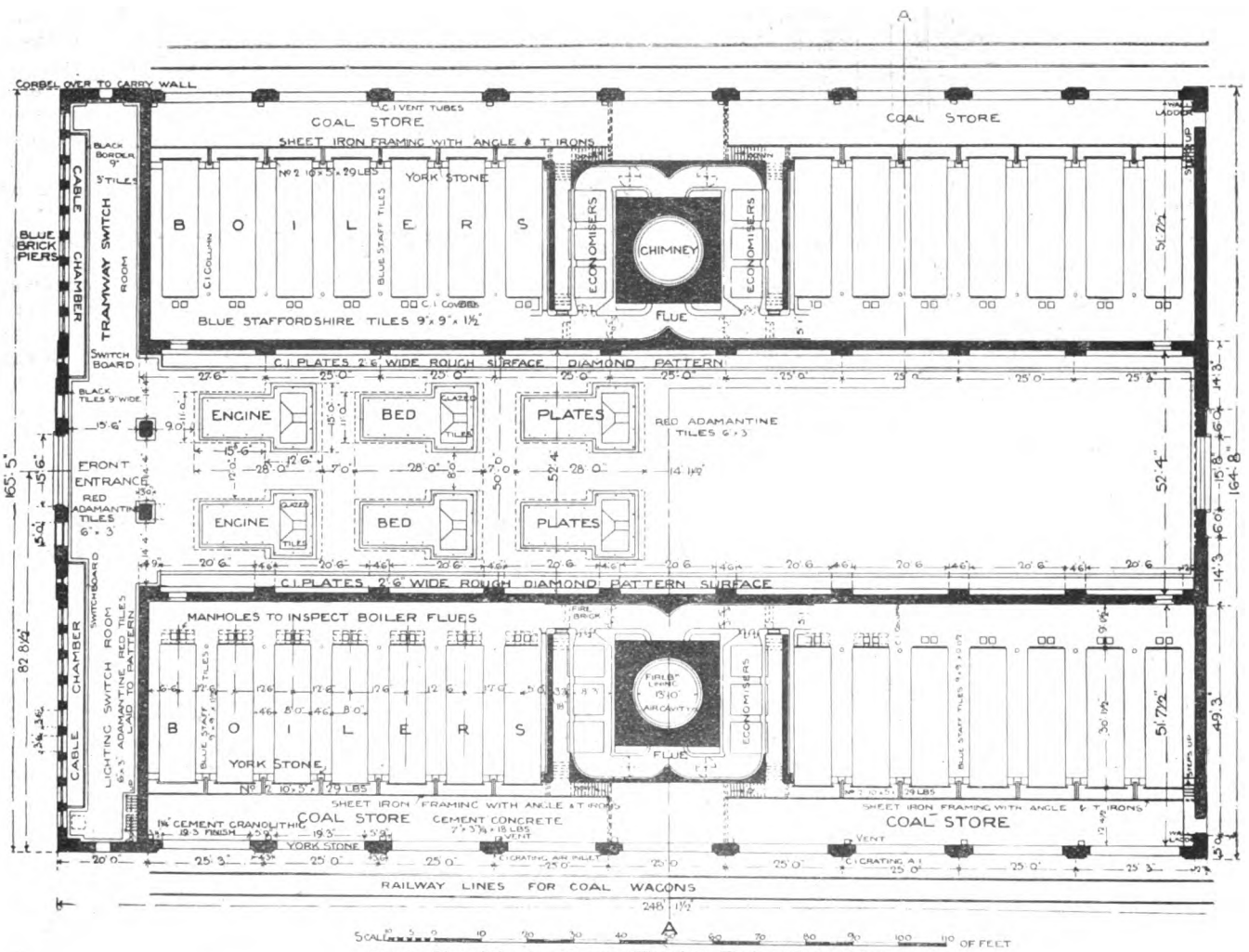


FIG. 2.—Plan of the New Liverpool Electricity Works at Lister Drive.

The shell plates are of steel, ¾in. thick. The circular seams are double riveted with lapped joints, and the longitudinal seams are butt-jointed with straps inside and outside, and are treble riveted. The flue plates are ½in. thick. Each boiler is fitted with 8in. parallel slide steam stop-valve, a safety valve for high steam and low water, and a duplex safety valve, and the other usual fittings. As mentioned above, each section of seven boilers is worked independently, and in the flue from each section is placed a Green's economiser. Each of the boilers is fitted with an injector for injecting the feed water into the boiler, and a duplicate supply is obtained from a vertical direct-acting steam feed pump.

Up to the present the engines used are all of the Willans and Robinson type, designed to run at the speed of 230 revolutions per minute, with an output of 1,200 i.h.p. on continuous load and 1,500 i.h.p. for short periods. The engines are single acting, having three cranks, the crank-shaft being 11in. diameter. The cylinders are 15in., 20½in., and 34⅝in. diameter, and the length of stroke 16⅞in. The bearings are lined with white metal. The engines are fitted with a high-speed sensitive governor and speed regulating gear, and also with automatic expansion gear. The armature of the dynamo forms the flywheel. These engines, with their dynamos attached, can be seen in Fig. 7, which gives a very good idea of the neatness of the station.

The dynamos are of the Siemens multipolar type, having an output of 1,420 amperes at 550 volts. The field magnets are mounted on a steel ring, made in halves and strongly bolted together, carrying 10 steel bolts. The magnets are shunt wound. The armature winding consists of copper bars, individually insulated and securely fixed in slots formed in the armature core, which is built up of best charcoal iron securely fixed to the steel centre of the armature. The commutators being of large diameter, special care has had to be taken in their mechanical construction in order to provide for the great centrifugal force which occurs at the comparatively high speed at which they are run. For this purpose steel enters very largely into the construction. The brush gear is of most substantial design, and is worked by a worm and wheel adjusting arrangement. As is usually the arrangement with such machines, the brushes are of carbon. The leads connecting the alternating sets of brushes are contained in the hollow casting which forms the support for the brush gear.

Both the two stations are working condensing. At the Pumpfields station the Korting ejector condensers are employed, and the condensing water is raised from the canal by Allen's steam-driven centrifugal pumps to overhead tanks. The water flows from the condensers by gravity in pipes along Vauxhall-road to a branch of the canal adjacent to Leeds-street, between which point and the station a large cooling area is provided. At Lister Drive the condensing is effected by a Klein counter-current jet condenser and steam-driven air and circulating pumps. The condensing water is cooled by means of two Klein's patent chimney coolers. The condenser is fitted with an automatic exhaust relief and oil separator.

Digitized by Google

Each station is provided with an accumulator room, with accommodation for four batteries of 240 cells each, each battery being capable of giving a discharge of 200 amperes for one hour, or 80 amperes for four hours. The accumulators are used to equalise the load for the tramway service, and to assist in balancing the load on the two sides of the three-wire supply for the lighting service. Balancers are also provided at each station for equalising the load

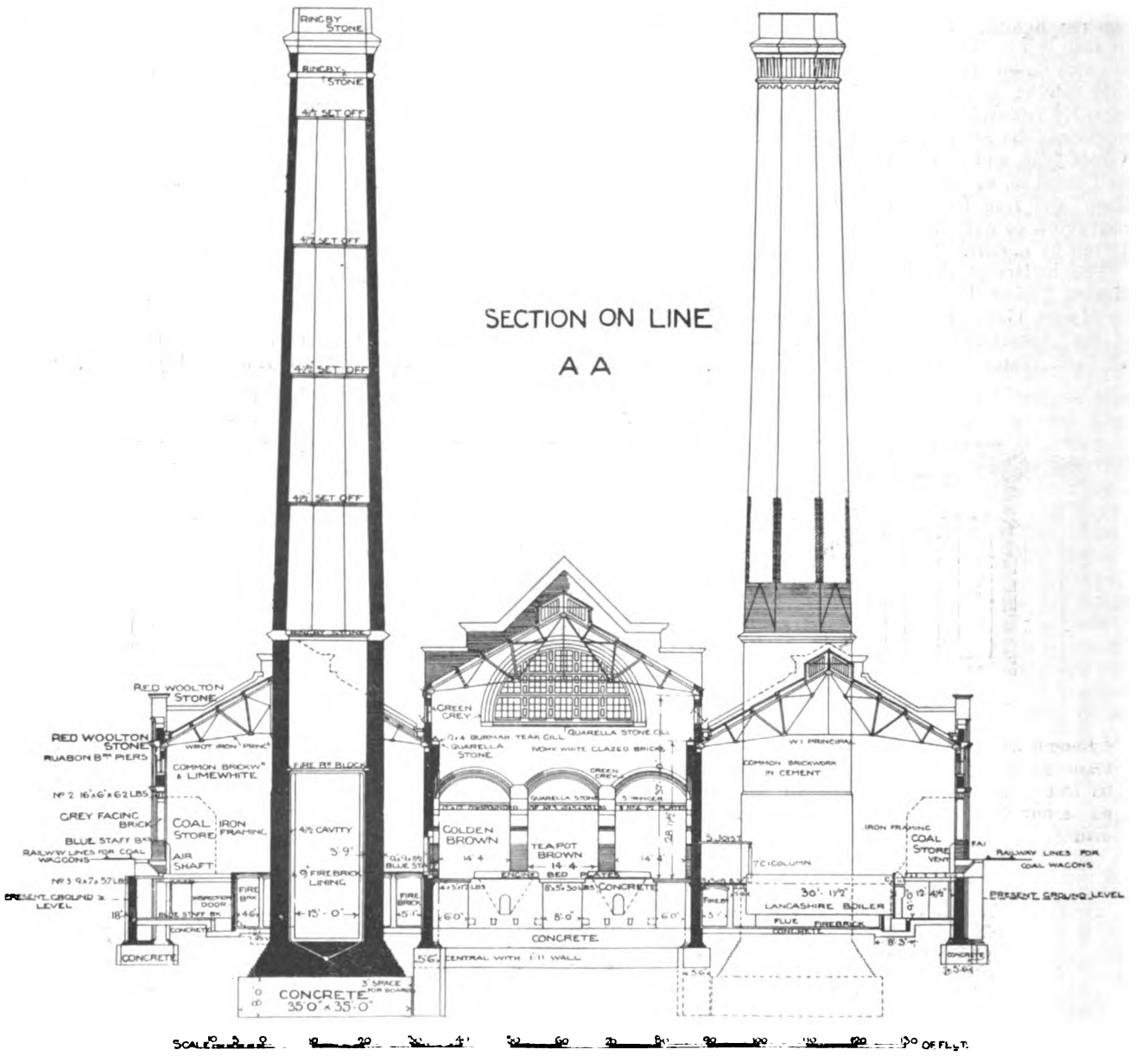


FIG 3.—Sectional Elevation.

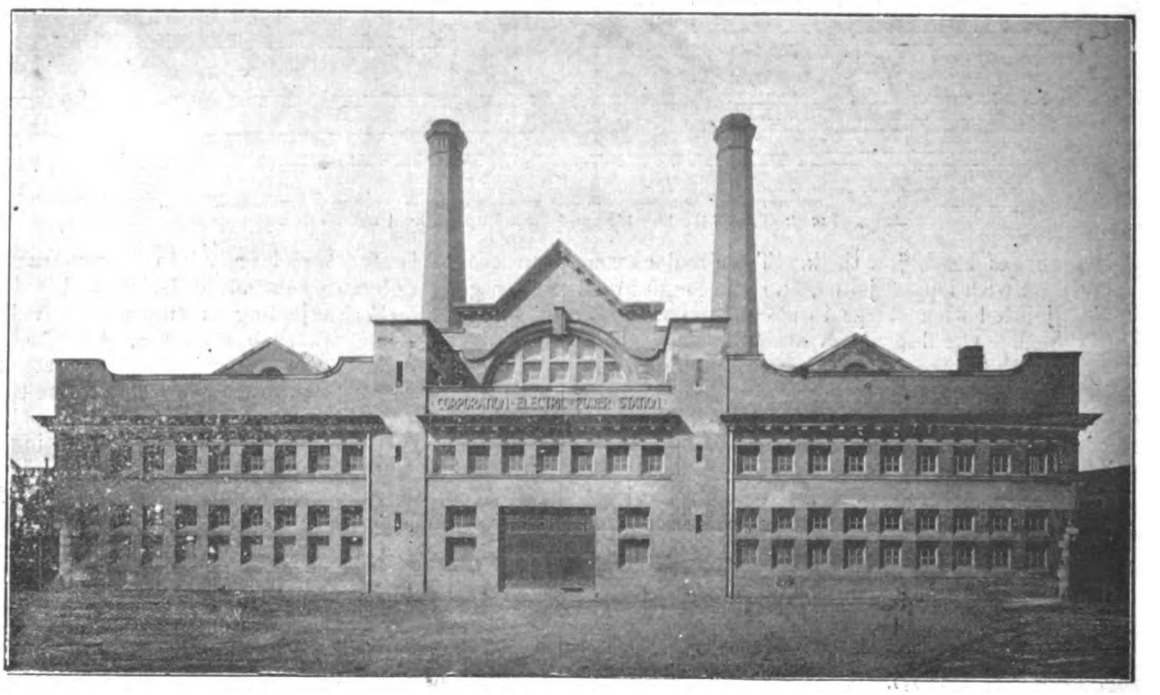


FIG 4.—Front Elevation of Pumpfields Electricity Station of the Corporation of Liverpool.

Digitized by Google

on the three-wire lighting mains, and motor-generators are also provided for the charging of the accumulators.

At each station there are two switchboards (Fig. 8), one for the lighting service and one for the tramways. The dynamos on one side of the station are connected to the tramway switchboard, and on the other side of the station to the lighting switchboard. The two switchboards are so connected that any set of plant may be used either for the lighting or for the tramway service. By this means it is possible to work the plant in the station in such a way that each set may run the same number of hours annually. The distribution of electrical energy for the tramways is at 500 volts pressure, with an earth return, and the distribution for lighting and power is on the three-wire system of 460 volts between the outer conductors, the middle wire being earthed at the station.

The following figures are of interest as showing what an important undertaking the electric lighting of Liverpool now is. Thus at the present time there are the equivalent of 132,000 lamps of 16 c.p. connected to the supply mains of the Corporation, and more than 150 electric cars are in daily service on the tramways. The number of units supplied during the half-year ending June 30, 1900, was: for tramways, 2,197,937; for lighting and power, 2,243,225—total, 4,441,162.

In addition to the two large stations described above, electrical energy is distributed in the central portion of the city from the Oldham-place, Highfield-street, and Paradise-

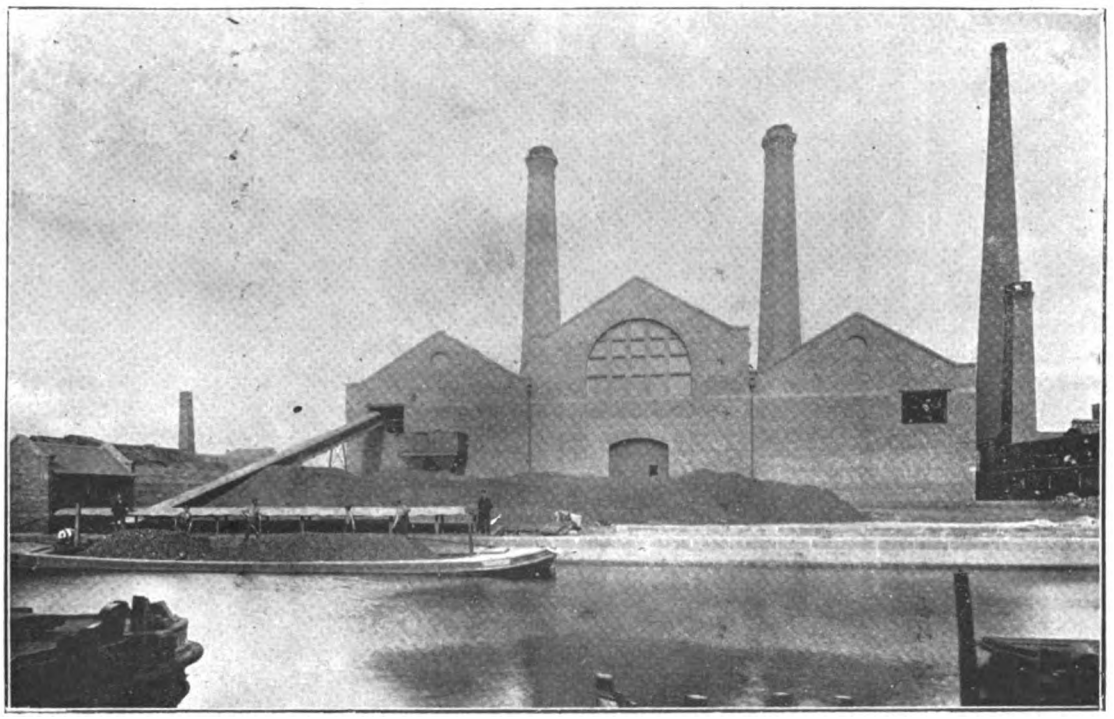


FIG. 5.—Back Elevation of the Station, showing Coal Elevator.

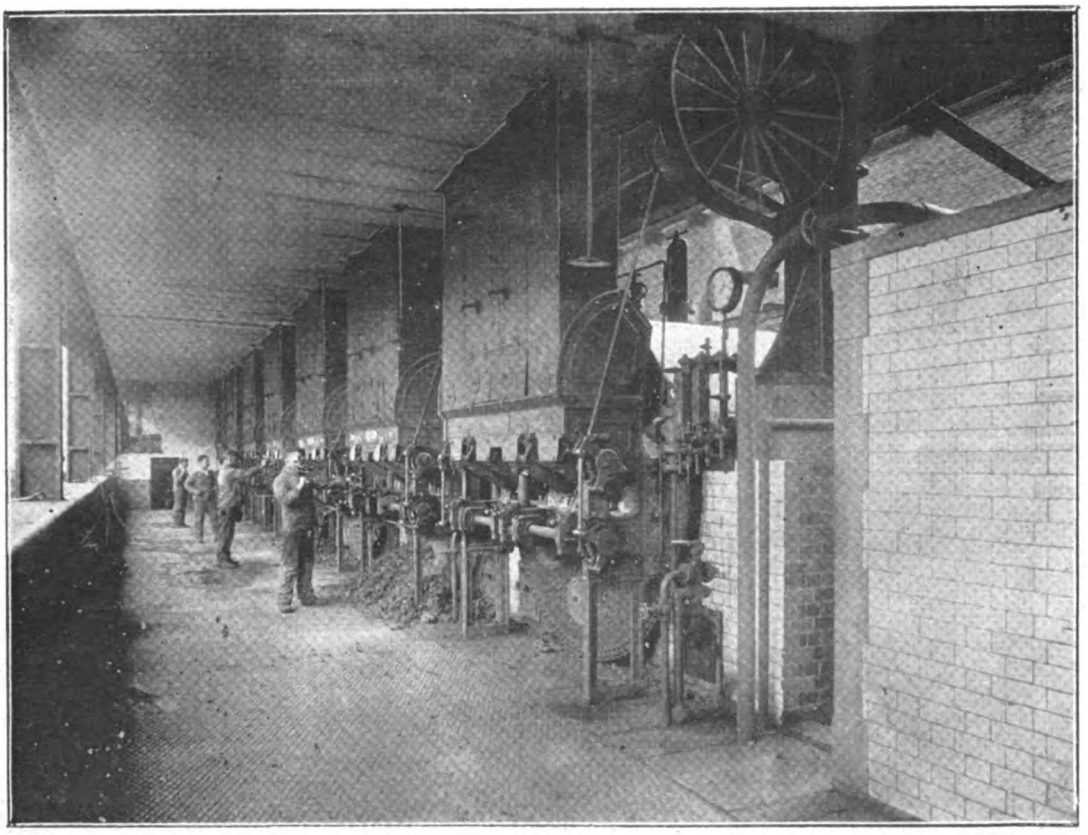


FIG 6.—View of the Boiler-Room, showing Automatic Stokers.

Digitized by Google

street stations, each having a capacity of about 3,000 h.p. Small supplementary plant is in operation at the Smith-

energy have been constructed at Fairclough-lane and Lodge-lane in connection with the new power stations.

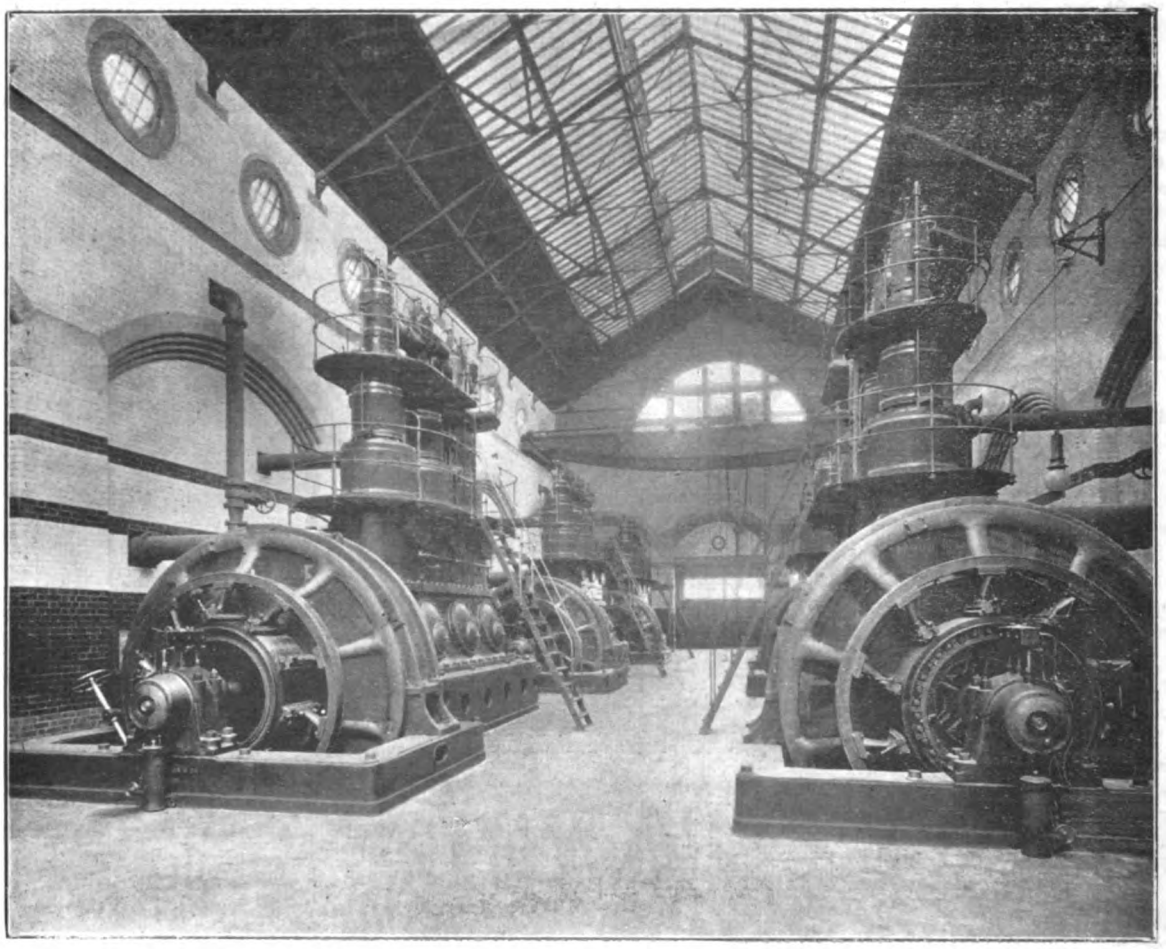


FIG. 7.—View of the Engine-Room.

FIG. 8.—The Switchboards.

down-road and Cobbs Quarry refuse destructors of the Corporation. Sub-stations for the distribution of electrical

The residential district of Sefton Park and Princes Park derives its supply from the Lark-lane station, which, with

Digitized by Google

the three town stations referred to above, were purchased by the Corporation from the Liverpool Electric Supply Company, Limited, in the year 1896.

The revenue of the electricity department of the Corporation of Liverpool last year exceeded £73,000, in spite of the fact that the electric tramways were not nearly completed. This year a higher return, both for lighting and traction, is to be expected. We have to express our thanks to Mr. A. Bromley Holmes for the photographs and drawings from which our description of the new stations were prepared. At the same time, we would congratulate the people of Liverpool on these new works, and on the economical production of electrical energy which will result from Mr. Holmes's careful designs.

THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT.]

(Continued from page 269.)

Another and undoubtedly one of the most useful papers contributed to the proceedings of the Verband at Kiel was that by Mr. Gisbert Kapp, which described an instrument for measuring the tractive effort required for motorcars on electric railways. The following is an abstract of the paper:

In the car to be equipped a tube is mounted parallel to the track, the ends of this tube opening up into vertical limbs. Let us assume the track to be perfectly level and the tube filled with water up to a point marked upon one of the limbs, which we will call the zero point. In order that the level of the water may be observed, this limb consists of a glass tube. If the main tube be inclined, the level of the water will change in proportion to the tangent of the angle of inclination, and we may thus conceive a scale marked upon the vertical glass tube with the zero point as its centre, the divisions of which correspond to the gradients 1 : 1,000, 2 : 1,000, and so on. The spacing of the division marks will depend upon the internal diameters of the vertical limbs and the length of the horizontal tube. Now, assuming the car to be at rest on an incline, the instrument, as described, being so mounted that the tube lies parallel to the track, the water-level will indicate with sufficient accuracy the gravity component in the direction of motion in kilogrammes per tonne of rolling weight, or other unit selected. The reading will not be absolutely correct, because the change in the water-level is proportional to the tangent, while the gravity component is, on the other hand, proportional to the sine of the angle of incline. Even in the case of considerable gradients the error is, however, extremely small. For instance, with a gradient of 5 per cent., the difference between the tangent and sine amounts to $\frac{1}{750}$, or 0·13 per cent., and for the maximum gradients met with in tramway work—that is to say, about 10 per cent.—it is only $\frac{1}{185}$, or 0·54 per cent. of the recorded value. That portion of the tractive force required to overcome the gravity component may therefore be read on the graduated glass tube without difficulty when the car is ascending a uniform gradient at a constant speed.

Now let us consider the case with the car moving upon the level at a variable speed. The accelerating force acting upon the water in the horizontal tube, due to the acceleration of speed, causes a change of the water-level. If l be the length of the horizontal tube, and h the difference in height between the water-levels in the two limbs, then

$$l\frac{p}{g} = h,$$

p representing the acceleration imparted to the car, and g the acceleration of the gravity. As $\frac{p}{g}$ is always smaller than 1, we may put

$$\frac{p}{g} = \sin\beta,$$

where β represents the angle at which the stationary apparatus must be inclined in order to give the same deflection as that resulting from acceleration on the level track. Hence the tractive force required to accelerate the speed of the car may also be read on the scale, so that the water-level at once indicates the total force in kilogrammes per tonne of rolling weight requisite for the gradient and acceleration. The following investigation will serve to show the degree of accuracy with which these data may be obtained. In Fig. 1 let $a\,b$ represent the horizontal tube of the length l, $a\,c$ and $a\,d$ its two vertical limbs, α the angle of inclination of the track, and p the acceleration imparted to the tube parallel to the direction of its length.

Further, let B and F represent the water-levels in the two limbs. Of the total indicated difference of level

$$\mathrm{A\,F} = l\tan(\alpha+\beta),$$

$$\mathrm{A\,C} = l\tan\alpha,$$

represents that part due to the gradient, and

$$\mathrm{C\,F} = \frac{\mathrm{E\,F}}{\cos\alpha},$$

the part due to the acceleration, whence

$$\mathrm{E\,F} = l\sqrt{1+\tan^2(\alpha+\beta)}\,\sin\beta,$$

$$\mathrm{C\,F} = l\sqrt{\frac{1+\tan^2(\alpha+\beta)}{\cos^2\alpha}}\,\sin\beta.$$

Without falling into appreciable error, we may take these root values as our units. The tractive effort indicated

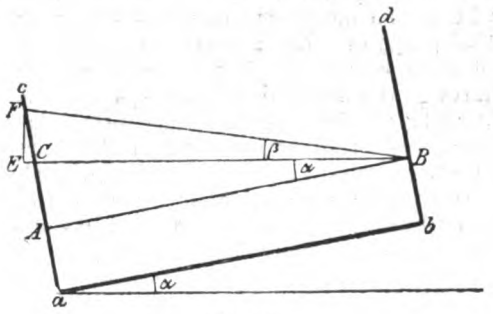


FIG. 1.

on the scale is A F kilogrammes per tonne; the actual value is

$$1{,}000\left(\sin\alpha+\frac{p}{g}\right)\text{ kg. per tonne.}$$

Hence by introducing an error factor into the calculation, which we will denote by $1{,}000f$, we obtain the equation

$$l\tan(\alpha+\beta) = 1{,}000f + 1{,}000\left(\sin\alpha+\frac{p}{g}\right).$$

As the relative dimensions of the instrument exert no influence upon the theory of its limit of error here investigated, we may give l what value we please. If we make the tube 1m. long, the scale divided into millimetre divisions will indicate the tractive effort in kilogrammes per tonne. The above equation now assumes the simpler form:

$$\tan(\alpha+\beta) = f+\sin\alpha+\frac{p}{g};$$

$$\tan(\alpha+\beta) = f+\sin\alpha+\sin\beta.$$

It is at once clear that the error will be the greater, the greater the gradient, and the greater the acceleration. As a mean value for the acceleration, we may take 0·4 for street tramways, while 0·75 may occasionally be reached, though, having regard to the comfort of the passengers, the latter figure would hardly be exceeded under ordinary circumstances. When the brakes are applied, especially if the emergency brake be used, this value may, however, be considerably exceeded. If the instrument is to be employed to determine the tractive effort of the motor, it would be well to take $p = 0{\cdot}75$ as the extreme limit of acceleration. But should it be desired to investigate the effect of the brake, we must assume a maximum retardation of about 1·40 upon the level in order to determine the maximum error.

Digitized by Google

For example, with a 5 per cent. grade and an acceleration of 0·4, we obtain

$$\sin \alpha = 0\,05;$$

$$\sin \beta = \frac{0{\cdot}4}{9\,81};$$

$$\sin \alpha + \sin \beta = {\cdot}0907.$$

Assuming the instrument to be free from error, it would indicate a difference of level amounting to 90 7mm. In reality, it shows a difference of 1,000 tan $(\alpha + \beta)$, which, calculated on the basis of the above assumed values, gives us about 91mm. The instrument, therefore, indicates about 0·3mm.—that is to say, one-third per cent. too much. In a similar manner we may determine the errors corresponding to other conditions of working, and so obtain the following table for starting up and braking the car:

TABLE OF THE LIMITS OF ERROR WHEN STARTING.

Profile of track.	Level.			Approximate rise.			Approximate fall.	
	—	—	...	5 %	10 %	...	5 %	10 %
Acceleration.....	0 4	0·75	...	0·75	0 4	...	0 75	0·4
Percentage of error..	0·00	0 29	...	0·60	0·82	..	0 23	0 38

TABLE OF THE LIMITS OF ERROR WHEN BRAKING.

Profile of track.	Level.			Approximate rise.			Approximate fall.	
	—	—	..	5 %	10 %	..	5 %	10 %
Retardation	0·75	1·4	...	0·75	1 4	...	0·75	0·4
Percentage of error...	0·29	1·03	..	0·23	0 80	...	0·60	0·8

In each case the error is either smaller or of the same magnitude as the personal error in reading such instruments, whence the instrument may be taken as correct for all practical purposes. But another and, indeed, a greater source of error consists in that in ascending a rise and when starting, the forward car springs are somewhat relieved, while the load on the rear springs is proportionately increased, the reverse order of things being the case when the car is on the descent or upon applying the brakes. In consequence of this circumstance, the tube is not supported parallel to the track, but given a slight inclination towards the same. The tilting effect is aggravated by a small wheel base, and also by an increase in the height of the centre of gravity of the car above the supporting points of the springs; further the uneven distribution of the load may produce such a tilt. These constitute sources of error which cannot be generally determined, but must be individually treated. After approximate calculations, I have come to the conclusion that these errors may amount to some per cents. of the value registered.

The instrument indicates directly only that amount of force required for the grades and for acceleration, and not the balance of power required to overcome the frictional resistance. In order to determine this balance, we first get the car up to speed, and then switch off the current and let it run over a level stretch of track, taking at the same time the reading of the water-level. This gives directly the retarding forces exerted by the lines, gearing, and motor friction. In order to eliminate the influence of a possible slight rise or fall in the track it is advisable to let the car run thus freely in both directions, always taking care to observe the water-level reading at the same spot. The mean of the readings is the so-called traction coefficient expressed in kilogrammes per tonne of the rolling weight. When this coefficient has been determined, it is necessary only to shift the scale of the instrument a corresponding amount in order to be able at once to read the total tractive force.

The form of instrument just described is eminently adapted for mounting permanently in a motorcar, and the tube, *a b*, may be as long as the body of the car permits, the vertical glass limb being placed in any convenient position on the end wall of the car. This vertical limb may also be provided with a float arranged in connection with an automatic recording instrument, whereby a permanent record of the tractive force may be kept. As in the case of the ordinary type of recording instrument, the paper band is carried by a drum, which by means of a ratchet and electromagnet is turned through a certain predetermined distance at every complete revolution of one of the driving wheels. In this manner a curve of the tractive force as a function of the track is obtained. The area of this curve represents the work done per ton of rolling weight. Instead of a glass water-gauge, a correspondingly graduated manometer may be employed to indicate the pressure. However, an instrument constructed as described, on account of the great length of the tube, *a b*, is not portable. In order to obtain a portable instrument I have resorted to the use of two fluids—namely, quicksilver, which serves to produce the difference of pressure in the point, *a b*, and water, to indicate this difference of pressure. A diagram of the instrument is shown in Fig. 2, where A and B are two cups of 40mm. diameter each, *l* the connecting tube of such length that the vertical centres of the cups are distant from each other 50cm., and *d* the water-gauge glass of 5mm. internal diameter. With these ratios the deflection corresponding to a gradient of ·1 per cent. is 4·7mm., and since we can read correctly to within 2mm. the determination of the tractive force with an accuracy within about 0 5 kg. per tonne of the rolling weight is possible. By lengthening the tube, *a b*, greater accuracy might be obtained, but at the cost of making the instrument too unwieldy. Moreover, it is quite unnecessary to strive for a greater degree of accuracy, since in the first place this is not required for practical purposes, and in the second it would be illusive owing to the sources of error occasioned by the tilting of the car.

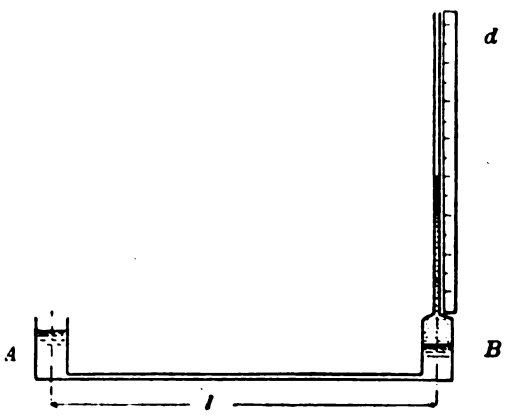


FIG. 2.

A much more convenient form of portable instrument could be constructed by substituting a coiled glass tube for the gauge glass. Since the gauge glass indicates only an angle of inclination, the same function might be performed also by means of the compression of the air in a uniformly bent tube. But although I have had constructed a half-dozen such tubes, I have not succeeded in obtaining with any one of them nearly the same accuracy of that given by the form shown in Fig. 2. This instrument has been subjected to tests both on one of the Berlin tramways and on the express railway owned by Messrs. Siemens and Halske in Lichterfelde. The damping obtained with the narrow tube, *l* (3mm. internal diameter), proved reliable for starting up and ordinary braking, but too great when it was a question of investigating the effects of the emergency brake. It is, therefore, advisable to give the tube a larger internal diameter, and to provide for adjustable damping by means of a throttle valve.

For the ordinary type of tramcar the instrument gave a traction coefficient of 12 kg. per tonne, which increased to 20 kg. round a moderately sharp curve. Upon the express railway the instrument was mounted in a car destined for the Berlin elevated railway, and indicated accelerating forces up to 75 kg. per tonne. Since the truck of the car is equipped with two bogies, and the centre of gravity lies somewhat low, a considerable tilting is avoided, and an error, therefore, scarcely to be expected. The free running trials to determine friction were made over a stretch of track having a gradient of ·3 per cent. During six journeys out and return (12 readings), with speeds of 13 5 km. to 30 7 km. per hour, the traction coefficient varied between the narrow limits, 8 kg. and 8·1 kg. per tonne. The weather was calm, whence it appears that air resistance has no appreciable influence for speeds up to 30 km. per hour. The increase of the coefficient produced by a curve of 200m. radius amounted to 1·5 kg. It remains to be added

Digitized by Google

that the car was quite new, not having been previously run, and after the trials it was discovered that a brake block had got heated, which would account for the somewhat high coefficient of 8 kg.

Contrary to what might, perhaps, have been anticipated, no discussion was evoked by this paper, though appreciation was evident.

(To be concluded.)

HIGH-SPEED RECIPROCATING ENGINES.*

BY ALLAN COATS, B.SC.

(Concluded from page 526.)

I do not suppose that the water in Messrs. Reavell's jacket is so great as this, but both Messrs. Willans and Mr. Raworth agree that steam-jackets are no use in high-speed engines. Another curious thing about these figures (Table A, Fig. 9) is that the combined efficiency rises as the engine is worked condensing. For instance, when the engine was working non-condensing and giving 47·8 h.p., the combined efficiency was 71 per cent.; while when working condensing and giving 43·6 h.p., so that the efficiency ought to have been (if anything) lower, the figure given is 77·8 per cent., or considerably higher.

TABLE A (Fig. 9).—Record of the Reavell Engine Test by Mr. Henry W. Gill.

Test No.	Steam press.	Vac.	Speed.	Output — Amps.	Volts.	KW.	Diagrams M.E.P. — L.P.	H.P.	I.H.P.	Steam per hour — Total.	Per I.H.P.	Per KW.	Combined efficiency.
I	160	—	408	440	110	48·4	35 1	33 9	84·2	1,613	19·16	33	77·2
II	160	—	410	330	110	36·3	21·4	28·5	61 3	1,230	20·1	33 9	79·4
III	160	—	412	220	110	24·2	13 5	21·3	43	924	21·5	38·2	75·5
IV	160	—	412	110	110	12·1	7 9	14·1	27·2	658	24 2	54 4	59·7
VI	157	26·75	412	520	110 5	57·5	42·0	34·75	94·35	1,587	16·82	27·6	81·8
VII	157	26·75	412	440	110	48 4	32·5	30·18	78·3	1,300	16 6	26·9	83 0
VIII	155	26 75	412	330	110	36·3	24 06	23 31	58·3	1,008	17 3	27·7	83·5
IX	159	25 5	412	220	110	24·2	18 81	15 81	42 6	735	17·25	30·4	76·1

The official test (non-condensing) was made in the presence of Mr. Oughterson. The engine was No. 30, and was tested on Jan. 26 and 29 last.

Governor Trial.

Load	0	¼	½	¾	Full.
Speed	414	412	410	408	408

Highest speed reached with full load thrown off, 420 revolutions.

The only case where combined efficiency can alter is when the load or speed is altered. The speeds in the trials do not vary at all, which, I think, can hardly be the case. The governor, however, is a very good one, although rather complicated: from full load to no load, giving 1·4 per cent. total variation, while the momentary variation gives 3·4 per cent. total variation. It governs on the principle of cutting off first and then throttling, from which the most economical results might be expected. This governor is, I think, the only throttling one which uses the effect of inertia as well as centrifugal force. The valve is kept single-acting by the pressure of the steam, and becomes double-acting at light loads.

Fig. 1 shows a new engine which I have designed and which was made by Messrs. A. F. Craig and Co., Paisley. Fig 10 gives the combined indicator diagram and Fig. 11 the various steam and inertia curves. Fig. 12 = turning moment at 567 revolutions.

The principal objection to single-acting engines is that they have a large cylinder volume per horse-power. This engine occupies a mid-position between ordinary single-acting and double-acting. For if we take the four spaces into which a tandem cycle engine is divided—*i.e.*, one above and one below each piston—three of them are used to expand steam in as against four in a double-acting and two in an ordinary single-acting compound. I do not say that this constitutes triple expansion, for the high-pressure shares the fall of temperature in the low-pressure, but the high-pressure does not reach the temperature of the low-pressure until the end of the return stroke, and not at the beginning, as most compounds do. There are other compound engines, like the Willans and Alley and McLellan, which divide the fall of temperature into three or even four stages, but their intermediate differences are very small—only 10lb. in the Willans compound as against 45lb. in this one. This engine has straight ports, which bell considerably at the mouth.

Turning to Fig. 1, steam is admitted to the underside of the high-pressure piston, and at ·6 of the stroke it is cut off and expanded. At the end of the up stroke, the high-pressure valve opens and places the underside of the high-pressure piston in communication with the upper side of the low-pressure. This valve remains open during the whole of the down stroke, so that steam in passing from the underside of the high-pressure to the top of the low-pressure is expanded again. On the following up stroke fresh steam is, of course, admitted to the underside of the high-pressure, while the low-pressure valve allows steam to pass from the top to the bottom of the low-pressure piston. At ·6 of the stroke the low-pressure valve is cut off, and the steam on the top side of the low-pressure piston is compressed, while that on the underside is expanded. The volume of the clearance on the top of the low-pressure piston is so arranged that at the end of the up stroke steam has been compressed up to the exhaust pressure from the high-pressure cylinder. On the second down stroke the steam is exhausted from the underside of the low-pressure piston, as usual. The top side of the high-pressure piston and the space between the high-pressure cylinder and valve chest is used as a steam

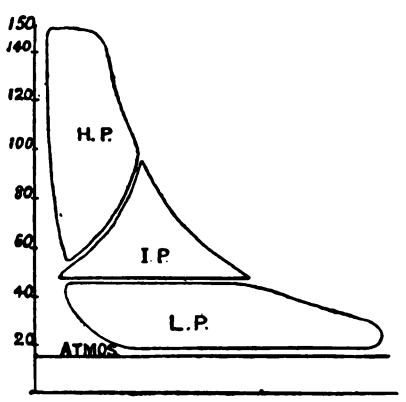


FIG. 10.

buffer. The supply of steam to this buffer is regulated by a small non-return reducing valve connected up to boiler steam. By regulating this valve, any pressure up to boiler pressure may be obtained at the bottom of the stroke in the buffer, and as it is a non-return valve, the pressure at top of stroke is regulated by the ratio of buffer volumes at top and bottom of the stroke. In this engine the pressure at the top of the stroke is rather more than twice that at the bottom, and at the bottom the pressure in the buffer is always reduced to less than the boiler pressure, the pressures above and below the high-pressure piston being equal at about half-stroke. The cylinders are completely and easily drained, owing to the valves being at the bottom of each cylinder, and the condensed water from the high-pressure does not go to the top of the low-pressure at all, but is thrown past the opening and is drained away from the recess above the low-pressure valve. Near the bottom of the low-pressure cylinder small grooves are cut in the sides, so that any water which may collect above the low-pressure piston may drain to the underside at the bottom of the stroke. A small right-angled stop-valve is placed at B (not shown in figure), and connected up to steam on the boiler side of the main stop-valve. This valve serves several purposes. In the first place, the engine is started by means of it, as it starts it slowly and allows plenty of time for the engine to heat up and water to drain away. Secondly, even if the water does not drain away completely, the valve being open acts as a relief cock. Of course, when the engine has got up some speed, the main valve is opened and this one shut. Thirdly, if the engine should ever be pushed for some extra power, this valve allows some steam to the high-pressure cylinder during the

* Paper read before Glasgow Technical College Scientific Society.

Digitized by Google

whole of the up stroke, and also to the top of the low-pressure cylinder during the down stroke, but is shut off by the piston valve from communicating with the bottom of the low-pressure cylinder on the up stroke.

This engine works single-acting at all speeds up to a very high maximum, and at all loads without an air buffer. The air-buffer engine soon reaches a maximum speed, beyond which it is impossible to go without increasing the dimensions of the buffer. Owing to the peculiar distribution of steam in this engine, and also to the fact that the buffer may have a pressure more than twice the boiler pressure, if desired, very high speeds can be obtained. At A a small relief valve is placed: this prevents the buffer pressure becoming too high. Water collecting in this space, of course, reduces the volume of the buffer, and raises the pressure until it becomes great enough to open the relief cock, when the water is blown out. It is not very easy at first sight to see why this engine should be single-acting, as the valves are both at the bottom of the stroke, where, of course, the steam pressure is upward. A little consideration will, however, soon show why the resultant pressure should be always downward. will be seen that at 800 revolutions a pressure of 300lb. per square inch on the high-pressure piston would be required merely to neutralise the inertia forces—*i.e.*, without producing any pressure on the crank-pin at all; at 567 the inertia forces correspond to 150lb. per square inch. These inertia curves gradually approach, and between ordinates 5 and 6 cross the horizontal line, and from thence to the end of the down stroke (ordinate 10) exert a considerable downward pressure on the crank-pin. At the beginning of the up stroke (ordinate 10) the curves, being above the horizontal line, indicate 100lb. and 200lb. downward pressure for 567 and 800 revolutions respectively. They again approach the horizontal line, and between ordinates Nos. 15 and 16 cross, and from there to the end of the up stroke indicate a considerable upward pressure. To counteract this inertia curve and produce an even downward pressure on the cross-head pin, very high pressures are required at the beginning of the down stroke. These pressures ought to form a curve which would be the inverse of the inertia curve. To do this with an ordinary steam distribution, admitting steam to, say, half-stroke, would be impossible. The curve given by

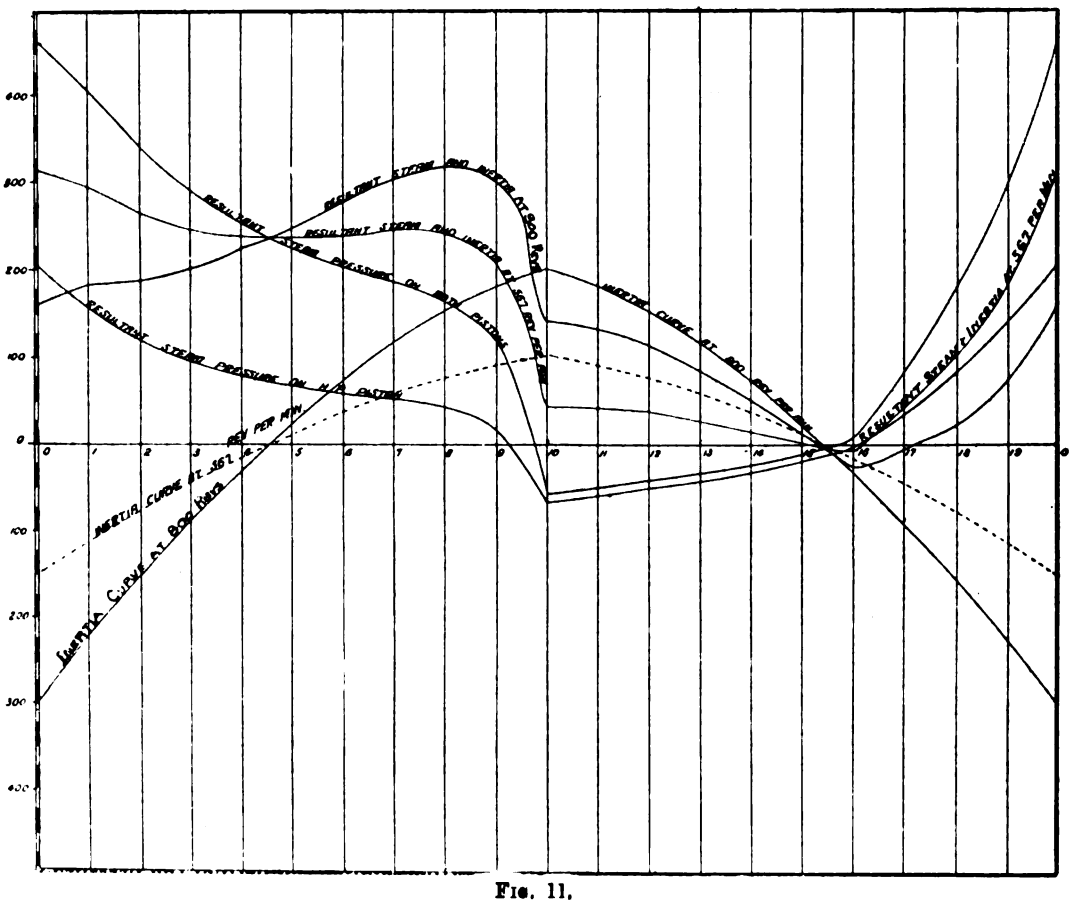


Fig. 11.

In order to assist you, might I, in the first place, rapidly run over the principal effects of inertia in the reciprocating parts with which we have to contend. Beginning at the top of the down stroke, very considerable pressures are required to start the piston, etc., on its downward journey. In this engine 300lb. per square inch would be required on the high-pressure piston if the engine were running at 800 revolutions, supposing no steam were acting on the low-pressure piston. As the piston travels down, these forces rapidly diminish, and about half-stroke vanish. During the second half of the stroke the inertia forces help the steam to propel the engine. On the up stroke the same effects take place, power being required at the beginning of the stroke to accelerate the parts. These inertia effects are shown in Fig. 11 for 800 and 567 revolutions. In this diagram all the ordinates above the horizontal central line correspond to pressures downwards, and *vice versâ*, and all pressures are plotted out in pounds per square inch of the high-pressure piston. These effects are traced during one complete revolution, beginning on the left-hand side at the top of the down stroke, while the beginning of the up stroke is at ordinate No. 10. From these curves it a steam cushion, however, almost exactly fulfils the requirements. In this engine both the high-pressure and low-pressure are under the influence of such a buffer, the high-pressure because of the steam buffer; the low-pressure because the volume of the high-pressure cylinder and the clearance on top of the low-pressure is expanded regularly without the admission of any fresh steam during the whole of the down stroke. The resultant steam

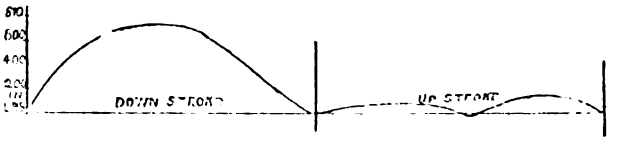


Fig. 12.

pressure on both pistons (the low-pressure referred to the high-pressure) is shown in Fig. 12, starting on the left of the diagram at about 475lb., and falling evenly till ·9 of the stroke, when the admission of fresh steam to the underside of the high-pressure and the equalising of steam on both sides of low-pressure piston causes it to drop suddenly,

Digitized by Google

till as the engine passes its bottom centre the balance of pressures on the pistons is upward. This upward pressure at the beginning of the up stroke is not great enough to lift the reciprocating parts off the crank-pin, and thus cause knock, but merely relieves the pressures on the crank-pin, etc. Between ordinates 15 and 16 the buffer pressure on the top of the high-pressure piston is equal to the steam pressure below, and at the same time the cut-off takes place in both cylinders, the result being that the difference of pressure on both sides of each piston increases very rapidly, and the curve shoots up till the end of the stroke. If, now, the inertia curve and the curve of resultant steam pressure on both pistons be combined, a curve showing the net effect on the crank-pin is obtained. This curve rises towards the end of the down stroke at 800 revolutions, but at 567 revolutions the curve is almost perfect, keeping nearly horizontal during the down stroke, almost relieving the bearings during ·9 of the up stroke, and suddenly rising at the end so as to have a useful pressure to begin the down stroke. Unlike other engines which rely on steam cushioning, this engine is single-acting from no load up to full load, for as the steam pressures fall under the high-pressure piston, the buffer pressures remaining constant become more effective, and at no load take up all the cushioning. Governing is effected by an inner rotating sleeve in the high-pressure valve, throttling the steam immediately on its entry into the cylinder. As there is no valve chest or receiver beyond the control of the throttle valve, the governing is very sensitive.

I arranged with Prof. Barr, of Glasgow University, to test the engine. Unfortunately, he was ill with influenza at the time, so I determined to test it myself, all data being taken by independent observers. We had a condenser at atmospheric pressure, and all steam was weighed by means of a pair of beam scales. The brake was an ordinary rope brake, but in order to prevent it getting too hot, water was kept running on it. Indicator cards were taken by a McInnes indicator, and no allowance was made for the fact that the cylinders were not lagged, and that the high-pressure valve was leaking more than 50lb. per hour with engine standing. Of course, this was not all loss, but was an uneconomical way of using the steam. On account of the excessively small fly-wheel, we were unable to get the full power out of it, so I am compelled to take the mean pressure referred to the low-pressure piston, and compare the results with Willans at the same mean pressure. The result was that at 32·5lb. mean pressure 21·9lb. of steam were used, and Willans at 33lb. (slightly more economical) used 22·8lb., or a difference of ·9lb. in favour of this engine. This same engine of Willans at full power—*i.e.*, 46lb. mean pressure and 158·5 boiler pressure—used only 19·19lb. per indicated horse-power. Had we been able to get full power from this engine, the steam consumption might reasonably be expected not to exceed 18·5lb. per indicated horse-power non-condensing, and at 150lb. pressure. The mechanical efficiency was very high, being 92 per cent., partly due to special pains which were taken to secure good lubrication, to the use of almost frictionless packings, and to the favourable conditions of bearing pressure on the up stroke. Unfortunately, a crack developed under the flange of the low-pressure cylinder, which prevented any further trials until a new cylinder could be made, when we hope to obtain the full power results.

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

INTRODUCTORY.

The title adopted for these notes has been suggested by Prof. Tilden's "Chemical Philosophy," a work which deals not so much with the actual reactions which occur, but rather with the principles underlying all chemical work, and which must be fulfilled in every successful experiment, So, in the present instance, the writer has no intention of adding to the numerous works which treat of the actual designing of dynamo-electric machinery, but, confining himself to the case of continuous-current machines, his intention is to lay more fully before the student some of the various points which must be constantly borne in mind by the successful designer.

The ground to be covered will therefore not include the actual dimensions required of armature, conductors, magnets, commutator, or shaft, as these are essentially only details, not principles. In all branches of scientific work the main or first principles upon which the particular branch under consideration rests will be generally found to be not only few in number, but also very easily to be understood, although the true reason of why a principle exists—such as, for instance, why a current should flow through a wire cutting lines of force—may be so hidden as to have been beyond solving up to the present: so in dealing with dynamo design the main principles are three in number only, and are as follows:

The first, due to Oersted, the Danish philosopher, and discovered in 1819, is that the passage of an electric current along a wire creates an external magnetic field. From this discovery has been derived the additional discoveries that if a wire be wound in the form of a helix or solenoid, this solenoid will behave like a magnet, and that if the wire be wound round a core of soft iron or steel, the strength of the magnet will be enormously increased. The north and south poles of this solenoid will depend upon whether the coil is wound right-handedly or left-handedly, and according to which end of the coil the current enters. A simple method of determining which is the north pole is that

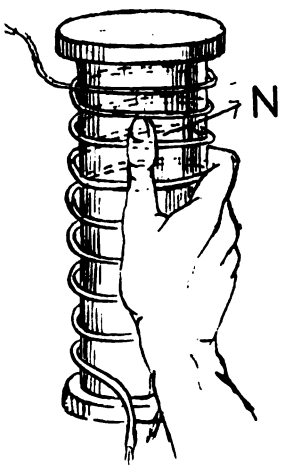


FIG. 1.

shown in Fig. 1. Place your hand on the coil with the thumb at right angles to the palm, and with the fingers pointing in the direction of the flow of the current through the coil; then the thumb will point towards the north pole. This great principle is the foundation of all electro-magnetism, and is of the utmost importance for a right understanding of many of the complex problems which arise in the course of dynamo design.

The second principle, due to Faraday and discovered in 1831, is often stated to be that if lines of magnetic force be cut by a closed coil or wire, a current will be generated in that coil. These lines may be cut either by moving the coil across the lines or moving the lines across a stationary coil. Vast as is the importance of the above principle in dynamo design—and it is on this principle that all modern machines are built—yet in the study of the philosophy of dynamo design the result which he derived from his first experiment is of equal value. From this experiment he found that a current is induced in a coil of wire if currents be started or stopped in neighbouring coils. The importance of this will be seen later when treating of the self-induction of the armature and its effect upon commutation. From this it was an easy step to the proof that a current is induced in a coil cutting lines of force, and that the value of the E.M.F. of this current will depend upon the number of lines cut in unit time. The assertion that the value of Faraday's first experiment is of equal importance to the latter part of this second great principle in the study of the philosophy of dynamo design must be taken in the spirit in which it is made—namely, that since all present-day machines are built upon this

Digitized by Google

principle of generating an E.M.F. by means of cutting lines of force, this principle (derived from his subsequent experiments) has become almost an axiom, and is so well known to every electrician as to almost entirely overpower the first experiment from which it was derived, so that this first experiment is not only lost sight of, but the relation of the two is constantly forgotten, and when the study of armature reactions is commenced the relationship of the two has to be relearned, and is often considered by many as a new property, and the connection between the two parts of the one principle is only acquired laboriously and with difficulty. When a wire cuts lines of force so as to induce a current, the direction of the flow of the current may be easily found by holding the right hand as in Fig. 2, with the thumb and first two fingers all at right angles to each other. Then, if the thuMb is pointed in the direction of the Motion, and the FORE-finger in the direction of the lines of FORCE, the seCond finger will give the direction of the Current.

The third principle is that the current which flows through a wire varies directly as the E.M.F. and inversely as the resistance. The importance of this principle, commonly known as Ohm's law, from its discoverer, cannot be overestimated, and, as will be seen from the section on commutation, its due appreciation, especially when the resistance is very low, is of the utmost value. This law is very often written $C = \frac{E}{R}$, but the student should also know it equally as well as $E = C\,R$ and as $R = \frac{E}{C}$.

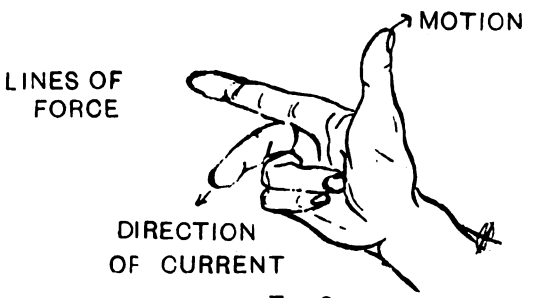


FIG. 2.

The above are the three fundamental principles, without a knowledge of which a discussion of the behaviour of a dynamo would be useless. There are, however, some secondary principles, which, while not of the same great importance, have such a value that the designer should constantly bear them in mind. The first of these is the fact that the pole of a magnet will induce opposite polarity in the end of a piece of iron or steel held near to it, to which is akin the fact that like polarities in magnets repel and opposite polarities attract each other. Another secondary principle is that known as Lenz's law, and is to the effect that the action of self-induction is such as to oppose the starting of any current along a wire and to maintain a current which is stopping. This action is very similar to that of inertia in mechanical work, where, for instance, the mass of a flywheel has a tendency to oppose the wheel being set in motion. The wheel, however, once revolving, the momentum of it will oppose the stopping, even to the extent of causing it to make many revolutions even after the motive force has been removed. Although the effect is exactly similar, it must be very clearly borne in mind that the cause is distinctly different. The dimensions of inertia are $M\,L\,T^{-1}$, while the dimensions of current are $M^{\frac{1}{2}}\,L^{\frac{1}{2}}\,T^{-1}$. Prof. Tait, in his "Properties of Matter," defines inertia as "passivity or dogged perseverance," and adds, "matter is, as it were, the plaything of force, submitting to any change of state that may be imposed on it, but rigorously persevering in the state in which it is left until force again acts on it." The tendency of self-induction to oppose a starting current and maintain a stopping current is of a different nature, and the distinction is of great importance. From our first primary principle we learn that the passage of a current along a wire creates an external magnetic field, and the lines of this field cut the wire while the field is being formed; from our second primary principle, we learn that when a wire cuts lines of force, a current is generated or induced in the wire. Now, the current induced by the wire cutting the lines of force due to its own external field is in the opposite direction to a starting current, and so prevents its instantaneously attaining its full value, while the current induced by the collapsing lines of force of the external field when a current is broken is in the same direction as the original current, and so tends to maintain the current for an appreciable length of time. The effects of this action will have to be be dealt with more fully when dealing with the question of commutation.

Another point which must be always kept in sight, is that if the current has two or more parallel paths along which it can flow, it will flow along each of these paths in inverse proportion to their resistance. This is evident from Ohm's law, for if we have an E.M.F. equal to E, and three paths whose resistances are respectively R′, R″, R‴, the currents which will flow along these various paths are

$$C' = \frac{E}{R'}; \quad C'' = \frac{E}{R''}; \quad C'' = \frac{E}{R'''};$$

and $$C = C' + C'' + C'' = \frac{E}{R'} + \frac{E}{R''} + \frac{E}{R'''}$$

$$= \frac{E\,(R'\,R'' + R'\,R''' + R''\,R''')}{R'\,R''\,R'''} = \frac{E}{R}.$$

The writer makes no apology for dwelling thus fully upon these first principles and elementary laws; he is quite aware that they form the groundwork of the theoretical and practical training of every electrician; but while admitting that almost every electrician could repeat the various laws, etc., and even demonstrate their truth in practice, yet when it comes to a complex problem, such as the solution of a peculiarity in the behaviour of a given machine, he has too often found that all laws and all principles are thrown to the winds. Suppose, for example, a machine sparks badly with its normal load, owing to faulty design; how often in place of going over the design step by step, and reasoning the matter out from first principles, is the procedure one of "we will try this: it cured such-and-such a machine"?—a machine which probably was designed to work under vastly different conditions. And when this haphazard guess chances to remedy the evil, the designer considers himself a heaven-sent electrician; when it fails, an equally well-thought-out alteration is suggested, and so on, until finally the machine is thrown on the scrap heap, or an expert who does not despise first principles is called in, and by quiet reasoning finds the error which has been made.

A dynamo may be designed in three ways. The first is by the method of pure guess work; magnets of a certain size are taken and such a quantity of wire is wound on them as may be thought advisable. The same method is adopted with the armature. A machine so designed may run well; certainly it deserves not to. By this system, after one or two failures, a saleable dynamo will be arrived at, although the actual speed and the desired speed will often be very divergent, and its general behaviour will more often than not leave much to be desired. The second method is to copy as nearly as possible the designs of some first-class efficient machines, and then so long as the machines have to work under the same conditions the results will be satisfactory, but the further apart these conditions are the less happy will be the results. The third and correct method is to design the machine by the light of past experience, not only experience in dynamos of practically the same output, but to utilise as far as possible details and information and experience gained from all sizes and classes of machines; for experience and the knowledge gained from previous work is half the battle, and then to apply the primary principles and laws to the design and see that all are in accordance with them. The student must remember that while the first principles are facts, deductions made from them without warranty of practice are theories, and that one ounce of practice is worth a pound of theory; and hence when in making a design a deduction is made and a certain result is anticipated, care should be taken to note in the finished dynamo if this deduction is borne out in practice, and so can be utilised in future as experience.

Digitized by Google

We will now assume that our dynamo is designed and built, and see how our first principles and the deductions therefrom should be applied to it.

(To be continued.)

THE EDISON AND SWAN COMPANY'S CATALOGUE.

We have received from the Edison and Swan United Electric Light Company, Limited, a copy of the new catalogue which they are now issuing. The catalogue is very much larger than any of the company's previous lists, and contains information concerning almost every electrical fitting and accessory that is made. The catalogue commences with a description of the action of an electric bell and diagrams of electric bell circuits for various purposes, such as burglar alarms, station signalling, etc. These descriptions naturally lead up to the bells supplied by the company, of which there are a large number. The ordinary quality bells listed range in price from 2s. each to

FIG. 1.

7s., these latter having conical-shaped gongs. There are also medium and best qualities made, these latter being very expensive. Special bells, wound for long-distance operation, are also sold. There are also supplied chime bells, ship's bells, circular bells, damp-proof iron bells, etc. A novelty in this direction consists of a metal-frame electric buzzer. This is a very small arrangement of similar construction to an electric bell, which does not give a sharp ring (which is in some cases considered objectionable), but makes a buzzing sound. Other bells are supplied which are in shape similar to the ordinary handbell, and of these the Bow bell, which we illustrate in Fig. 1, is noticeable for its neat appearance. The price of a 3in. bell of this kind is only 6s. The patent watertight bells which the firm manufacture are also well worth a notice, the internal arrangement of these being kept entirely free from dust or damp. Electrical indicators naturally come next in the list, there being a large variety of these, including semaphore indicators. Small complete bell sets are then listed, following which come electric bell-pushes and bell-pulls in seemingly endless variety, there being no less than 38 pages of the catalogue devoted to these.

FIG. 2.

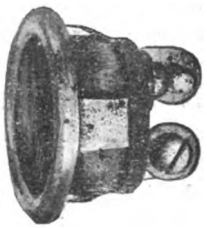


FIG 3.

The prices range from the low price of 6d. upwards. It is useless to describe the commoner forms of wood, china, and brass pushes, which are so well known, but of these the company manufacture many different kinds. Some of their table pushes and paper-weights are rather artistic, and that shown in Fig. 2 should be rather popular just now, when Britons generally think so much of the British lion. Fig. 3 shows a very neat little push, which is shown full size, and which will fit into a ⅜in. hole, and is provided with spring clips to keep it in place. Fire-alarms, Leclanché cells, and batteries of all kinds are then dealt with, and also galvanometers, current detectors, binding screws, tools, etc. Lightning conductors and an automatic speaking-tube complete this valuable list of electrical fittings.

EDINBURGH ELECTRICITY ACCOUNTS.

The accounts of the Edinburgh electric lighting station for 1899-1900 have just come to hand, from which it appears that the total amount expended on capital account to date has been £595,655. 8s. 1d. We give herewith the revenue account, abstract of general balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel	£12 071	1	1			
Oil, waste, water, stores, etc.	1,121	4	2			
Salaries of engineers	997	11	10			
Wages at station	2,620	4	8			
Repairs and maintenance—Buildings	57	18	10			
Machinery and plant	2,569	17	2			
Instruments	3	14	9			
				19,441	12	6
Distribution of Electricity.						
Salaries of engineers	165	0	0			
Wages	887	0	3			
Repairs, etc., of mains and cables	806	7	10			
Repairs and maintenance of meters	197	3	10			
				2,055	11	11
Public Lamps.						
Wages	2,234	19	6			
Carbons	808	5	0			
Repairs	1,079	13	11			
				4,122	18	5
Rents, Rates, and Taxes.						
Rents	45	4	6			
Feu-duties of station	110	4	0			
Rates and taxes and insurance	2,994	11	5			
				3,149	19	41
Expenses of Management.						
Special expenses—salaries of engineers	425	18	4			
General establishment charges	1,039	15	4			
Stationery and printing	182	11	11			
Proportion of management expenses	1,892	2	8			
				3,540	8	3
Miscellaneous expenses				376	8	10
				32,686	19	10
Carried to net revenue account				30,972	9	2
				£63,659	9	0

Cr.	£	s.	d.
Sale of current per meter—Private lighting at 3½d. per unit, less discounts	49,022	12	8
Motor power at 1½d. per unit	3,608	3	0
	52,630	15	8
Arc lamps: public lighting, £10,371. 16s. 4d.; private lighting, £28	10,399	16	4
Meter rents	44	1	8
Rents of properties in Torphichen-street	274	2	8
Miscellaneous receipts	310	12	8
	£63,659	9	0

BALANCE-SHEET.

Liabilities.	£	s.	d.
Bank balance	13,920	18	6
Sundry creditors for outstanding accounts	106	6	3
Deposits by consumers	35	10	0
Reserve fund	14 595	11	6
Net revenue account balance	3,674	9	4
Surplus	45,027	1	1
	£77,359	16	8

Assets.	£	s.	d.
Balance at debit of capital account	45,027	1	1
Sundry debtors for sale of current per meter	15,175	12	3
Stores on hand	2 561	11	10
Reserve fund investment	14 595	11	6
	£77,359	16	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		6,273,397
Quantities sold: Private lighting	3,780,343	
Motor power	579 612	5,551,728
Arc lamps	1,191,773	
Quantity used in stations		339,903
Quantity unaccounted for		381,766

Callender's Cable Co.—The directors of this company announce an interim dividend at the rate of 10 per cent. per annum.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	541	Mistakes in the Rating of Incandescent Lamps	561
Liverpool Electric Lighting	546	Power Generation — Comparative Cost by the Steam-Engine, Water-Turbine, and Gas-Engine	564
The Verband Deutscher Elektrotechniker	551	Light Railways	564
High-Speed Reciprocating Engines	553	Forthcoming Events	564
The Philosophy of Dynamo Design	555	Questions and Answers	565
The Edison and Swan Company's Catalogue	557	St. Marylebone	568
Edinburgh Electricity Accounts	557	Contracts for Electrical Supplies	568
The Institution	558	Traction Notes	569
Correspondence	559	Lighting Notes	571
The Foundation Stone Laying of the Hackney Electricity and Refuse Destructor Works	560	Provisional Patents	575
		Traffic Returns	576
		Companies' Stock and Share List	576

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

THE INSTITUTION.

Was it not Froude who first pointed out the great difficulty of obtaining historic accuracy? If our memory serves correctly, Froude pointed out that seldom or never did a listener hear a similar account of an incident which the various individuals who described it witnessed. The difficulty which exists in obtaining an absolutely correct account of what happens to-day is enormously intensified when the description is of an incident which occurred a hundred or a thousand years ago. When one comes to think over these difficulties in getting accurate information, it becomes doubtful how far any historic incident has been truly and faithfully described. Still, when the narrator of a historic incident is a witness thereof, or has had access to living witnesses, the probability as to the truthfulness of his statement is greater than it would be if the narrator was writing or speaking in after years. Having these views of Froude before us, and applying them to electrical matters, it would seem to be wise in the concluding year of the century that, as far as possible, the true history of the various developments of electrical applications should be authoritatively recorded. It seems to us that the institution, above all others, upon which this work should devolve is that of the Electrical Engineers. Many of its members have either been largely concerned in the development of applied electricity, or have been closely connected with those who have been so concerned. We would suggest, then, that the Institution, perhaps, in addition to its ordinary work, collect and publish a series of monographs upon the various applications of electricity, which should, as far as possible, crystallise the history of these applications. It may be, as Mr. Fahie has shown in his researches, that too much prominence has been given to certain individuals, and insufficient attention has been paid to the work of others, and such things being discussed now could more easily and more faithfully be made straight than if left to future historians. During the last year or so the Institution has been exceedingly active. It has, so to speak, thrown out its arms and embraced the provinces, bringing within its fold the whole of the electrical talent of the kingdom. Would it not be possible to further increase this activity, and appoint a small committee to deal with each special branch of electric engineering, to bring together materials for a series of monographs which should be complete and, as far as human action is concerned, authentic. It has always been said that scientific men are seekers after truth, and yet it is well known that the true history of applied science is very difficult to obtain. The ordinary man, if asked the position of Stephenson in the development of the locomotive, would probably answer that it was he, and no one else, to whom the world is indebted for a great step in its progress. Others would say that Stephenson would not have been able to do what he did had he lacked the work of others to assist. Coming back to electrical matters, practically the whole development of applied electricity has been during the last seventy years of the century. What Faraday commenced

Digitized by Google

others have carried on, till the end of the century shows an enormous development in all electrical matters. We have made this suggestion for what it is worth, and must leave the Institution to consider the matter. While, however, on the subject of the Institution, might we venture upon one complaint? Its meetings during the session are held for the purpose of discussing questions of interest to the profession. To many the mere question whether the meeting lasts half an hour longer or half an hour shorter is of no importance, but, on the other hand, we think there should be a rigid adherence to the unwritten rule which ends the meeting at a particular time. We have referred to this point before and pointed out that comparatively few members live within walking distance of the place of meeting, most being dependent upon trains for getting home. Many of the members, again, are engaged in business, and, though it may be a singular trait in the character of an Englishman, like to keep fairly regular hours. If, however, the time of concluding the discussion is an unknown quantity, and happens to be exceptionally late, many who would have foregathered together and had a friendly chat are unable to do so; for although the ostensible reason for meeting together may be to hear and formally to discuss the paper, there is no doubt that what is of almost equal importance is the informal talk which happens before and after the conclusion of the meeting. Generally this informal discussion must be after the meeting, hence the greater necessity of not making the meeting too long. This, then, is the second question that we put forward for consideration. The decision on both matters must be left to the Institution, though the latter lies very much in the hands of the President.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE PATH OF THE SUN.

SIR,—I see a review of my work, "The Path of the Sun," in your issue of Sept. 28 by Mr. Edwin Edser, but as it strikes me, it is more an attempt to exhibit the superior knowledge of Mr. Edser than a review.

To follow his elementary instructions on points undisputed is needless, and I will confine myself to what he describes as my fallacies. For example, he remarks that "it is concluded [*i.e.*, by me] that the revolution of the nodes of the sun produces a conical motion (of the earth's axis) of 47deg. *about an axis perpendicular to the ecliptic.*" Now, as it is admitted on all hands that the conical motion of 47deg. does take place, where is the fallacy? It must be in my statement that this is produced by the revolution of the nodes of the sun; but if that be the fallacy, Mr. Edser presents no argument to prove it so, and I have only Mr. Edser's authority for it, the value of which I am unable to estimate, but he seems to think it sufficient. It is impossible, however, to reply to an oracular assertion.

"But," he says, "another fallacy lies behind. We are first told that the revolution of the *nodes of the sun* carry the earth's axis round once in every revolution, and then that the revolution of the sun itself does the same thing." Well, the revolution of the nodes of the sun and the revolution of the sun itself are equivalent phrases, the former being produced by the latter, and there need be no misunderstanding on the point.

While the earth is making its annual journey round the sun, the sun has moved on a certain distance in its orbit, with the result that the sidereal position of both orbs is altered and the place of the crossing of the sun over the equator has moved on with the sun—that is, the nodes have sidereally shifted. That is a description of what actually happens, without regard to any theory, and the geometry of the statement it is impossible to dispute. Now, whether I describe the movement of the earth's axis to be produced by the revolution of the nodes or by the revolution of the sun, no one who understands the actual movements of the two bodies can misunderstand either statement, as both have the same meaning.

Just a word or two as to Newton's explanation of precession. I have historically proved precession to have been nothing more than a conjecture of Hipparchus. Newton adopted this conjecture as true, neither he nor anyone else being able to give any other explanation; and Newton in his turn conjectured that the conic movement of the earth's axis was produced by the action of the sun and moon upon the protuberance at the earth's equator. He then proceeded to calculate the proportional influence of each in producing this movement. That is all he did; and there is nothing whatever existing in the nature of proof but that calculation. Now, my contention is that a calculation cannot prove the nature of a movement. Mathematically you may prove the velocity, size, force, mass, or weight of a celestial body, but to prove anything relating to a quality, condition, or attribute by figures is impossible.

To settle the matter, let Mr. Edser take Newton's figures and show how they prove that the motion of the earth's axis is that of a spinning top, instead of a gliding motion round the circle of the sun, as I state it to be. If he do, I will grant him the palm of superiority.—Yours, etc.,

WM. SANDEMAN.

Hollin Bank, Oswaldtwistle, Lancs., Oct. 8, 1900.

ELECTROMAGNETIC INDUCTION.

SIR,—As, after his letter in your issue of the 12th inst., silence on my part would evidently be misinterpreted by Mr. Dunton to his own advantage, I trust that you will excuse me for once more trespassing on your space.

I should be considerably annoyed to think that I had failed to convince Mr. Dunton of the genuineness of the mare's nest which he has found, but, judging from his last letter, he is apparently still wriggling under his original delusion. His attempt to put the "electrical engineer's bible" in the scales to bring the balance down in his favour, only emphasises more clearly his persistent inability to grasp the difference between defining the behaviour of a closed circuit moving entirely in an uniform magnetic field and a closed circuit moving only *partially* in a magnetic field. The behaviour of the former is dealt with by Dr. Thompson in the paragraph quoted by Mr. Dunton, and the behaviour of the latter is dealt with by Messrs. Slingo and Brooker in the paragraph also quoted by Mr. Dunton. Both paragraphs are perfectly correct.

Quoting from p. 27 of the *fourth* edition (I do not possess a fifth) of "Dynamo-Electric Machinery," Dr. Thompson, in dealing with the former case, says: "It is, however, necessary that the moving conductor should, in its motion, so cut the magnetic lines as to alter the number of lines of force that pass through the circuit of which the moving conductor forms a part. If a conducting circuit—a wire ring or single coil, for example—be moved along in a uniform magnetic field, as indicated in Fig. 14, so that only the same lines pass through it, *no current will be generated.*" But this is only another and far simpler way of stating that it is impossible to so move a closed conducting circuit in an uniform magnetic field, that the algebraical sum of the E.M.F. impressed thereby on the component parts of the circuit is not zero *unless* the number of "lines" passing through it is increased or decreased. The impressed E.M.F. must essentially be produced by the conductor itself *cutting through* the "lines," whatever the shape of the conductor may be, and the fact that current can only be induced in a closed circuit, moving entirely in an uniform magnetic field, by varying the number of "lines" passing through it, only follows in a secondary manner from a property common to all closed circuits—viz., that the algebraical sums of both the vertical

Digitized by Google

and horizontal components of such circuits are zero. In the statement of Messrs. Slingo and Brooker condemned by Mr. Dunton, this property does not apply, however, as it deals with the E.M.F. impressed on a conductor (not a closed circuit) moving in a magnetic field, and the current which results *when* the ends of that conductor are connected together outside the field.

If, however, Messrs. Slingo and Brooker's statement is wrong, then the following statement on p. 26 of "Dynamo-Electric Machinery" is also wrong: "Now, Faraday's principle is nothing more nor less than this, that by moving a wire near a magnet, across a space in which there are magnetic lines, the motion of the wire, as it cuts across those magnetic lines, sets up magnetic whirls round the moving wire, or, in other language, generates a so-called current of electricity in that wire." Personally, I fail to see anything wrong with this latter statement, and yet I venture to think that Mr. Dunton, by his own methods of reasoning, could have made out a far better case of "slipshod language" from this statement than from the one which he chose. I am, of course, aware that the quotation of "slipshod" statement from one authority is no justification of a parallel statement from another, but since Faraday and Dr. Thompson are the prominent authorities whom Mr. Dunton has brought forward to pull him out of the pit into which he has fallen, this method should carry some weight with him.

I freely admit that I have "not the ability to perceive the glaring contradiction" which Mr. Dunton mentions, but sincerely trust that I am not, as he suggests, alone amorg your readers in this respect.

In conclusion, I must apologise for having written at such length on a subject which must have lost its interest long since.—Yours, etc., F. JOHNSTON.

THE FOUNDATION STONE LAYING OF THE HACKNEY ELECTRICITY AND REFUSE DESTRUCTOR WORKS.

The ceremony of laying the foundation stone of the Hackney electricity and refuse dust destructor works, performed by Alderman W. H. Dickinson, D.L., chairman of the London County Council, yesterday (Thursday) afternoon, was attended by a large gathering of guests invited by the Vestry of the parish of St. John-at-Hackney. The event marks the commencement of another important link in the chain of what may be termed borough electricity supply stations which surrounds smaller London. Shoreditch, Islington, and Poplar, all immediate neighbours of Hackney, have already inaugurated supplies—Poplar, indeed, quite recently—but although later to make a definite move, Hackney certainly does not intend to be ousted so far as the initial boldness of its undertaking is concerned. It is proposed to expend close on £250,000 upon the joint schemes as an initial instalment, of which sum about £225,000 will be absorbed by the electrical portion.

The site of the new works is in Millfields-road, Lower Clapton, N.E., and the proceedings yesterday afternoon were presided over by Mr. GEORGE OGAN, chairman of the Electric Lighting Committee, who, after a prayer had been offered up by the Hon. and Rev. A. G. Lawley, M.A., rector of Hackney, for the success of the undertaking, said that in starting this electrical undertaking they had taken a step in their municipal history. The trader who refused to keep his establishment well lighted and fitted went to the wall, while the trader who kept his store in good order got on well. It was the same in municipal life, and the parish which did not provide a good system of lighting for its inhabitants soon lost numbers of them, who went where they were better looked after. In consequence, the Vestry had taken the matter in hand, and had determined to have a light worthy the parish, and for this reason they had given the matter into the hands of Mr. R. Hammond, who was one standing very high in his profession.

The CHAIRMAN then called upon Mr. Robert Hammond, M.I.C.E. (consulting engineer to the Vestry), to briefly describe the works, in responding to which request

Mr. HAMMOND said, after reading the programme, he had wondered if the chairman would have had the boldness to ask him to speak. This was in consequence of a report in one of the papers to be placed under the stone, in which it was stated that the most foolish thing the Lighting Committee had done had been to appoint an engineer. However, in spite of all temptations, they had called upon an engineer, and he would speak a few words with reference to the undertaking. He would first say the works were devoted to two purposes, one being the destruction of all the refuse in the borough of Hackney, and the other was the production of electricity. They were going to send the current through 100 miles of cables, and the pressure would be ready for the use of those who cared to use it in some 50 miles of streets. The pressure was going to be sent out by some 5,000 h.p., and it would try very hard to come home again. This could only be done through the little lamp filaments, which incidentally it would heat white hot, and thus light their lamps. In the case of motors for factories, it would be forced to drive them. They hoped when the undertaking was in working order it would not cost the borough a penny. In the other part of the undertaking they were going to dispose of the refuse of Hackney in the only way in which it should be disposed of—namely, by burning it.

Alderman DICKINSON was then presented with a trowel and mallet by the architects, Messrs. Gordon and Gunton, and, after declaring the stone to be well and truly laid, said it was a pleasure to him to take part in such a function. He had just laid the foundation stone, and he hoped it would be the beginning of a great undertaking. It would be, he was sure, the end of a great controversy. They had buried under the stone a number of papers, and he thought he might also say they had buried the dissensions and disagreements on the subject of electricity which had taken place in the Vestry. He then referred to the history of the electric light undertaking in Hackney. As long ago as 1893 the Vestry had obtained the order which empowered them to supply Hackney with electric lighting, and after certain delays a committee was appointed in 1895 for the purpose of carrying the order into effect. In 1897 some difference arose as to how it should be carried out, and the committee came to the conclusion that the powers should be handed over to some private company who undertook to supply at a cheap rate, but at the same time taking all the profits. The people of Hackney, however, by a Vestry election prevented the arrangement being carried out. A resolution was then passed to the effect that the order was the property of the ratepayers, and that the Vestry should use the same for the benefit of the ratepayers, and the Vestry refused to sell the order to any company. This was the right course to pursue, and no one should doubt its expediency. They had the advantage of consulting one of the most able all-round electrical engineers (Mr. R. Hammond) in regard to this question, and he was not only able to advise them as to the practical methods of generating the electricity, but as to the way in which to make the undertaking pay. His report was a remarkable monument of arguments for the carrying out of electrical supply by public bodies. He showed in that report the example of Leeds, in which, by a majority of one, the committee came to the same conclusion as that of the Hackney Vestry and sold the order to a company. This company for four years made very large profits, and the Corporation then bought it out at a very high price. Five years ago there were only two bodies in London carrying out their own electric supply. Now there were 12, and before long 19 would be supplying, or about to supply, electrical energy. The local authorities had become convinced that it was wiser for them to carry out the works than to put it in the hands of companies. Of the two undertakings in London from which results could be obtained for any length of time—Hampstead and St. Pancras—both were making the works pay. The cost of the new works was to be some £250,000, of which £225,000 was for the electrical works and the remainder for the refuse destructors.

Digitized by Google

The price to be paid for the energy was very low, in fact, the lowest in London—namely, 4d. per unit for private lighting, 3d. per unit for public lighting, and 2d. per unit for power supply. These charges would allow the light to compete with the gas company's charges. It was expected that they should realise a profit of £1,000 in the first year, this gradually increasing up to £14,000 in the fourth year. It depended, however, entirely on whether the ratepayers supported the Vestry in the matter. He would recommend them, when the electric light was available, to shut off the gas from the premises and get the Vestry to put them in a free installation of electric light by a free-wiring arrangement. He trusted the electrical enterprise in Hackney, like the stone, was "well and truly laid" as a municipal enterprise.

Mr. T. HOSGOOD then proposed a vote of thanks to Alderman Dickinson, which was seconded by Mr. W. L. BEURLE, supported by Mr. SMITH, L.C.C., and adopted unanimously.

Alderman DICKINSON then acknowledged the vote of thanks.

Other speakers followed.

The following notes on the undertaking, prepared by Mr. Robert Hammond, the consulting electrical engineer, were appended to the order of proceedings presented to each guest:

The buildings are being erected by Mr. John Greenwood, from the designs of Messrs. Gordon and Gunton, F.R.I.B.A., Finsbury House, Blomfield-street, London, E.C. They are situated upon a site of about five acres in Millfields-road, Hackney, and adjoining the grounds belonging to the London County Council. The site allows for ample means of extension, and has the advantage of a frontage to the Lea River Canal, which will give economical facilities for the supply of fuel and the shipment of the clinker material. The engine-house will be 130ft. by 50ft., and is designed in bays with arcading, the walls being lined with an ivory-white glazed brick dado and surbase. In connection with this engine-house there are switch-rooms, cable-rooms, engineers' offices, lavatories, workshops, and stores, also an extensive basement for the engine-beds and cable arrangements. The upper floors of the building contain an accumulator-room, 143ft. by 30ft., with covered platform and trap-doors to loading space below, together with workmen's and foremen's quarters, baths, lavatories, w.c.'s, and kit bins.

The buildings will form a very handsome block in brickwork, with red and malm brick facings and stone dressings. The roofs will have steel principals with boarded covering, also felting and blue slates. There is an ample provision of skylights, which will be glazed with patent glazing. The chimney shaft in connection with these works has an internal diameter of 10ft., and will be carried up to a height of 200ft. with firebrick linings and the necessary lightning conductors, and has been specially designed in regard to appearance and as an ornament to the neighbourhood. The buildings have been designed to afford sufficient space to accommodate 6,000 h.p. in boilers, engines, dynamos, and switch gear. Sufficient land has, however, been acquired to permit of a further 6,000 h.p. being added by an extension of the present buildings.

In the first instance it is not proposed to erect plant of more than 3,000 h.p., this, with the accumulators, being sufficient to supply current for about 50,000 8-c.p. lamps alight at once, after allowing for a sufficient reserve. There will be six boilers of the Babcock and Wilcox water-tube pattern, three being fired by the refuse destructor gases, and three being placed in the permanent boiler-house. The ordinary working pressure will be 180lb per square inch, but the refuse-fired boilers will be capable of working up to 250lb. per square inch to counterbalance any irregularities in the firing.

The engines are of the triple-expansion type, and are designed for a working pressure of 175lb. per square inch. Each engine is arranged to drive two dynamos direct without intermediate gearing, and a common condenser and cooling apparatus is provided for each pair of engines. One pair of engines are being built by Messrs. Belliss and Morcom, Limited, of Birmingham, and one pair by Messrs. Willans and Robinson, Limited, of Rugby, the dynamos being supplied by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne.

A battery of accumulators, having a capacity of 2,800 ampere-hours, has been ordered from the Tudor Accumulator Company, Limited, of London, the primary object of the battery being, as far as possible, to store for future use the energy developed in the refuse destructor at times when it would otherwise be wasted.

The working pressure on the distributing mains in Hackney has been fixed at 480 volts across the outer conductors of a three-wire system, so that the actual pressure of supply for ordinary purposes will be 240 volts. With a view to utilising the power derived from the refuse destructor to the utmost, and at the same time meeting a probable demand for power as well as lighting, the direct-current system of distribution has been preferred.

The electricity mains are of ample section to meet any probable requirements for some time to come, and are being laid or will shortly be laid in about 50 miles of streets. Arrangements are also about to be concluded by which mains can promptly be laid in almost any street or road in the district in which there is any demand for electricity for lighting or for power purposes. The first contract for cables was placed with the British Insulated Wire Company, of Prescot, and the work of laying the mains is now in progress. The mains are of the triple-concentric type throughout, and are laid in stoneware and iron troughs filled in solid with a bituminous compound.

For public street-lighting arrangements have been made for the erection of 320 arc lamps, which will be run nine or ten in series across the outer conductors of the three-wire system, provision being made for controlling all the lamps from the electricity works. The lamp pillars will be spaced from 50 to 60 yards apart, and the posts have been designed so that the top of each lamp is about 21ft. above the ground.

The refuse destructor consists of 12 furnace cells, capable of burning a maximum of 150 tons of refuse per 24 hours. Arrangements have been made for the automatic handling of the refuse, so far as this is possible, from the moment it is tipped at the works to the time when it emerges from the furnaces in the form of clinker. The surplus energy will be utilised for driving the plant in the electricity works. The elevators, blast fans, and feed pumps will all be driven by electric motors. The contract for the destructor has been let to Messrs. Hughes and Stirling, of London.

MISTAKES IN THE RATING OF INCANDESCENT LAMPS.*

BY ARTHUR J. ROWLAND, MEMBER.

A 16-c.p. lamp is a such a common article of commerce and in such general use that we all recognise it when we see it, or think we do, either by the size of its bulb or the length of the filament or both. Very few people go beyond such mechanical identification except for the extra assurance they gain by a look at the manufacturer's label. Some, indeed, presume to tell that a lamp is of a given candle-power by looking at the brightness of its filament or by considering the general lighting of a room; but it need scarcely be said that an estimate formed by such a method is utterly worthless, since one is too much influenced by contrasts in brightness, or deceived by the temperature at which a given filament is burned, to really tell anything at all about the candle-power.

The importance of exact knowledge of the candle-power of incandescent lamps is at last being recognised among lamp users generally. One of the signs of this in the present times is the great number of photometers recently set up and used outside of laboratories. Certain standard measurements are made with these, which are good so far as they go, but commonly many important things are quite passed by unnoticed. Not only should the user of incandescent lamps want to know that the

* Paper read before the Franklin Institute.

Digitized by Google

lamps he buys really have the candle-power marked on them, and that they maintain their candle-power properly as they grow old in service, but he ought to know and fully understand a number of other things regarding the real candle-power and watts per candle-power of the lamps he uses. Some of these seem to have quite escaped notice, and their importance is so great as to merit careful consideration.

What a 16-c.p. Lamp ought to be.—Let us first enquire into just what a 16-c.p. lamp ought to be. That it should be one which gives a light equal to that of 16 candles in the direction in which the light is useful seems a natural and fair definition. A little careful observation of lamps as they are installed shows that at least 85 to 90 per cent. of those used are put in place with base upward or tipped end downward, and it is the light which comes from this tipped end of the lamp which is useful. In cases where the lamp is installed in a different position, either the lamp is subordinated to some artistic feature of the electrolier, or the lamp is installed "side on" to better keep it out of the way. So it comes that the light we ought really to want to know about, the light we ought to measure, is that coming out of the end of the lamp. Or, at least, it is sure that, if we call the axis of the lamp a line through it from the middle of the base up to the sealed-off tip, the light of value is that coming into space below a plane perpendicular to the axis, half-way along its length. We can never use more light than this, since for satisfactory lighting the sources must be above us, and in real service we make use of much less, as will be presently shown. Should we take the average candle-power of all the light rays into space below the imaginary plane just defined, this would be called the mean hemispherical candle-power, just as the average candle-power of all the light rays given by the lamp in every direction is called to the mean spherical candle-power.

The Importance of the Light from the Tipped End.—The placing of lights is to-day being made much more intelligently than by the old rules of so many 16-c.p. lamps per 100 square feet of floor surface, or per 100 cubic feet of room to be lighted. Some certain amount of illumination is now striven for, and a proper distribution of light rather than of lights is sought.

In a great deal of lighting one tries intentionally to give illumination concentrated about particular points. For example, in lighting a library it is the library table which is to be brightly lighted; other parts of the room need little more than the scattered rays otherwise useless, which reach them directly from the light source or after reflection. The light rays in poor planes and the reflected light which comes from the table, the walls, and objects in the room, though contributing little to the important light, serve to break up shadows and produce diffusion. Almost the same thing would be true of the lighting of a bedroom, where the light should be concentrated about the bureau or dressing table.

In quite a different sort of lighting, still the same things hold true. Take the lighting of a factory or mill for example. The light must be on the machines or work, and be very good there. That which gives the room its general lighting is waste light from the light sources. To light the whole room as brightly as the machines would be too costly to be practical. For such lighting, let us consider what rays are useful and what rays waste light. If the lamp hangs directly above the thing to be lighted, and its area be not more than 5ft. by 5ft., no rays of light beyond 30deg. from the axis of the lamp will be useful, and the higher the lamp is hung, the less the angle in which the useful light is found.

A second sort of lighting is that in which a uniform distribution of light is required, as in concert halls or auditoriums of various sorts, and in shops for the sale of merchandise. A fundamental principle in this class of lighting is to use many sources of small candle-power each, all so placed that the light from them is directed downward, with perhaps a little diffused side light to break up the shadows, especially in small interiors. The lighting engineer is forced to use single lamps to procure this, except in large rooms, and they are nearly always installed base upward. The light from the tipped end produces the light of value.

A third sort of lighting is for decorative purposes, but that is so very especial and foreign to considerations of candle-power at all in most instances as to merit no consideration here.

The light below the lamp—that from the tipped end—is then the important and useful light in all practical cases. This is true, too, not only from the specific cases cited, but where large electroliers with many lights are used as well; for in such cases the lamps are usually flared out, with axes at some angle approaching 45deg., in which case high candle-power from the tipped end and low from the sides of the lamp would contribute to a good, even illumination of the room.

The importance of procuring high candle-power below the lamp has been recognised a long time. But what expensive and roundabout methods have been taken to procure it. It is very common to use reflectors to increase the amount of light in the direction below the lamps. While reflectors have their place in lighting, and an important one, too, for most purposes they are exceedingly poor and are used in ignorance of the effects they produce or because no better device for light redistribution can be had. No matter whether the reflector covers the lamp or not, no matter whether it is of porcelain, a glass mirror, or a polished metal surface, it inevitably cuts the light off absolutely in some directions and so directs it in others as to produce sharp shadows and brilliant lighting contrasts. In satisfactory lighting contrasts of light and shade are always avoided, and by producing diffusion most shadows are lost. Other devices, like McCreary shades and specially shaped incandescent lamps having a reflector incorporated with the lamp, have faults precisely the same as reflectors. Holophanes, with their prismatic and accurately formed surfaces, turn the light downward, and at the same time diffuse it by refraction, so that on all artificial lights the distribution of the light, and the lighting therefore, is improved by their use. A holophane gives a redistribution of light immeasurably better than a reflector always. If an incandescent lamp is installed base down, holophanes or reflectors must be used on it or the lamp be valueless in supplying really useful light.

The common use of such devices is evidence that the ordinary incandescent lamp does not give as much light below it as is required there. Is there, then, a bad light distribution from them? An examination of modern lamps will tell us.

Filament Types and Candle-Power Distribution.—There are five different types of filament in use to-day by various prominent lamp manufacturers, and in most cases a filament type indicates the product of a certain manufacturer who has adopted that as the one used in his standard lamps. These typical filaments are enough different from each other to show interesting individuality. I have classed them as follows: (*a*) straight U-shaped filament; a type rapidly passing altogether out of use. (*b*) Single curl filament; a type much used, having a circular loop in the filament midway of its length. This type was originally designed to render filaments stiffer and less liable to bend without an anchor, and also to shorten the lamp bulb. It was found to give a better distribution of light than type *a*. (*c*) Long curl anchored filament; a type differing from type *b* in that the loop is long in the direction of the lamp axis, and is anchored to the part of the lamp where the leading-in wires pass through the glass. (*d*) Double filament; a type which uses two filaments like type *a*, set so the current passes through them in series, the filaments being in planes approximately parallel. (*e*) Double-coil filament; a type like *b*, except that there are two turns in the coil instead of one.

Besides being typical in the matter of general form, the light distribution observed from these various filaments is also typical. It is, however, considerably influenced by the exact relation of different dimensions in the filament itself used by particular firms; as, for example, the diameter of a coil or the spread of the filament shanks. Results below are therefore departed from somewhat if different makes of lamps had been used in the tests.

Fig. 1 shows average candle-power values from lamps of

Digitized by Google

each of the different types. The arrows indicate the direction from which the candle-power was measured, and the number gives the candle-power. These values are true averages of the types shown. In the averages struck no "freak" lamps were included. The five types are each represented by the product of some prominent lamp maker. All the lamps are rated 16 c.p., all were in the standard bulb used by the manufacture of a type, and, as it happened, all were 3·5-watt 110-volt lamps. A careful inspection of the figure shows one that the form of filament has a most important relation to the candle-power distribution, as, of course, it must, since the candle-power delivered in a given direction is determined almost wholly by the amount of filament length visible from that direction. A filament of type *a* shows only the end of the U when one looks in at the tip, and so the candle-power must be low, even if the U be broad. A double filament must show low candle-power for the same reason; and if the filament loops are narrow and the legs of the filaments straight, as they were in the lamps of the make tested, the candle-power may be even lower out from the tipped end than for a filament of type *a*. A filament with a coil in it shows much more projected length when viewed from the lamp's end, and so gives comparatively high candle-power in that direction. We see, then, that a 16-c.p. lamp is very different in the candle-power it gives in various directions, and very different in a given direction with difference in type of filament. That lamp which gives most useful light is undoubtedly the best. Hence there is no question but

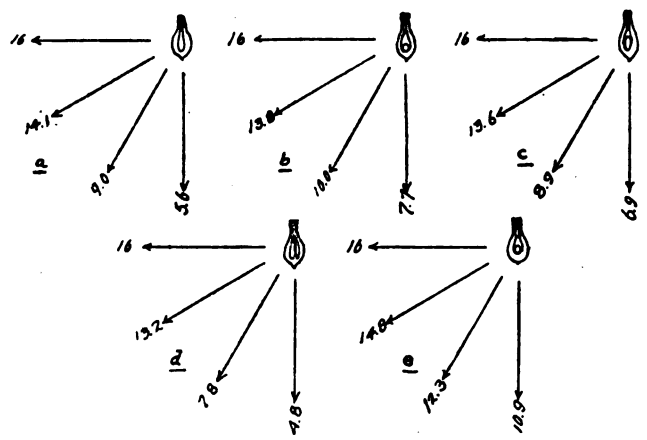


FIG 1.—Showing Average Candle-Power Distribution from Incandescent Lamps of various types *a*, straight U-shaped filament; *b*, single-curl filament; *c*, long-coil anchored filament; *d*, double filament; *e*, double-coil filament.

that the 16 c.p. lamp with filament of type *e* is a far better lamp for general lighting purposes than any other. It is almost beyond belief that this has escaped notice in all the years incandescent lamps have been made and used, and yet it has been so. I first had my own attention called to the matter by the Shelby Electric Company, for whom I was making some tests of candle-power. It is their lamps which I show as type *e*. In an attempt to find whether in the past anyone had attached importance to the light coming out from the tipped end, I have been surprised to note how, over and over, this or that experimenter or lamp manufacturer has been on the verge of the discovery and then passed it by. One of the most recent cases I have noticed is that of a lamp manufacturer who advertised sign lamps with "all the light from the end," but seems never to have thought that this would be the right sort of lamp to use as his standard product.

Fig. 2 gives the relative amount of useful light from filaments of the different sorts expressed in per cent. of the light given by the double-coil filament (type *e*). The Shelby lamp (type *e*) for which data is given was made tipless—that is, the sealing-off after exhaustion was not done, as usual, at the tipped end. The gain in candle-power by omitting the tip, so far as tests which I have been able to make indicate, is about 12 per cent. The loss in tipped lamps is probably due to light absorbed through the thicker glass at the tip and partly to reflection and refraction of light into useless directions, which otherwise might have been saved to be useful.

What folly it turns out to be to use special devices to turn the light downward when the lamp itself can have the filament constructed so as to give a proper light distribution. A design of filament for incandescent lamps so they will give large candle-power from the tipped end is second in importance only to satisfactory efficiency, and maintained candle-power with fair average life.

FIG. 2.

Filament.	Light in given direction in per cent. Vertically downward.	30deg. from vertical.
Type *e*	100	100
,, *d*	44	63·4
,, *c*	63·7	72·4
,, *b*	70·6	81·3
,, *a*	51·4	73 2

Illumination by Lamps using Filaments of Different Types.—A large amount of light streaming from the end of the lamp is only useful if it produces a proper illumination. In Fig. 3 is plotted the illumination of a level surface 5ft. below a 16-c.p. lamp of different makes, the distribution being shown one way out from the lamp only. A single representative lamp was taken of each of three important sorts, and the candle-power as marked on the diagrams determined for the light given in each of the directions shown by the arrows. The illumination was then calculated in candle-feet, and this plotted vertically from the base line. The solid curved line bounding the shaded area runs through the points so found, and all vertical distances from the base line give the amount of illumination there. Some of the values found are marked. Thus, for

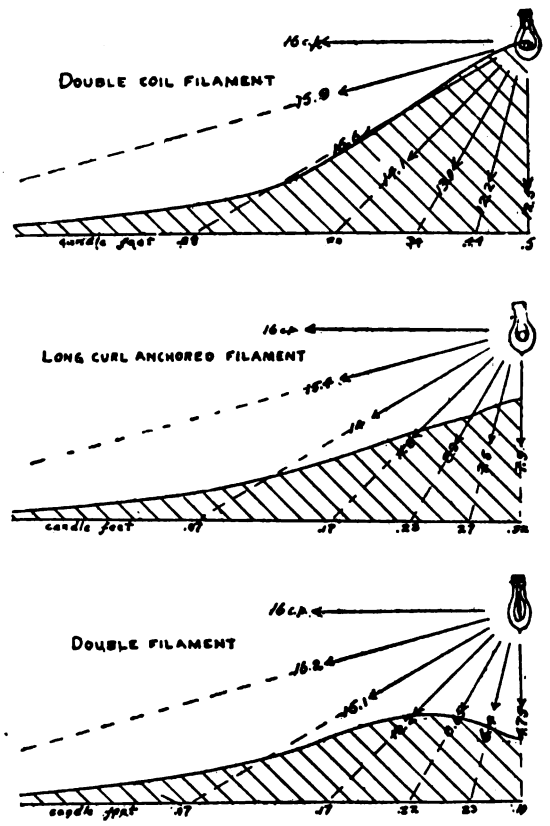


FIG. 3.—Illumination by Filaments of different types.

the long curl anchored filament ·32 of a candle-foot is procured at the surface illuminated by the ray giving 7 9 c.p., 27 by the ray giving 7·5 c.p., etc. The candle-foot unit is the common one—that is, an illumination of 1 candle-foot is that of a surface everywhere 1ft. distant from a light giving 1 c.p. in every direction. A surface 2ft. distant at every point from such a light source would have an illumination of quarter of a candle-foot. A first look at the diagrams would seem to indicate that the double-filament lamp is best, since it gives more uniform illumination than either of the others. In any case we need not concern ourselves with the light received from rays making an angle greater than 45deg. with the vertical, since up to this angle a circular area 10ft. in diameter, above the centre of which the lamp hangs, is being lighted. Under the lamp the light is most valuable, and there we want to get most light. The double-coil filament turns out

Digitized by Google

then to be by far the best form. If in lighting an interior the lamps were hung separately and placed about 6ft. apart, the evenness of the illumination produced would be about the same for lamps having double-coil filaments, or lamps having long curl anchored filaments, but the amount of illumination procured from double-coil filaments would be so much greater that they are much to be preferred. We are assuming all along that 16-c.p. lamps, as the manufacturers call them, are in use. If lamps were placed 15ft. apart, the distribution of light with double-filament lamps would be very good if an even distribution is desired, but the average illumination would be low.

(To be continued.

POWER GENERATION—COMPARATIVE COST BY THE STEAM-ENGINE, WATER-TURBINE, AND GAS-ENGINE.*

BY JOHN B. C. KERSHAW, F.I.C.

There is no question of greater importance at the present moment to those engaged in the management of our manufacturing industries than that of power generation. The supremacy which the steam-engine has so long enjoyed is now assailed from two sides. The water-turbine and the gas-engine have become dangerous rivals. During the past 10 years a most remarkable development of hydraulic power has been taking place on the Continent of Europe in France and Germany, and in America at Niagara. The aggregate amount of power at the present date generated from falling water forms no inconsiderable portion of the total power utilised in manufacturing industries; and two years ago it was estimated by the author to be between 236,000 h.p. and 350,000 h.p. On the other hand, gas engineers have been busily engaged in working out the problems presented by large gas-engines and by the utilisation of the waste gases of blast furnaces. Gas-engines up to 650 h.p. have been built, and have worked smoothly and economically; while at Seraing, in Belgium, and at other places the blast furnace gases have been utilised for driving the engines which supply the blast. The question, therefore, which the engineer now has to settle when deciding upon the site and locality for a new factory, or when deciding upon the system of power generation to adopt for extensions of the old, is no longer so simple as when only one method of power generation in large units was open to him. It is no doubt true that the choice between the three possible sources of power is one which in many cases will be settled purely by local considerations; and the proximity of a large waterfall or of an extensive coal-field to the factory, will be held to point to the turbine or to the steam-engine as the most economical power generator. In a great number of cases, however, especially when the decision of the engineer covers the choice of a site for the factory, the problem is capable of no such easy solution; and the most economical source of power can only be determined after an exhaustive study of comparative costs data. The aim of the writer in the present paper has been to collect and arrange in comparable form some of the more important figures bearing on the cost of power generation. Full references are given to all the original articles from which these figures are drawn. Taking the best figures for each of the three sources of power dealt with above, and bringing them all to a common basis of comparison—namely, the cost of the electrical horse-power year of 8,760 hours—the author obtained the figures given below:

TABLE VII.—Comparative Costs of Electrical Power.

Source of power.	Lowest cost per E.H.P. year of 8,760 hours— Estimated. £ s. d.	Locality.	Actual. £ s. d.	Locality.
Water	1 5 5	Canada	1 19 0	Switzerland
Steam	4 18 8	North England	4 9 7	United States
Gas (producer)	5 0 0	England	—	—
Gas (blast furnace).....	4 1 7	Germany	—	—

The figures in the table support the opinion, now generally held, that water when developed without excessive capital expenditure is the cheapest source of mechanical or electrical energy. When, however, the hydraulic engineering expenditure has been heavy, or when the power after generation has required to be transmitted over long distances, the margin between the relative costs of water and steam power is greatly narrowed, and in some cases disappears. Electrical energy generated by falling water is costing more at Rheinfelden, at Zürich, and at Buffalo than it would cost in South Lancashire if generated by steam power in large units; and the margin between the actual charge for power at Niagara and the estimated cost of steam power in large generating stations in South Lancashire is only 12s. 1d. per electrical horse-power year. In this connection it is interesting to note that the charge for electric power in Buffalo is 13s. 6d. per electrical horse-power year higher than at Niagara; and the excessive charge to small consumers in the same city (£25. 11s. per electrical horse-power year) would seem to indicate that the cost of transmission between Niagara and Buffalo represents at least 20s. per electrical horse-power year on the power sent into that city. Turning now to a consideration of the relative position of gas power, the question of the practicability of large engines may be taken as settled. If they do not cost excessive sums for maintenance and repairs, large gas-engines, in conjunction with coke ovens and blast furnaces, may entirely alter the present position of affairs; and the new industries which at present are being established in the neighbourhood of water-power stations may find themselves in severe competition with similar manufactures carried on in the coal and iron districts of the older manufacturing countries. It has been calculated that 2,000,000 h.p. is annually wasted in the gases issuing from the blast furnaces of the United Kingdom. If these waste gases could be industrially utilised in the manner suggested, we should to a large extent be compensated for our lack of natural water power. But blast furnaces demand coke, and coal beds are exhaustible, so that even if this source of mechanical and electrical energy be tapped it can only postpone, but not avert, the final triumph of the waterfall and of the turbine.

* Abstract of paper read before the British Association at Bradford.

LIGHT RAILWAYS.

The Commissioners have held an enquiry at Kidderminster into the application of the Kidderminster and Stourport Electric Tramway Company for powers to construct a line from Kidderminster to Bewdley, with a branch to Franche. At the close of the enquiry Lord Jersey said the Commissioners understood there was an agreement as to the line going up to a point by the railway bridge at Wribbenhall. They would go and inspect the route beyond, and did not propose to come back to hear any further statements. They would consider the matter, and then communicate with the County Council and with the promoters.

The Light Railway Commissioners have granted an application for a light railway, between five and six miles in extent, known as the Wales and Laughton light railway. The proposed line commences at a junction with the Great Central Railway near Kiveton Park, and extends through the parishes of Wales, Todwick, North and South Anston, and Dinnington, to within a short distance of Laughton-en-le-Morthen.

The Light Railway Commissioners have held an enquiry into the application for the deviation of a line at West Hartlepool and the application for an order to authorise the Durham and district light railways promoted by the British Electric Traction Company, and granted the application.

The Light Railway Commissioners have held an enquiry respecting the proposed light railway in the Nidd Valley, from Pateley Bridge to Lofthouse, and granted the application.

An enquiry has been held by the Light Railway Commissioners with respect to an application by the British Electric Traction Company for an order to construct a light railway in and between South Shields and Jarrow, to be called the Jarrow and South Shields Light Railways.

FORTHCOMING EVENTS.

FRIDAY, OCT. 19.

Institution of Mechanical Engineers.—At 8 p.m., at Institution House, Storey's gate, first monthly meeting. Paper on "Observations on an Improved Glass Revealer for Studying Condensation in Steam Engines and Rendering the Effects Visible," by Mr. Bryan Donkin.

SATURDAY, OCT. 20.

Glasgow and West of Scotland Technical College Scientific Society.—At 7 30 p.m., at 38, Bath-street, Glasgow, presidential address by Mr. David Home Morton, M.I.C.E., M.I.M.E., on "The Standardisation of Machinery.'

FRIDAY, OCT. 26.

Physical Society.—At 5 p.m., at Burlington House, exhibition of experiments illustrating certain phenomena of vision, by Dr. Shelford Bidwell, F.R.S.; and papers on the "Concentration at the Electrode in a Solution, with special reference to the Liberation of Hydrogen by the Electrolysis of a mixture of Copper Sulphate and Sulphuric Acid," by Dr. J. S. Sand; and "Electromotive Force and Osmotic Pressure," by Dr. R. A. Lehfeldt.

Institution of Junior Engineers.—At 8 p.m., annual general meeting at Westminster Palace Hotel.

SATURDAY, OCT. 27.

Institution of Junior Engineers.—At 3 p.m., visit to the Millbank Station of the London Hydraulic Power Company, Millbank-street, Westminster.

Digitized by Google

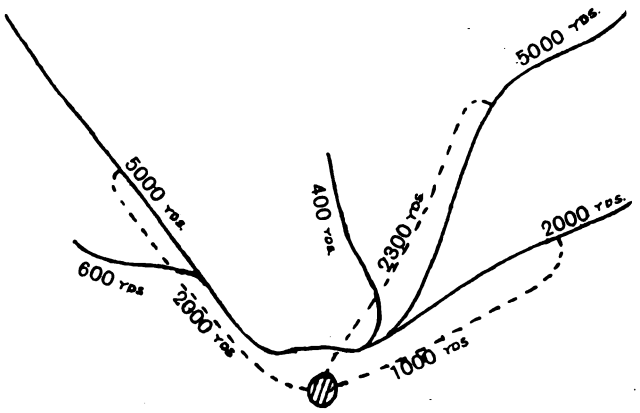
QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

317. Describe the best and cheapest form of main and distribution switchboard suitable for a small private station of two 65-kw. steam dynamos at 110 volts; first, with necessary switching arrangements for accumulator charge and discharging; and, second, without same.—K. M. K.

318. In a traction scheme, as per appended sketch, would it not be advisable to feed the trolley wires at the station in



addition to the feeders, or would it be best to transmit all the energy through the feeders and not tap on to trolley wires at station ?—ARMATURE.

ANSWERS.

Question No. 311.—What is the advantage gained by setting the cranks of a small compound vertical engines at angles other than 90deg.—for instance, about 145deg.

Best Answer to No. 311 (*awarded* 10*s.*).—In the case of high-speed engines such as are in general use for the direct driving of dynamos, a small flywheel is sufficient to maintain adequate regularity of speed. The analysis of the turning moment acting on the crankshaft is of no practical importance except to the builder, who has to design the parts and bearing surfaces to suit. The high speed, however, causes the inertia forces, which increase as its square, to be of considerable importance. In the case of a two "line" engine, the best arrangement of the cranks is at 180deg., in which position the force tending to lift the engine twice in each revolution is a minimum. The importance of this force may be judged from the fact that in the case of a two-line engine, in which the moving piston lines weigh 420lb., the stroke being 9in., and the ratio of connecting rod to stroke 2·4, this force amounts to 1·2 tons at a speed of 350 revolutions a minute. For infinitely long connecting rods this force vanishes. There remains a periodic rocking force about a horizontal axis at right angles to the centre line of the engine and midway between the cylinder lines, due to one piston going up while the other goes down. The third inertia force, due to the weight of the crankpin and lower part of the connecting rod at right angles to the other two, is of no importance.

In the case of a slow-speed engine of about one quarter the angular velocity, the inertia forces will be of much less importance in spite of the heavier moving parts, and even turning moment is of greater importance.

In the case of a two-line engine this is best accomplished by placing the cranks at right angles. This is the usual arrangement in marine, mill-driving, and locomotive work. Some such arrangement is necessary if the engine is to be self-starting in every position, especially if it has to do so against its load. In the case of electric generators this is not the case, so the cranks may be in the same plane. The three-line engine with cranks at 120deg. is practically perfectly balanced, and is self-starting in any position. Mention may be made of Mr. Webb's four-cylinder compound locomotives. These have four cylinders driving the same axle. The inside and outside cranks on one side of the engine are opposite and at right angles to the other pair. This gives a much better balanced engine than the usual arrangement of two cranks at right angles, and incidentally has greatly simplified the valve gear of the inside cylinder.

The case cited of two cranks at 145deg. is a compromise of the two types. It gives an engine which is self-starting and which is of a more even turning moment than one with cranks at 180deg., while the inertia forces will not be so large as would be the case if the cranks were at right angles. Engines running at a speed at which this arrangement might be desirable are not common. Engines either run too slow or else they are able, as in the case of electric generators, to be run up to speed before the load is put on, in which case a two-throw with opposite cranks or a three-throw engine is preferable.—E. H. R.

Answer to No. 311 (*awarded* 5*s.*).—To appreciate the advantages aimed at in setting the cranks of compound engines at angles other than 90deg., it is desirable to discuss first those cases where the cranks are opposite each other, and at an angle of 90deg. respectively. When the cranks of a compound engine are fixed opposite each other, both pistons are at the end of the stroke at the same time, and the larger, or low-pressure cylinder, valve is admitting steam to that cylinder during the same time that the high-pressure cylinder is releasing its steam. Thus there is a

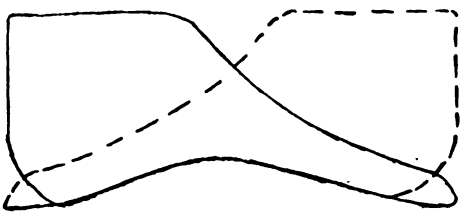


FIG. 1.

free passage for the steam to escape from the latter cylinder, and a continuous flow of steam from the high to the low pressure cylinder. Under these conditions it is not necessary to provide a receiver space between the two cylinders, and the engine can be designed to have the cylinders placed as close together as practicable, thereby allowing of a compact type of engine. With the cranks

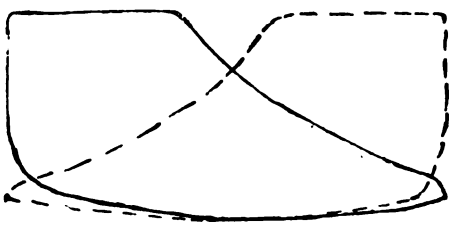


FIG. 2.

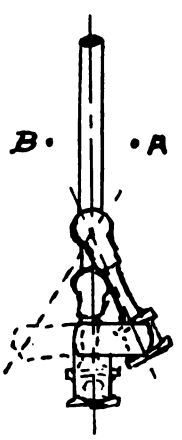
set at an angle of 90deg. to each other, however, the larger piston, neglecting the obliquity introduced by the connecting rod, is at the middle of its stroke when the smaller one is about to release its steam. Now, should cut-off to the low-pressure cylinder occur before half-stroke, a receiver becomes desirable to exhaust the high-pressure cylinder steam into, as the low-pressure cylinder is not taking any steam away. If, however, the engine is of a compact type and no special receiver space has been provided, and merely the unavoidable space between the high-pressure cylinder and the low-pressure valve utilised, the pressure in

Digitized by Google

this confined space would increase, comparatively to the terminal pressure, too high, and since the back pressure in the high-pressure cylinder depending upon the receiver space, this pressure would also be high. In fact, the exhaust line of the high-pressure diagram would take the form shown in Fig. 1, where a considerable rise about mid-stroke is shown. With the cut-off in the low-pressure cylinder about or somewhat after half-stroke, the rise of pressure, of course, would not be so pronounced. In Fig. 2 the form of the high-pressure diagram for cranks set opposite each other is given for comparison. It will be seen, therefore, that a better distribution of the steam can be effected with the cranks opposite each other, and if this were the only factor to consider, that method of setting the cranks would be the best to adopt.

We have, however, to study the effect of the angle between the cranks upon the twisting moment, and here an angle of 90deg. is a distinct advantage. For if twisting effort diagrams are constructed for crank angles of 90deg. and 180deg. respectively, it will be found that there is a more uniform twisting effort when the cranks are set at 90deg. This is evident from a casual consideration only, for when one crank is exerting its maximum effort the other is practically on the dead centre, and the twisting effort is a minimum. Further, with the cranks opposite each other, both are on the dead centres at the same time, and there may, therefore, be a difficulty in starting the engine, and this tells unfavourably for cranks so set. The above considerations, therefore, lead designers to adopt some middle cause, and we find in consequence the cranks of compound engines set at various angles, ranging from 90deg. to 180deg., to each other in accordance with the ideas of the designer.—G. T.

Answer to No. 311 (*awarded* 5s.).—In all compound marine engines the cranks are set at 90deg. This enables the engines to be started without the aid of pinch bar or other appliances. They have also an almost even twisting moment on the shaft. Now there is a great disadvantage in this type of engine due to vibration. On referring to the diagram we will say that the centre of gravity of the



engine is A when one crank is pointing to right, but when one crank is pointing to left the centre of gravity will change to other side, say at B. This sets up vibration, which is very objectionable in towns. Now there is the well-known Belliss central-valve compound engine with cranks set at 180deg. This does away with the vibration nuisance; but there is a point where there is no twisting moment on shaft—viz., where the cranks are in line with the connecting rods. Then 90deg. from this position we have a maximum twisting moment. This necessitates a thicker shaft; also a heavy flywheel to keep a more constant speed, which a varying twisting moment does not give. The engine referred to has its cranks at about 145deg. This engine will partly combine the advantages of a more even twisting moment; also the vibration will be greatly decreased.—W. A. T.

Question No. 312.—Having a ring armature (laminated), 9½in. outside diameter, 5in. inside diameter, and 3¼in. deep, I wish to wind same as a step-down transformer for use on a 100-volt 60-cycle circuit so as to yield 40 volts from the secondary at its maximum capacity. What size of wire and number of turns will be required on primary and secondary? Would it be possible to subdivide secondary circuit so as to yield various voltages?

Answer to No. 312 (*awarded* 7s. 6d.).—

Let E_1 stand for E.M.F. of primary coil;
E_2 ,, E.M.F. of secondary coil;
S_1 ,, number of turns in primary coil;
S_2 ,, number of turns in secondary coil;
n ,, frequency = 60;
N ,, magnetic flux.

Then $E_1 = 4{\cdot}45 \times n \times S_1 \times N \div 10^8$.

Now, cross-section of iron $= \left(\frac{9\frac{1}{2} - 5}{2}\right) \times 3\frac{1}{4}$ square inches

$= 2\frac{1}{4} \times 3\frac{1}{4}$ square inches

$= 7{\cdot}3$ square inches.

For transformers, magnetic flux should be about 40,000 lines per square inch.

$\therefore N = 7{\cdot}3 \times 40{,}000 = 292{,}000$.

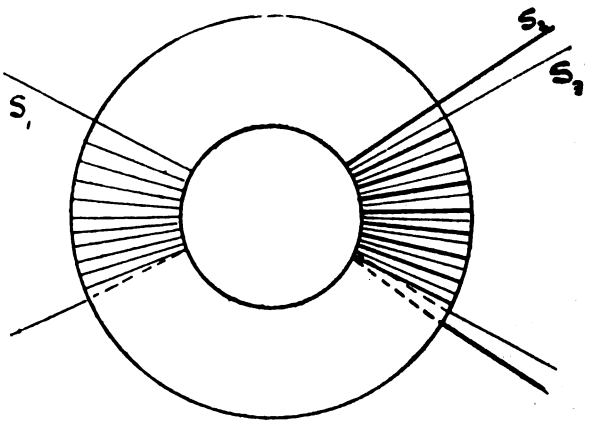
$E_1 = 4{\cdot}45 \times n \times S_1 \times N \div 10^8$;

$100 = 4{\cdot}45 \times 60 \times S_1 \times 292{,}000 \div 10^8$;

from which we get $S_1 = 128$ *turns (primary coil).*

Again, $\frac{E_1}{E_2} = \frac{S_1}{S_2}$, or, $S_2 = \frac{E_2 \times S_1}{E_1} = \frac{40 \times 128}{100}$;

$S_2 = 51{\cdot}2$—say *52 turns (secondary coil).*



Magnetising current:

$$\frac{4\pi}{10} C_m S = N \times \frac{l}{A\mu};$$

$\mu = \frac{B}{H} = \frac{5{,}000}{1{\cdot}66}$ { B = lines per square centimetre. H = magnetising force.

$= 3{,}000$.

Mean diameter of ring = 7¼in.

$\therefore l = \pi \times 7\frac{1}{4} \times 2{\cdot}54$cm.

$$\frac{4\pi}{10} C_m \times 128 = 292{,}000 \times \frac{22{\cdot}8 \times 2{\cdot}54}{7{\cdot}3 \times 6{\cdot}45 \times 3{,}000},$$

from which $C_m = {\cdot}53$ ampere.

Taking the magnetising current as about 4 per cent. of full load,

$\therefore$ full-load current (primary coil) = 25 × ·53 amperes
= 13·25 amperes.

Capacity of transformer = 100 × 13·25 watts
= 1,325 watts.

Taking hysteresis loss as one watt per 1lb. of iron, output of secondary coil = 1,325 − 45 watts = 1,280 watts.

$\therefore$ secondary current $= \frac{1{,}280}{40} = 32$ amperes.

Primary coils should be wound with $^{37}/_{24}$ S.W.G.

Secondary coil should be wound with $^{19}/_{18}$ S.W.G.

The secondary circuit can be subdivided, the number of turns in each of the secondary coils being obtained from the formula $\frac{E_1}{E_2} = \frac{S_1}{S_2}$. The secondary coils should be wound together (preferably) as shown in the diagram.—H. W. GEARE.

Digitized by Google

Answer to No. 312 (*awarded* 7*s.* 6*d.*).—In the case of a small transformer of this nature, probably only intended for experimental work, it is of more importance to consider the ease of winding than the efficiency. On this account the following windings have been arranged to make the core loss approximately equal to the C^2R loss instead of making it distinctly less, as is usual in commercial transformers intended to give a high all-day efficiency.

Two distinct windings are given below, the first being for an ordinary transformer with separate primary and secondary windings, and the second for an "auto-transformer" with the primary and secondary windings connected together in series, as shown diagrammatically in Fig. 1. This last, which gives nearly double the output of the first, is undoubtedly the type of winding to use for

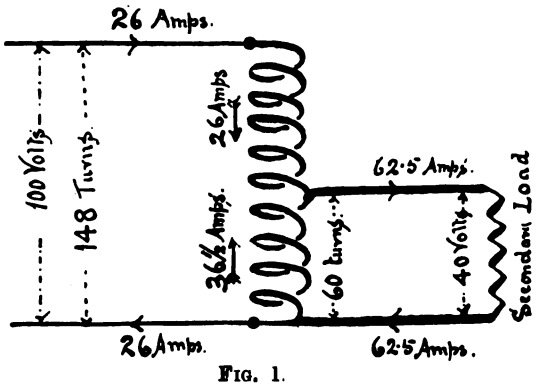


FIG. 1.

such a voltage ratio as 100 to 40 unless the transformer is intended for *boosting* purposes—*i.e.*, to give 140 volts by adding the 40 secondary volts on to the 100 primary volts, in which case the auto-transformer obviously cannot be used, as the two windings are already connected in series. In the following workings it has been considered better to use several small wires in parallel in place of a single large wire, as the difficulty of winding the latter on such a small core would be prohibitive. The several parallel wires can be either wound on simultaneously or each separately so long as the number of turns and total lengths of all the wires are kept alike. It is immaterial whether the primary or the secondary be wound on first.

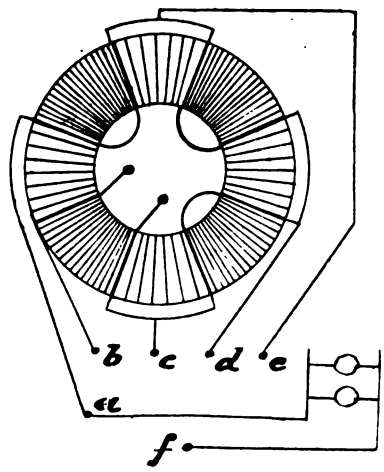
The wires given will be found to go on to the core fairly easily together with the necessary insulation, and should leave a hole about 2½in. or 3in. in diameter through the centre of the core when all is finished.

Proposed Windings.

Type.	Ordinary transformer.	Auto-transformer.
Estimated output with safe temperature rise (not enclosed in case)	40 volts, 37·5 amperes, or 1·5 kw.	40 volts, 62½ amperes, or 2·5 kw.
Primary wire	·104 D.C.C. (No. 12 S. W. G.) Two parallel.	·104 D.C.C. (No. 12 S. W. G. Four parallel for both primary and secondary windings.
Secondary wire	·116 D.C.C. (No. 11 S. W. G.) Four parallel.	
No. of primary turns	148 (or 296 single wires).	148 total turns (or 592 single wires). With a connection for the secondary output made after the 60th turn (as shown in Fig. 1).
No. of secondary turns	60 (or 240 single wires).	
Approximate C^2R loss in the whole of the windings	50 watts.	50 watts.
Induction density in the iron core	5,500 C.G.S.	5 500 C.G.S.
Approximate core loss (assuming average commercial iron).	45 watts.	45 watts.
Full load efficiency	94 per cent.	96 2 per cent.
C R drop	3 3 per cent.	2 per cent.
Core loss as a percentage of full load output.	3 per cent.	1·8 per cent.
Approximate weight of primary wire.	12½lb.	27lb.
Approximate weight of secondary wire.	16lb.	
Weight of core iron	45lb.	45lb.

With regard to the last paragraph of the question, connections can be made to the secondary winding (in either type of transformer) at as many points as is desired, and a corresponding number of different voltages can thus be obtained without difficulty.—Q.

Answer to No. 312 (*awarded* 5*s.*).—The armature core described may be utilised as a transformer core, though, its discs being most probably thicker than those usually employed in the latter case, the loss from eddy currents will be greater. The windings may be arranged in alternate primary and secondary groups round the ring as shown in the figure, where the primary connections and terminals are indicated inside and the secondary connections and terminals externally. By tapping the secondary



at four equidistant points as shown, voltages of 40, 30, 20, and 10 volts may be obtained, according as *b*, *c*, *d*, or *e* is switched on to *f*. The external circuit, connected to *a* and *f*, is conventionally shown with lamps, though, with these voltages, such would, of course, not actually be the case. As, however, this winding is less simple than the wrapping of the whole core by each coil, and is, moreover, productive of some magnetic leakage, we shall here design for the primary to be wound entirely round the ring, and to be overwound by the secondary coils.

Taking approximate dimensions, the outer diameter of core = 24·15cm., the inner diameter = 12 7cm., and the depth = 8·25cm. The plates are bound up by tape, which we may take as occupying a thickness of 2mm. On an assumption that the windings will be 1cm. thick on the outer circumference, and 2cm. thick on the internal, the total cooling surface is 2,137 square centimetres. Taking 87 per cent. of the core section to be actually iron, and 13 per cent. to be insulation between the discs, the iron section is 41·5 square centimetres, and the weight of the core is 19 kilos. With an induction of 4,500 C.G.S. lines, the total flux is $4{,}500 \times 41\,5 = 187{,}000$ lines. According to Kapp's experiments, if we let the temperature of the transformer be about 50deg. C. above that of the surrounding atmosphere, 42cm. of cooling surface are required for each watt dissipated in heat. Our surface will thus permit of 52 watts being lost altogether. At a frequency of 60, about 25 watts are expended in magnetising 19 kilos of iron to the induction chosen. We thus can lose 27 watts in the copper without over-running the cooling surface.

Now, by the usual formula for the E.M.F. induced (effective), and allowing a drop in the secondary of one volt, $41 = 4\,44 \times 187{,}000 \times 60 \times \text{turns} \times 10^{-8}$, whence the number of secondary turns is given as 82. The primary turns are $\frac{100}{41} \times 82 = 200$. Assuming the diameter of the wire to be 3mm, more or less, the length of primary wire comes out to 64m., and of the secondary to 29·5m., approximately.

One condition of efficiency—viz., that iron and copper losses should be about equal—has been satisfied. If we arrange to satisfy another, that the copper loss should be about equal in the two coils, the following ratio should hold:

$$\frac{\text{area of second wire}}{\text{area of first wire}} = \frac{\text{length of second wire}}{\text{length of first wire}} \times \frac{\text{second current}}{\text{first current}} = 2{\cdot}9.$$

Digitized by Google

Dividing the circumference by 200, and allowing ·25mm. for cotton covering, we find the primary wire may be 3·2mm. diameter, wound one layer deep externally and two layers deep inside the ring. The secondary may thus be 4·9mm. covered to 5·4mm., which can be accommodated if wound like the primary. From tables the resistances when hot are found to be: primary = ·18 ohm; secondary = ·031 ohm. The working conditions may now be tabulated from these data:

Load in watts.....	50	...	100	...	500	...	800	...	1,000
Primary current ...	·75	...	1·25	...	5·3	...	8·23	...	10·64
Secondary current...	1·25	...	2·5	...	12·5	...	20	...	25
Copper watts	·148	...	·48	...	·99	...	24 8	...	38 5
Iron watts	25	...	25	...	25	...	25	...	25
Efficiency per cent.	67	...	80	...	94·5	...	97	...	99
Temperature C. above atmosphere.	30°	...	32°	...	33°	...	48°	...	57°

By making connection to the secondary at three intermediate points, as in the figure, various voltages in steps of 10 may be obtained; or, of course, by tapping at a suitable length any desired E.M.F. under 40 volts.—ZERO.

ST. MARYLEBONE.

On Tuesday evening a special meeting of the members of the St. Marylebone Vestry was held at the Court House, Marylebone-lane, Mr. T. H. Brooke-Hitching, C.C., chairman of the Vestry, presiding, for the express purpose of resuming the adjourned debate on the motion of Mr. Edward White, L.C.C., that the Vestry now confirm that part of the minutes of Thursday, Aug. 2, 1900, which related to the proposed purchase of the St. Marylebone undertaking of the Metropolitan Electric Supply Company, and which empowered the Advisory Special Electric Lighting Committee to conclude negotiations with the Metropolitan Electric Supply Company for the transfer of its undertaking under the West London (Marylebone) Electric Lighting Order as embodied in the provisional agreement dated June 25, 1900, and signed on behalf of the company by Messrs. Harrison Cripps and T. Carr Saunders, and on behalf of the Vestry by the Vestry's delegation, Mr. T. H. Brooke-Hitching, Dr. J. Fletcher Little, and Mr. G. Paxton, it being a condition that the figures supplied by the Metropolitan Electric Supply Company be verified by a chartered accountant and an expert electrical engineer to be employed by the Vestry. The price to be proposed to be paid by the Vestry for the undertaking was £916,000.

The discussion was a lengthy one, occupying the attention of the Vestry for over three hours. Messrs. DUNN, PAXTON, W. SUTHERLAND, J. ANGLIM, and others spoke strongly in favour of the delegation's recommendation being adopted, contending that if the Vestry did so that it would have the electric light company's undertaking as a going concern at a reasonable price, and that they would soon see that they had a paying concern. The present lighting of the streets was a disgrace.

Sir EDWIN GALSWORTHY (chairman of the Metropolitan Asylums Board), Mr. G. R. H. STRINGER, Mr. MARTIN MORRIS, and others spoke strongly in opposition, and urged that it would be unfair for members, now that the Vestry was in a dying state, to undertake such a huge undertaking, and that such an important matter should have been left to the new borough council to deal with. It was contended, also, that the price asked was far above what ought to be paid. The company required £500,000 for the goodwill, and in less than 40 years the Vestry would have the undertaking, having to pay nothing for goodwill.

On the question being put to the vote the non-confirmation was carried by 31 to 26. A division was called for, and taken, but the voting was the same. The non-confirmation of the minutes being passed, the scheme proposed by the special committee falls through.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

St. Albans.—The Corporation invite offers for their electric lighting provisional order. Details in our advertisement columns.

Lowestoft.—The Corporation invite tenders for wiring the town hall. Tenders by Nov. 2. Details in our advertisement columns.

Heywood.—The Corporation invite tenders for wiring premises in Heywood. Tenders by Oct. 31. Details in our advertisement columns.

Belfast.—The Gas and Electric Committee invite tenders for various plant. Tenders by Nov. 23. Details in our advertisement columns.

London County Council.—The Council invite tenders for the supply, for one year from Jan. 1 next, of engineers' goods and electrical stores. Tenders by Oct. 29.

Palma.—The Municipality of this town, in the province of Baleares, Spain, invite tenders for the installation and maintenance of 60 arc lamps. Tenders by Oct. 30.

Swansea.—The Corporation invite tenders for the supply of electricity meters, demand indicators, and main fuses. Tenders by Oct. 29. Details in our advertisement columns.

Ayr.—The Corporation invite designs, specifications, and tenders for electric tramway cars with trucks and complete electrical equipments. Tenders by Nov. 1. Details in our advertisement columns.

Pemberton.—The Council invite tenders for boilers (preferably Lancashire), engines and dynamos, battery, switchboard, crane, and conductors. Tenders by Nov. 8. Details in our advertisement columns.

Whitechapel.—The Electrical Committee invite tenders for the supply of a hand-driven overhead travelling crane for their new electricity supply station. Tenders by Oct. 23. Details in our advertisement columns.

Cardiff.—Tenders are invited for slow-speed vertical engines, slow-speed generators, boilers, and economisers. Specifications, etc., may be obtained from Mr. A. Ellis, M.I.E.E., Old Post Office-buildings, Cardiff. Tenders by Oct. 23.

Grantown-on-Spey.—The Commissioners of the burgh invite tenders from electric light companies to supply electric light for public and private consumption within the burgh. Tenders by Nov. 6. Details in our advertisement columns.

Wolverhampton.—The Tramways Committee invite tenders for erection of car depôt, paint and repair shops, etc., at Cleveland-road. Plans, etc., may be seen at the office of Mr. J. W. Bradley, C.E., M.I.M.E., borough engineer, Wolverhampton. Tenders by Nov. 19.

Bradford.—The Corporation invite tenders for the construction and erection of a 30-ton electric travelling crane for their new electricity works, Valley-road, to operate on a 500 volt direct-current circuit. Tenders by Oct. 25. Details in our advertisement columns.

Cienfuegos (Cuba).—Tenders are invited for a service of public electric lighting for the above town. Intending contractors can present their estimates and state their conditions until Oct. 26. All enquiries and tenders should be addressed to the Secretary's Office in Cienfuegos, Cuba.

Glasgow.—The Executive Committee invite tenders for the wiring for arc and incandescent lighting and electric motors at the Glasgow International Exhibition, 1901. Full particulars can be had on application to Mr. Thomas Young, the engineer, 4, West Regent-street, Glasgow.

Dartford.—The Urban District Council invite tenders for the erection of an electric light station at Dartford, in accordance with drawings and specifications prepared by their architects. Specifications may be seen at the office of Messrs. Heaketh and Stokes, 110, Cheapside, E.C. Tenders by Oct. 20.

Lowestoft.—The Corporation invite tenders for the supply and erection of two water-tube boilers and fittings economiser, etc., pipework, etc., in engine and boiler house, and one 250 kw. steam dynamo (vertical enclosed high-speed engine). Tenders by Nov. 2. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of 1,000, 2,000, or 3,000 tons steel straight track rails; 100, 200, or 300 tons steel curved rails; 50, 100, or 150 tons steel fishplates. Specifications, etc., can be obtained from Mr. John Young, general manager, 88, Renfield street, Glasgow. Tenders by Oct. 23.

Leeds.—The Leeds Tradesmen's Benevolent Institute invite tenders for the installation of electric light required in alterations and additions to 41, Park square, together with three shops and business premises, Park lane, Leeds. Plans, etc., can be obtained from Messrs. Butler, Wilson, and Oglesby, architects, 12, East-parade, Leeds.

London (City).—The Streets Committee of the Corporation invite tenders for the hiring of a mechanically-driven dust-cart for collecting and removing the dust, trade refuse, and street sweepings from the City to the Corporation's depôt at Lett's Wharf, Commercial-road, Lambeth, S.E. Tenders by Nov. 10. Details in our advertisement columns.

London, S.E.—The Strand District Board of Works invite tenders for the construction, delivery, and fixing of an engine and dynamo, switchboard, etc., for their destructor works, Shot Tower Wharf, Commercial-road, Lambeth. Specification, etc., to be obtained at the offices of the Surveyor to the Board, between 10 and 12. Tenders by Oct. 24.

Kendal.—The Corporation invite tenders for building engine-house, boiler-house, accumulator-house, chimney shaft, offices, etc., in connection with the electric lighting station to be erected at the gasworks, Kendal. Specification, etc. may be seen at the office of the engineer, Mr. T. N. Ritson, A.M.I.C.E., Gas Offices, Parkside road, Kendal. Tenders by Oct. 29.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2,

Digitized by Google

1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

RESULTS OF TENDERS.

Walsall.—The tender of T. Tildesley, Willenhall, for erecting a transformer station in Pleck-road for the sum of £430 has been accepted.

Ayr.—The Lighting Sub-Committee have accepted the tender of Messrs. Bruce Peebles and Co. for two 200-kw. Belliss-Peebles traction generators, at £4,380.

Stafford.—The Electric Lighting Committee have accepted the tender of the Electric Construction Company, at £322, in connection with renewing the armatures and field coils of the dynamos.

Limerick.—The Town Council have received the following tenders for the erection of an electric generating station building at Frederick-street, Limerick: P. Bourke, Carr-street, Limerick, £2,650; M. Gough, Colooney-street, Limerick, £3,925.

Wigan.—The Corporation have accepted the following tenders: Estler Bros., London, steel poles and section pillars; Blackwell and Co., London, flexible bonds and castings; Bergtheil and Young, overhead construction material; Naylor, bracket arms.

Whitby.—The Urban District Council have accepted the following tenders in connection with the electric lighting: Carrick and Ritchie, travelling crane, £169; C. H. Parsons and Co., two steam dynamos, etc., £2,679; Tudor Accumulator Company, battery, £1,486.

Grays.—The following tenders have been accepted:

Danks, boilers	£2,325 0 0
British Schuckert Company, steam dynamos	2,147 10 0
Green, economiser	241 10 0
General Electric Company, switchboards	628 15 0
D.P. Battery Company, battery	836 1 0
Carrick and Ritchie, crane	95 10 0
Callender, cables	3,546 0 0
Carter, electric light buildings	4,174 0 0
Carter, engineering and road work	1,005 14 0

Messrs. Carter's tender was also accepted for the dust destructor building at £850.

London County Council.—The following tenders have been received in connection with the electric light installation for the Victoria-embankment and Westminster Bridge:

	Five lamps in series (enclosed arcs).	Ten lamps in series (open arcs).
St. Helens Cable Company	£5,016 5 0	£4 300 0 0
Siemens Bros. and Co.	5,762 12 6	4,947 17 6
British Insulated Wire Company	5,786 16 10	5,013 1 8
W. T. Henley's Telegraph Works Company	6,288 1 10	5,552 5 10
Western Electric Company	8,429 12 0	7,582 3 6

The St. Helens Cable Company's tender for open arcs has been accepted.

BUSINESS NOTES.

TRACTION.

Hampstead. — The circular letter from the Vestry of Paddington, referred to in our Holborn note, is before the General Purposes Committee of the Vestry.

Perth Police Commission.—The directors of the tramways company consider that a sum of at least £30,000 will be required to purchase the undertaking. The Commissioners are offering £20,000.

Hull.—Saturday last week was the busiest day the tramway department has experienced since it came into existence. The passengers totalled 123,946, and the aggregate receipts were £516 8s. 10d.

New Malden.—The District Council is making a canvass among the ratepayers with the object of obtaining their views on the tramways question. Electric trams seem to be preferred to any other system.

Edinburgh. — The Tramways Sub-Committee of the Town Council have agreed to recommend the acceptance of an estimate for the erection of the power station at Portobello. The total cost amounts to nearly £21,000.

Wycombe. — A scheme for the establishment of electric tramways was approved by the Town Council on Monday. The scheme provides for a service from the eastern to the western boundary of the borough, a distance of four miles.

Holborn.—The Board of Works have concurred in the resolution of the Vestry of Paddington protesting against further facilities being given to the London County Council for the laying down of tramways without the consent of the local authorities.

Glossop.—The Council have adopted a supplemental agreement with the Urban Electric Supply Company, Limited, with respect to proposed tramways in the borough. They have also decided to extend the tramways up Victoria-street and along Charlestown-road.

Electric Railways Co.—This Company has been registered with a capital of £75,000 in £1 shares, the object being to adopt an agreement with W. Shawe, to acquire any rights relating to railways, tramways, electric lighting or other electrical installations, the supply of electricity, etc.

Southport.—On Wednesday of last week the electric cars began running from Chapel-street, Eastbank-street, and London-street, continuing on their return journey up Houghton-street. Steps will be taken very shortly to raise the capital required for the proposed tramway from Southport to Lytham.

Stirling.—The annual general meeting of the shareholders of the Stirling and Bridge of Allan Tramways Company, Limited, was held at the company's office, Bridge of Allan, on Wednesday. Draft proposals between the Commissioners and the Tramway Company are being considered by a committee.

Coatbridge.—Mr. Murphy having failed to sign the agreement for the tramway he proposed to run in the burgh, authority has been given for the signing of an agreement with the Scottish House-to-House Electricity Company, Limited, who have works in the town, and who intend to apply to Parliament for powers.

Chester.—The Corporation have decided to acquire the undertaking of the tramways company for £18,000. The trams will be transformed into electric ones, and application is to be made for a special Act of Parliament authorising the Corporation to make the five extensions as recommended by the Tramways Committee.

Liverpool.—The resolutions in connection with the extension of the electric tramway system, which were blocked out last week, were carried at Wednesday's meeting of the City Council. This time the Irish members abandoned their hostile tactics, and joined with the other councillors in passing the resolutions. The Cork-street route was abandoned.

Wigan.—The Tramways Committee of the Corporation have decided to make application to the Urban District Councils of Standish and Aspull for sanction to construct tramways in their townships. They have also resolved to make enquiries from various towns as to the hours of labour and wages of tramway employés and as to the administration of tramway undertakings generally.

Bingley.—The District Council intend to apply for parliamentary powers for the manufacture and distribution of electricity, for an extensive scheme of street improvements, and for other powers. It has been suggested that the Council should combine with the Shipley District Council in a scheme for the extension of the Shipley tramways to the edge of the district and into Bingley.

Moss Side.—The chairman of the Highways and Lighting Committee (Mr. Box), with the clerk and surveyor, have been appointed to confer with the chairman of the Manchester Corporation Tramways Committee with regard to obtaining powers by the Council for the construction of additional tramlines in Withington-road and Greame-street, and for the continuation of the Princess-road lines to the Moss Side boundary.

Renfrew.—At the last meeting of the Town Council a letter was read from Mr. Turner, Greenock, informing the Council that application was intended to be made to the Secretary for Scotland for a provisional order for the construction of tramways within the burgh of Renfrew. The Tramways Committee was reappointed to confer with Paisley and Johnstone in promoting or assisting in promoting a measure for the building of tramways from Renfrew to Paisley.

Cardiff.—At the meeting of the Tramways Committee last Friday it was reported that Lord Tredegar declined to sell outright the land necessary for a railway siding for the electric generating station on the Newport-road site, but he offered the land at a rental of £25 A resolution was passed that the Corporation be asked to take over the equipment of the lines in their own behalf, and that the electric tramway engineer be allowed to appoint his own assistant at a salary commencing at £225, rising to a maximum of £300.

Birmingham.—The City Council have agreed that on and after Nov. 9 next a new committee be formed, to be called the Tramways Committee, to be nominated by the General Purposes Committee, under the standing orders, and that the powers and duties of the Council in reference to tramways be transferred from the Public Works Committee to the new committee. As an indication of the magnitude of the work the committee would have to do, it may be mentioned that the three companies in Birmingham take 55 million fares, and their gross takings are £300,000.

Brierfield.—At a recent meeting of the Urban District Council the Clerk reported an interview he and the chairman had had with the various authorities respecting the tramways. The only point was giving a joint notice to the Tramway Committee to purchase the entire length, and also to ask that before arbitration was entered upon what price they wanted and to state what they had to sell. It was also agreed that a notice should be sent asking to buy the tramway company's offices in Burnley, their depôt, and their rolling stock, and each of the other authorities would buy the lines in their own respective district.

Newport.—The report of the Lighting and Traffic Committee was discussed at the last meeting of the Corporation, and it was proposed as an amendment to the report that when the tramways were electrically equipped the Corporation should work the lines themselves, and not let them out to lessees. The amendment was defeated. In reply to the question of either the extension of the tramway system to the Alexandra Dockhead or the running of a service of 'buses, the Town Clerk said he would lay before the Traffic Committee at their next meeting the offer of a gentleman to put a motor 'bus on the road from the end of the tramline to the dockhead.

Salford.—The tramways engineer has reported that the rate of construction of the Great Clowes-street route is equivalent to one mile of single track in five weeks, and on the Pendleton route to

Digitized by Google

one mile of single track in nine weeks. The consideration of the report of the tramways engineer as to the cost of construction of tramways in other towns has been deferred until the actual cost of the works in Great Clowes-street is ascertained. On Wednesday the General Purposes Committee adopted the report of the Tramways Committee, and decided to recommend the Council to adopt the report and to confirm the arrangements with the Manchester Corporation.

Leigh.—The following recommendations of the Tramways Committee were approved at Tuesday's meeting of the Town Council: "That the town clerk, borough surveyor, and electrical engineer be instructed to report upon the advisability of the Corporation (1) constructing and working tramways; (2) constructing tramways and letting them on lease; (3) permitting a company to construct and work tramways within the borough. That the town clerk be instructed to request the South Lancashire Tramways Company, in pursuance of the South Lancashire Tramways Act, 1900, to widen St. Helens-road and King-street, the east and west sides of the north and south approaches to Leigh Bridge and Leigh-road."

Hanley.—At the last meeting of the Town Council a letter was read from the Potteries Electric Traction Company, in reply to a communication from the Council, stating that the company had building at the present time a large number of cars with a carrying capacity of 42 passengers, and that they were about to place another large order for cars of the some capacity, which it was hoped would be executed within the next four or five months, so that by the end of January it was anticipated the number of cars on the road would be nearly double what it is at present. It was decided to call the attention of the Potteries Electric Traction Company to the injustice in the increase of the fare from Miles Bank to Hanley Park from 1½d. to 2d.

Erdington.—The following resolution will come before the Urban District Council at their next meeting: "That in the opinion of this Council the time has arrived when it would be to the advantage of the inhabitants to have a system of tramways properly equipped on an up-to-date system, having regard to the great and increasing traffic on the main road of omnibuses and other passenger vehicles, and that it be an instruction to the General Purposes Committee to consider and report upon the desirability or otherwise of this Council applying for a private Bill giving them power to construct such tramway, it also being understood that the improvement works intended to be carried out in High-street be so designed as to arrange for the passage of such tramways."

Portsmouth.—The electric tramcars about to be ordered will be of the improved type, with the extended top deck and the reversed stairway, giving additional accommodation for six persons, at an extra cost of £40 per car on the contract price. The Tramway Committee's report on the reconstruction of the existing tramlines has been adopted, and they have been empowered to make variations where necessary. The committee hope to be able to submit estimates next December, and to commence the work of reconstructing the lines on the day on which they take them over—Jan. 1—so as to be able to run in time for the summer traffic. The cost of the double line is estimated at £16,000 per mile, that of the interlacing lines at £12,000 per mile, while a single line would cost £8,000 per mile. Taking the proposed lines at 20 miles of double track, this will mean an expenditure of £320,000.

Chelsea.—At the last meeting of the Vestry the surveyor submitted an application from Mr. A. J. Mules Brown, on behalf of Mr. G. Palmer Harding, for permission to erect wires on the lamp-posts in King's-road and Lower Sloane-street, from World's End towards Victoria, for the purpose of running electric cars. He explained that this was a new form of electric tramway which would do away with the necessity of laying rails or overhead wires in the streets. All that would be required would be to place connecting irons along the side of the road on a line with the kerb on poles. The cars would be for 24 passengers, and would weigh three tons. If the system could be worked practically it would solve the tramways questions, but there were many points to be considered, and he thought the matter might go to the Works Committee. The Vestry, however, decided to adjourn the consideration of the matter for a year.

New General Traction Co.—The half-yearly report of the directors states that the tramways at Norwich were opened on July 30, since when they had been working most successfully, producing results beyond the anticipations of the Board. The tramway in Coventry was finished and opened on Jan. 18, and a fair return on the investment is anticipated. The Philadelphia Suburban Traction Company's lines (about 20 miles), connecting Philadelphia with the cities of Chester and Media, are nearing completion, and a portion of the line has been in successful operation since July 1, and the directors feel satisfied with the future outlook. The Douglas Southern line has been in operation some time, and the Board expects the same dividend as was paid last year—viz., 6 per cent. on the preference shares. The directors expect that the company will be in receipt of dividends or interest from all the undertakings by the end of the current year.

Charing Cross-Hampstead Railway.—An account of an interview has appeared in the daily Press in which Mr. H. C. Davis, of New York, who is vice-chairman of the syndicate that has taken over the rights of constituting the Charing Cross, Euston, and Hampstead Railway, stated that the work will probably be commenced in February next, and it is hoped that it may be finished in two years. The power station for generating the electricity which will provide the motive power will be at Highgate-road. There will be two sets of lines, one starting from High-street, Hampstead, and running down Haverstock-hill, and the other from a station adjoining that of the Midland Railway at Kentish Town. They will unite at Camden Town High-street, and run to Euston Station. It will go under Tottenham Court-road to a station connected with the Central London Company's at Oxford-street, and thence to Charing Cross, thus linking together the Midland, London and North-Western, Central London, and South-Eastern Railways. The trains are to be worked on the "multiple unit" system, each carrying its own motor underneath, so that there will be no engines. The corridor cars will be glazed at the ends, so that passengers can see from one end of the train to the other. There will be an all-night service, and during the busy portions of the day trains will run every 2½ minutes. The journey from Hampstead to Charing Cross is expected to take 20 minutes. Mr. Davis said there would be no company floated here, the Yerkes Syndicate being prepared to find all the capital.

Strikes.—We learn that the difficulty with the Hull tramway men has been met by the Tramways Committee in a conciliatory spirit, with the result that now the men are working under improved conditions. The dispute was on the hours the men had to work, and the new arrangements consist of a 60-hour week, with one day in seven off for each man.—With regard to the Ashton tramwaymen's dispute, the *Manchester Guardian* says the Amalgamated Association of Tramwaymen and Hackney Carriage Employés has published its reply to the statement of the Oldham, Ashton, and Hyde Electric Tramway Company in reference to the strike of tramwaymen at Ashton. The reply, which is in the form of a letter to the Board of Trade, shows that 36 men in the company's service had worked from 4 to 54 hours' overtime during the three weeks preceding the strike, the aggregate overtime in that period having been 664 hours. Those men had gone on duty between four and five o'clock in the morning, and after they had finished their ordinary shift they had returned to work between 2.30 and five o'clock of the same day, and so worked the overtime referred to. The union contends that the company has no ground for reducing the staff, and alleges that men have been dismissed for joining the union, and that others have been threatened with dismissal in the event of their joining. In conclusion, the union say: "We feel convinced that if the Board would only allow us the opportunity of placing our side of the case before them, and producing evidence, a different aspect would be put upon it altogether, and it is for that purpose and in the interests of peace that we ask that some intervention should take place by the Board of Trade, and we bind ourselves to accept their decision."

Manchester.—In the last report of the directors of the Manchester Carriage and Tramways Company reference is made to the agreement which has been made with the Manchester Corporation as to the future working of the tramways by electricity within the city and within the districts of a large proportion of the surrounding local authorities. At the last Town Council meeting the following resolutions were adopted: "That this meeting hereby consents to the inclusion in the said Bill of provisions to confer further powers upon the Corporation in connection with their tramways undertaking by authorising the construction of additional tramways within the city, as follows: A double line of tramway commencing by a junction with the existing tramway in City-road, and passing thence along Medlock-street and Upper Medlock-street to the junction of the last-named street with Embden-street. A single line of tramway commencing at the junction of Upper Medlock-street and Embden-street, and passing along Embden-street in an easterly direction into and along Boundary-lane, and terminating by a junction with the existing tramway at the junction of Boundary-lane with Coupland-street. A single line of tramway commencing by a junction with the existing tramway in Greenheys-lane, and passing thence along Pigott-street into and along Renshaw-street, and terminating by a junction with the proposed tramway in Embden-street. A single line of tramway commencing by a junction with the existing tramway in Cheetham Hill-road, at the corner of Woodlands-street, and passing thence along Woodlands-street, Humphrey-street, Moss Bank, and Lansdowne-road, and terminating in such road at its junction with Oak-road. A single line of tramway commencing at the junction of Lansdowne-road and Oak-road, and passing thence along Oak-road into and along Crescent-road, and continuing along the last-named road in a westerly direction, and terminating by a junction with the existing tramway in Cheetham Hill-road. To substitute double lines for the existing single lines in Corporation-street and Cross-street."

Devonport.—We are informed that the probable date of the opening of the Devonport and district tramway lines for traffic will be about the end of December next. The Corporation have adopted a report of the Tramways Committee recommending that Mr. C. Chadwell, C.E., be instructed to prepare bills of quantities and specifications for the construction and equipment of St. Budeaux tramways, and to advertise for tenders; that the work be undertaken at the earliest possible moment, and that application be made for sanction to borrow the necessary moneys; and, further, that, having regard to the insurmountable delay in the construction of the St. Budeaux sewers and the rebuilding of Camel's Head Bridge, application be made for an extension of the period for the construction of the tramways. The minutes also contained a resolution that the committee would be willing to lease the line to the Devonport Tramways Company on the following terms: (1) The lines to be constructed by the Corporation at its own cost. (2) The lines when constructed to be leased to the company for a term of years. (3) The company to pay during the lease a yearly rent made up of the following items: (*a*) wayleave rent at the rate of £50 a mile; (*b*) the annual sum required for interest and sinking fund on the cost of construction; (*c*) one-third of the annual sum required for interest and sinking fund on the cost of rebuilding

Digitized by Google

Camel's Head Bridge. (4) The lease to contain such provisions as might be agreed upon or be reasonably required by the Corporation. (5) Following the precedent of the Croydon tramways, the lessees to be guaranteed in the due observance of the covenants and conditions of the lease by the British Electric Traction Company, Limited, entering into a bond with the Corporation in the sum of £15,000. (6) The company to repay to the Corporation the expenditure incurred by the latter in obtaining the powers for the St. Budeaux line, and also an agreed proportion of the cost of obtaining the powers for the new tramways authorised by the Devonport Corporation Act, 1900. (7) The tramways included in the lease to be worked by electrical energy, and that energy to be purchased from the Corporation.

LIGHTING AND GENERAL.

Stockton.—The electric lighting of the town is to be commenced next week.

Weston-super-Mare.—The electric lighting company have commenced to lay mains.

Stroud.—The resolution to apply for a provisional order, noted in our last issue, was agreed to on Wednesday.

Knottingley.—The question of electric lighting will again come before a meeting of the District Council shortly.

Dorchester.—Application is to be made to Parliament for a provisional order for lighting the borough with electricity.

Cuba Submarine Telegraph Co.—The directors recommend a dividend on the ordinary shares at the rate of 5 per cent. per annum.

Islington.—The London County Council have agreed to lend the Vestry £3,100 for electric light installations and street-lighting.

Blairgowrie.—The Police Commission have been conferring with Mr. Hawtayne with reference to the question of electric lighting.

Hampstead.—Fawley and Crediton roads are to be lighted by means of 16 incandescent electric lamps, at an estimated capital outlay of £98. 8s.

Indo-European Telegraph Co.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum.

Maidstone.—An additional £4,000 is to be applied for in consequence of Mr. Preece's report on Messrs. Stevens and Barker's electric lighting scheme.

Newington.—The full financial report on the electric lighting scheme will probably be submitted by the end of the month. The accounts have been closed up.

Basingstoke.—The Council have engaged Mr. Reginald P. Wilson, of 66, Victoria-street, Westminster, to make a report in connection with the electric lighting scheme.

Burton.—During the past month the quantity of electric light sold in Board of Trade units was 9,790, showing an increase of 1,267 in the corresponding month of last year.

Canterbury.—The Council have decided to refer the matter of the assessment of the electric light works to arbitration, subject to an agreement being entered into by the Guardians.

Rochdale.—At the next meeting of the Corporation the General Purposes Committee will recommend the formation of two new bodies to be known as the Electric and Tramways Committees.

Grangemouth.—The Electric Lighting Committee have been empowered to employ a parliamentary agent for opposing the application of the North British Electric Supply Company.

Ellesmere.—At the next meeting of the Urban District Council, a letter from the Postmaster-General with reference to the proposed establishment of a Post Office telephone exchange in the town will be further discussed.

Grays.—The expenditure on the electric light scheme will come to £15,000. The accepted tenders appear in another column. A saving of £650 has been made on the original tenders for the building, and £350 on the cables.

Newport.—The Corporation have decided to apply to the Local Government Board for sanction to borrow £30 000 repayable within 25 years, required for electric lighting purposes. Of this sum £10,000 has already been spent.

Wealdstone.—The Council are allowing the Harrow Electric Light and Power Company to supply electric light to premises in the course of erection in that part of Station-road which has been transferred to their district from Harrow.

Barry.—A special meeting of the Council has been summoned with the object of "considering the desirability of passing a resolution that application be made to the Board of Trade for a provisional order under the Electric Lighting Acts."

Eastbourne.—The Town Council intend to apply to the Postmaster-General for a license, to expire in the year 1911, authorising the Council to provide a system of public telephonic communication within the borough of Eastbourne.

Friern Barnet.—At a recent special meeting of the District Council the question of applying to the Board of Trade for a provisional order for electric lighting was considered, and consideration of the whole matter was deferred till Oct. 27.

Rochester.—The Town Council are corresponding with the Chatham, Rochester, and District Electric Light Company with regard to the latter's offer to treat with the Corporation for the sale of that part of the undertaking which is within the city.

Hull.—We learn that the cause of the recent failure of the electric light lay in the mains, and was owing to a short-circuit, and not to a breakdown of dynamos, as was generally anticipated.

Launceston.—The differences which have existed for some little time past between the Launceston Town Council and the gas company have resulted in a proposal to light the town temporarily with oil, with the intention of eventually installing the electric light.

Ripon.—The City Council have decided to apply to the Board of Trade for a provisional order under the Electric Lighting Acts to authorise the Corporation to supply electrical energy in the city. The engineers appointed are Messrs. G. Harrison and Co., of Ripon.

Bermondsey.—Services have been recommenced at St. James's Church, Bermondsey. The exterior of the edifice has been repaired, the interior repainted, redecorated, and the electric light has been installed, the total cost, with other improvements, being about £2,000.

Appointments Vacant.—An assistant is required in the meter-testing department by the Edinburgh Corporation. There is also a switchboard attendant wanted by the Bradford Corporation. Full particulars of these vacancies appear in our advertisement columns.

Whitby.—The Urban District Council have accepted a number of contracts in connection with the installation of electric light. They have also decided to advertise for tenders at once for the loan of £9,000 towards the cost of the works, and for the remaining balances when required.

Luce-in-Makerfield.—Application is to be made to the Board of Trade on or before Dec. 21, 1900, for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise the Urban District Council to supply electric energy for public and private purposes within their district.

Trowbridge.—Mr. D. Stevenson's report on the electricity supply has been adopted, and the Council have decided that the special meeting to consider the question of electricity supply be convened in such a form that it might deemed a statutory meeting in case the Council decide to apply for a provisional order.

Presentation.—On Friday, the 12th inst., the directors and London staff of the Brush Electrical Engineering Company presented their general manager, Mr. R. Percy Sellon, with a wedding gift, consisting of a silver bowl and inkstand, together with an illuminated album containing the autographs of the subscribers.

Vivograph Syndicate, Limited.—This Company has been registered with a capital of £80,000 in £1 shares, the objects being to carry on in all their branches the businesses of electricians, electrical, mechanical, metallurgical, and general engineers, and contractors for the supply of electrical and other power.

Poplar Lighting.—With respect to the article on the opening of the Poplar electricity works, which appeared in our last week's issue, we are informed that the lamps supplied are all of the patent Brockie-Pell type, and were made by the Brockie-Pell Arc Lamp Company, they being the sole owners and manufacturers of this lamp.

Rotherhithe.—At the Vestry meeting on Tuesday a letter was read from the County of London and Brush Provincial Electric Lighting Company, Limited, relative to the notice served by that company in June last of their intention to apply for a provisional order in respect to this parish, asking for the consent of the Vestry in the matter.

Brighton.—At the Council meeting on Wednesday afternoon a report was submitted recommending that application be made for a loan of £56,500 for electric lighting. Machinery and plant will absorb about £26,500 of the total sum, and mains and house services about £28,500. The remaining £1,500 will be for contingencies.

Book Received.—We are in receipt of an exceedingly well illustrated and exhaustive work entitled "Flame Electricity and the Camera; Man's Progress from the First Kindling of Fire to the Wireless Telegraph and the Photography of Colour," by George Iles, and published by Grant Richards, London, on Tuesday, Oct. 16.

Oldham.—The Town Council propose to apply to the Local Government Board for sanction to borrow £157,000 for the purpose of erecting at Greenhill a station for the supply of electric energy, both for lighting and power and for tramway purposes, together with the necessary engines, boilers, dynamos, workshops, stores, and all accessories.

Sudbury.—The Town Council have confirmed their intention noticed in our last issue, and have resolved to make application to the Local Government Board for borrowing powers for the two sums of £4,523 and £15,536 required, and that intimation be given that at the same time an application would be made for a loan for electric lighting works.

Wakefield.—During the present week Messrs. Fowler, of Leeds, have placed two transformers in the electrical sub station at the top of Westgate, as part of the extra plant necessary for enabling the Corporation to cope with the extraordinary load. The capacity of the new transformers will admit the simultaneous lighting of about 3,000 additional lamps.

Gloucester.—At a special meeting in committee of the Gloucester City Council on Wednesday it was decided to recommend the Corporation to entertain a proposal for purchasing and working the local tramways. The company owning these lines at present have applied for powers to lay down new and extended lines, and to employ electricity as the motive power.

Digitized by Google

"Britannic the Second."—The Thames Electric and Steam Launch Works, of Strand-on-the-Green, Chiswick, recently launched a neat little steam-launch of the above name, which they have constructed for H. Artrop, Esq. The fittings of the boat throughout are of teak, and electricity is used to light the cabins, and also for the bells required on board.

Heywood.—The Council have already applications for 2,700 8 c.p. lamps out of the 4,000, or about two-thirds of the power which they are providing for. The charge for current has been fixed at 6d. per unit, inclusive of free wiring. Application is to be made for power to borrow an additional £2,000 for electric lighting works. This will make a total of £17,000 obtained.

Stirling.—The electrical engineer is preparing a report on the cost of erecting 10 lamps in the Craigs district. A proposal by the engineer to charge less for the electric light to basement premises lit during the day, and recommending that the rate be 4d. per unit, with a minimum charge of £1 per quarter, the consumer paying for the special meter required, has been approved.

Penzance.—Out of the 28 applications received for the appointment of an electrical engineer to report on electric lighting the following have been selected: Lacy, Clirehugh, and Sillar, F. J. Warden-Stevens, James C. Shoolbred, W. H. Trentham, Reginald P. Wilson, Thomas L. Miller, Medhurst and Lloyd, Robert Hammond. The appointment will probably be made on Monday next.

Norton.—The Norton (Malton) Urban District Council on Monday sealed an agreement with the Northern Counties Electricity Supply Association, authorising the latter to apply for a provisional order to light the district by electricity. The company undertakes to do the public lighting at 30 per cent. less than the present cost of gas, and to charge private consumers not more than 7d. per unit.

Rome.—The Italian Government have established telephone wires along the Italian Alps with the object of connecting Rome with Paris. Owing to the enormous difficulties which have been encountered, it has taken seven months to complete the work. The French Government are now making preparations their side of the Alps, and it will take some months yet before the line to Paris is completed.

Catalogue.—We have received from Messrs. J. P. Hall and Co., of Oldham, a copy of their catalogue of electrical machines. The catalogue is neatly bound, and the inside matter is very plainly set forth. Various machines are illustrated, and measurements, speeds, powers, and quantities connected with the dynamos and motors supplied by the firm are given. The firm has, we notice, obtained a silver medal at the Paris Exhibition this year.

Colwyn Bay.—Mr. Leigh (the engineer) has submitted a report upon the extension of cables necessary for the purpose of connecting Pwllycrochan Hotel and the Penrhos College, and the probable cost thereof, and the Urban District Council have deferred its further consideration for a month. The engineer will in the meantime furnish the committee with an estimate of the cost of the extra plant required to meet immediate wants.

Macclesfield.—A committee, consisting of the Mayor, Aldermen Pickford, Eaton, Fountain, and Savage, and Councillors Cameron, Shaw, Ibeson, and Cross, have been appointed to confer with the town clerk and take all steps necessary for the procuration of a provisional order to establish an electrical installation for the borough. The question of the appointment of an electrical expert has been left over until after the elections on Nov. 9.

Chiswick.—The work of laying the cables in connection with the electric light in this parish is being proceeded with rapidly, and the erection of the generating station is in progress. The company will probably be in a position to supply the light from their own station by the latter end of the year. We understand that, as a temporary measure, arrangements have been made with the Hammersmith Electric Light Company for the supply.

Fire Alarms.—On Thursday evening last week the City brigades were turned out in strong force by a "call" from a warehouse in Australian-avenue, Bishopsgate-street, which is fitted with a new fire-alarm apparatus. This arrangement is supposed to get into working order through heat, which at a certain temperature acts upon mercury, and by contact with electricity rings the fire alarm. The bells were still ringing when the different fire brigades arrived, but there was no fire.

London Gazette.—A supplementary dividend of ½d. per £ has been declared in the estate of A. G. Inrig, 46, Whitepost-lane, Victoria Park, London, payable on Oct. 23 at the office of the trustee, E. H. Hawkins, Wholesale Traders' Association, 3, Barbican, E.C.—The Light Railway Commissioners have submitted to the Board of Trade an order made by them for the construction of light railways in the parish and urban district of Rhyl, in the county of Flint.

Welsbach Meeting.—We note comments in the evening papers complaining that reporters in the first instance were refused admittance at the Wednesday's meeting of the preference shareholders of the Welsbach Company, and that after the point had been conceded "copy" was conspicuous by its absence. The subsequent meeting did not produce a quorum, some £950,000 stock being represented, whereas a representation to the amount of a million was necessary under the articles.

The Andrews Joint-Box.—With respect to the Andrews and Glass joint-box, described in our last issue, we are informed by the makers, Messrs. Cowans, of Salford, that no special skill is necessary on the part of the man using this joint-box. In a service joint recently made by a labourer, though his time fell short of the record referred to in our article by seven minutes, the result was a joint with which no fault could be found. Some instruction is, of course, necessary in the first instance, and Messrs. Cowans arrange to send a man to make a few sample joints in any place where the box is being given a trial.

Stock Exchange.—The Stock Exchange Committee have appointed Oct. 31 as a special settling day for United River Plate Telephone Company's further issue of 23,361 5 per cent. cumulative preference shares of £5 each, £3. 10s. paid, Nos. 16,640 to 40,000. The committee have also ordered the said securities to be quoted in the official list. The committee have also been asked to appoint a special settling day in Willans and Robinson's further issue of 10,000 ordinary shares of £5 each, Nos. 90,001 to 100,000, and 10,000 6 per cent. cumulative preference shares of £5 each, Nos. 70,001 to 80,000, and to allow the following securities to be quoted in the official list: Willans and Robinson's further issue of 10,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 60,001 to 70,000.

Papristeel Conduits.—We have received from the General Electric Company a circular which they have just issued regarding their "papristeel" conduit. This is an improved form of the firm's well-known "union" steel tubing, in so far that to the mechanical advantages of this latter are added good insulation and proof against damp. This tube can be supplied with screwed fittings if necessary, and is standardised to fit their "union" system of accessories. This will be found of great advantage in the installing of the tube and the cost of the system, combining as it does the qualities of the various mechanical and insulating conduits is exceedingly low. The conduit is made with external diameters ranging from ½in. to 1½in. The insulating material consists of paper tube, this being drawn over with the union steel conduit.

Hornsey.—The District Council have decided to at once proceed with the installation of the electric light in a portion of the district under their charge, and last Friday Colonel Luard sat at the Council offices, Highgate, to take evidence with reference to the application of the Council to the Local Government Board for sanction to borrow £73,500 for the purposes of the scheme. The scheme is that of Mr. Robert Hammond, and the buildings are to be erected from the plans of Mr. E. J. Lovegrove, the Council's engineer. The generating station will adjoin the Great Northern Railway at Hornsey, and be on the same site as the new public baths, the spare heat from the furnaces being used in the baths. It is intended to replace 155 gas lamps by 94 arc lamps, and the estimated revenue at a lower price than gas at 3s. per 1,000ft. is sufficient to leave a margin of £1,764, after paying all charges.

Fitting Lord Ellesmere's House.—A number of leading manufacturers in England and France were recently invited to submit designs for electric fittings for Bridgewater House, London, the town residence of the Earl of Ellesmere. Considerably over 100 designs were sent in, and those submitted by Messrs. Dennison, Berlyn, Sillem, and Co., Great Portland-street, W., were selected, and the order has been placed with that firm. A brief description of these fittings should be interesting. Thus massive circular dishes of elaborately cut glass, 24in. in diameter, surmounted by finely designed metal coronas form the principal part of each electrolier. These coronas of wrought and chased metal are in the style of the Italian Renaissance, in keeping with the decoration of Bridgewater House. The electroliers consist of handsome coronas with six crystal pendants surrounding the larger central cut-glass dish, and carrying 45 lights in all, these coronas being supported by chains and rings from metal crowns at the ceiling above. The state rooms alone will take 16 of these electroliers, and the scheme is throughout of the most costly description, and in its way is quite unique.

London County Council.—At Tuesday's meeting of the Council the Highways Committee recommended the Council to make application in the next session of Parliament for powers (1) for the construction of tramways for electrical traction between the present terminus of the London County Council tramways at High street, Tooting, to the county boundary at Waterfall Bridge; (2) to acquire the St. Matthew's girls' school premises adjoining the Camberwell tramway depôt for the establishment of a generating station for the London County Council tramways. The committee also recommended that the resolution of the Council of Aug. 1, 1899, with reference to the application to the Board of Trade for a license under the London Tramways Act, 1888, to authorise the experimental use of mechanical traction on the tramways between Westminster Bridge and Tooting, be not further acted upon. This action is taken because powers have now been obtained by the London Council Tramways (Electrical Power) Act, 1900, for the reconstruction for electrical traction of the whole of the Council's tramways, including the portion from Westminster Bridge to Tooting. It was further recommended that no further action be taken upon the resolutions of the Council of March 27 and May 15, 1900, respectively, with regard to the institution of proceedings against the London Electric Supply Corporation in respect of the company's failure to maintain a proper supply of electrical energy in the areas included in the company's orders of 1889 and 1890. A very large number of applications to lay mains, etc., were sanctioned under the usual conditions, also an application from the General Post Office for permission to lay (*a*) two 3in. pipes for telephone wires from the south-west corner of Temple-avenue into the Victoria-embankment subway, and (*b*) one 3in. pipe from the south-west corner of Carmelite-street into the subway.

Portsmouth.—The Postmaster-General has granted the application of the Town Council for a license to establish and work for 25 years a municipal telephone exchange in that town. A special

Digitized by Google

committee is to be appointed to take charge of the undertaking, and the co-operation of local authorities in contiguous townships has been secured. The Fareham Urban District Council have decided to support the proposal on condition that they retained control of their roads.

Sevenoaks.—At the last meeting of the Urban District Council the report of the sub-committee appointed to interview the Electrical Power Distribution Company, Limited, on the question of supplying Sevenoaks with the electric light was presented, and it was stated that the company had met them with every good spirit, which pointed to the probability of the electric light being provided for Sevenoaks on most satisfactory terms, and at great convenience to the district.

Perth.—At a recent meeting of the Electric Lighting Committee, a letter was read from Mr. Hawtayne stating that the lamp columns ordered for Atholl-street have the lamps supported centrally, and that they would not be suitable for the lighting from the side of the street. The Commissioners therefore decided to abide by their first resolution and retain the lamp-posts in the middle of the street. The distributing mains will be laid along the south side of the street, and a cable run across to each lamp therefrom.

Articled Pupils.—At a recent meeting of the Sheffield Town Council attention was called to a resolution to receive a youth as an articled pupil at the electric supply department. It was taken for granted that the head of a department is not to receive any premium. At the same time it was argued that this was unfair to a head official, for why should he give special attention to a youth without recompense? Ultimately the Council accepted the youth, as suggested by the committee, and referred the general question to the Finance Committee.

Ilford.—At the last meeting of the Urban District Council the Clerk read a letter from the Local Government Board with reference to the Council's suggestion to contribute £350 to the cost of placing the telegraph wires underground. They stated that they knew of no authority under which such payment could be made, and therefore could not authorise such payment. It was resolved that a deputation consisting of the chairman, vice-chairman, and the clerk should attend on the Local Government Board to explain the matter.

Brighton.—It has been decided to include in the Bill to be promoted by the Corporation in the next session power to the Corporation to purchase and hire out to consumers or wiring contractors electric motors, cooking, heating, and ventilating apparatus. Feeder No. 11 is to be extended to the south side of Grand Junction-parade at an estimated cost of £2,500. The engineer has been instructed to report upon a proposal that the public street lamps in the upper portion of New England-road and the lower portion of Chatham-place should be lighted by electricity.

Morecambe.—At the last meeting of the Urban District Council a letter was read from the Technical Instruction Committee, asking that, on the score of health, electricity might be used as an illuminant instead of gas. The excessive heat caused by the gas had caused many headaches. It was decided to refer the matter to the Plans Committee. During the discussion it was suggested that in the meantime estimates might be obtained from tradesmen as to the cost of substituting electric light, and it was stated that a minute had been formerly passed authorising the adoption of the electric light.

Glasgow.—On Saturday the Port Dundas electricity works were thrown open for the inspection of the electrical engineers and others in the city interested in the development of the application of electricity. The visitors, about 700 in number, were received by Bailie Maclay, convener of the Electricity Committee; Bailie Willock, convener of the Works Committee; and by Mr. Chamen, chief engineer. We learn that the opening of the station, which was described in our issue of Sept. 21, has excited such great interest in electrical circles far outside of Glasgow, as well as amongst the general body of ratepayers, that the committee will probably have the works open again for inspection by the general public.

Walsall.—The total number of consumers supplied on Sept. 30 last was 165. The total units generated at the station during the month of September was 29,043. The total units from the transformers was 21,564. The Local Government Board have approved that the land formerly part of the site of the Wolverhampton-street gasworks be appropriated for the electric lighting undertaking. The Board have also sanctioned loans of £6,320 and £3,150 out of the proposed loan of £15,000 for the purpose of the electric lighting undertaking, and they have asked for a detailed estimate of the cost of the proposed works in relation to the application for a loan of £5,678 for the extension of the electric lighting mains to Bescot.

Smethwick.—The Council have decided to consult Mr. J. G. Aldridge, electrical engineer, with regard to their negotiations with the British Electric Traction Company. We understand that a somewhat more favourable basis of negotiations has been arrived at, according to which the Council would have the power to take over the concern in seven or fourteen years after the expiration of the present lease, the British Electric Traction Company paying all expenses of management, and while agreeing to hand over to the Council a percentage of the gross receipts, will also undertake to supply electricity for lighting and other purposes to private consumers at the same rates which are current in neighbouring districts.

Hove.—It has been decided that a committee, to consist of seven members, be appointed to carry out the following duties—viz.: to superintend the lighting of the public streets; to fix and determine the situation of all lamps within the borough; to have charge of all matters arising out of the electric lighting orders in force within the borough, or any deed of transfer, contract, or deed made thereunder, particularly as to carrying out the electric lighting order for Aldrington; and generally to take cognisance of electric lighting within the borough, and also to have the special control of any officer appointed particularly for electric lighting purposes; and that the duties of the Works and Improvements Committee be varied accordingly.

Sheffield.—The question of the cheap supply of electricity was discussed at the Town Council meeting last week, and it was suggested that the Electric Light Committee should make full enquiry whether the supply could be obtained at the pit mouth or elsewhere. The consumption of electricity would increase by leaps and bounds in the near future, and the Council should know which was the cheapest source of supply. The committee propose to recommend the Council to establish a new generating station for the development of electricity on a large scale, and the whole question will then be discussed. The question of the pit mouth is to be considered by the engineer. It appears that the water power of the city cannot well be utilised for the generation of electricity.

City of London.—A scheme was introduced at the Court of Common Council on Thursday week for the testing in future of all electric meters within the City under the direction of the electric inspector at the expense of the City of London Electric Lighting Company and the Charing Cross and Strand Electricity Supply Corporation, each company to contribute, in addition to the other expenses, £200 per annum to the Corporation in respect of the electrical inspector's salary. Under those circumstances, it was proposed that the inspector's salary should be increased from £350 to £500 per annum. Under the scheme the Corporation would be relieved in future of all expenses connected with the appointment, those expenses at present amounting to £350 per annum. Finally, consideration of the matter was adjourned.

Airdrie.—The Scottish House-to-House Electricity Company, Limited, have acquired the interest of the New General Traction Company, Limited, in the Airdrie tramway scheme, and they are arranging to obtain similar powers for the adjoining burgh of Coatbridge, which they at present light with electricity. Airdrie Town Council having previously acquired a provisional order for the electric lighting of the town, a conference was held on the 12th inst. as to the House-to-House Company acquiring that order, and lighting Airdrie from their works at Coatbridge as well as running the tramway. A resolution was carried recommending the Town Council to dispose of its provisional order to this company upon terms indicated by the company's representative, but which have not as yet been definitely concluded.

Salford.—A private conference of members of local authorities was held on the 10th inst. in the town hall to consider the question of providing or securing an improved telephonic service within the National Telephone Company's district, of which Manchester is the centre. The Mayor of Salford presided. Other members of the Corporation and about 30 representatives of neighbouring authorities, including Eccles, Bowdon, Failsworth, Prestwich, Levenshulme, Swinton and Pendlebury, Whitefield, etc., were present. A resolution was carried unanimously, "That a committee be now appointed to consider the question of providing better facilities for telephonic communication, and to report their recommendations on the matter to a future meeting." It was decided that the committee should consist of one representative from each of the local authorities invited to the conference.

Harrogate.—The Corporation's electric light installation was established in April, 1897 and the total loans sanctioned up to the present time amount to £68 724. During the third year 365,404 units have been sold, as against 201,363 in the second, bringing in a total revenue of £6,400, an increase of £1,732. The net profit for the past year, after the payment of all charges, is £777. The previous year showed a deficit of £729, which has now been discharged. There is an increased demand for the light, and the Corporation have reduced the tariff. The Council have decided to apply to the Local Government Board for sanction to a further loan of £10,000 for a new boiler house and generating plant equal to the supply of 10 000 additional lamps. An additional trunk main from the works to the town has also been arranged for. This immediate extension, however, forms only a portion of the complete extensions contemplated. The remaining portion of the projected works is estimated to cost £40,000.

Londonderry.—Mr. Macrory, electrical engineer, has prepared a report on supplying the shipyard with electricity for lighting and power purposes. He stated he had obtained from the managing director of the shipyard particulars of their requirements and made his calculations as to the extra plant, engines, conduits, cables, etc., necessary, of which details were given in the report. This projected scheme would be so wrought out as to serve in its district as a part of a larger extension for private lighting and power when such should be deemed necessary. He also gave detailed estimate of revenue and expenditure. The whole cost of the project to supply the shipyard with electric lighting and power on the basis of the requirements indicated would cost for everything £5,300. This money could be borrowed. To repay the borrowed money with interest, as well as to pay for the maintenance of the machinery in good order and the ordinary working expenses, a sum of £1 421 per year was wanted. It was estimated that the shipyard would pay to the Corporation £1,580 annually, thus leaving a net profit of about £160 a year.

Derby.—The Town Council have applied for a loan of £35,000, this being the estimated amount of capital expenditure on electric lighting account for the next two years. During the discussion

Digitized by Google

on the subject, it was stated that the net result of the year's trading was that the committee had paid not only the ordinary interest upon the capital, which amounted to £105 000, but they had also repaid £2,507 of loans borrowed, and, in addition, they had a small margin of £113 to the good. Of the £35,000, £8,650 was required for a new engine, and it was necessary to order the engine within a short time, as manufacturers could not put forward the work under something like two years of notice. In the first eight months of this year there had been an increase of 9,000 in the number of lamps, as compared with an increase of 7,800 last year. This demand was still increasing, and there were more demands in the office now for electric lighting than at any previous time. Hence the desirability of looking ahead, and providing themselves with machinery which would certainly be wanted within the time he had stated. A new chimney would be required, and the extension of the mains would cost £7,500.

Motor-Generators.—The Metropolitan Company are gradually converting their old single-phase system into a continuous-current system, the generating station being situated at Willesden, from which the current will be sent to various sub-stations in the company's area. The contract for the electrical equipment of the new Manchester-square sub-station has been placed with Messrs. Witting Bros., Limited, 49, Cannon-street, E.C., and comprises about 9,000 h.p. of heavy machinery. There will be six synchronous polyphase motor-generators of 500 kw., each machine consisting of a 900 b.h.p. motor direct coupled with a multipolar continuous-current generator of 500 kw. In addition to the six large sets, there will be three auxiliary motor-generators of 70 kw. to 80 kw. for starting and exciting the large machines, and for helping with the day load. The two phase current generated by the Westinghouse alternators in the power station at Willesden is stepped up from 500 to 10,000 volts per phase, then sent over about 5½ miles of cable to Manchester square, where it is transformed down to 1,000 volts per phase for the motor generators. The sub station equipment will be of a highly interesting nature, as special arrangements are necessary in such cases to ensure the perfect parallel working of the large synchronous motors at all loads; the problem of feeding such large synchronous motors, placed at the end of a long transmission line, possessing both inductance and capacity, being by no means an easy one when the power is supplied from a steam-driven station, as is the case in question.

St George (Hanover square).—The Vestry met specially on Thursday week to consider the question of the lighting of the parish by electricity. At the outset of the meeting a letter was read from the Gaslight and Coke Company, asking the Vestry to postpone for a short time their final decision on the matter, as at the next meeting of the company they would have under consideration a more comprehensive scheme for the better gas lighting of the parish at much less cost than the scheme of the electric lighting company, which they would submit to the Vestry. The recommendation of the committee was that the agreement between the Vestry and the Westminster Electric Supply Corporation, Limited, be approved and adopted, and that the seal of the Vestry be affixed to the agreement with the corporation. The agreement, which was adopted and sealed by the Vestry, provided among other conditions that the company should commence the works immediately on the completion of the agreement, and should complete the 600 arc lamps by June 30, 1902. Lighting according to schedule was to be at the rate of £32 per annum for each 750 watt arc lamp, £22 for each 500-watt arc lamp, £4 per annum for each 120 watt incandescent lamp, and £3 for each 60 watt incandescent lamp, these rates to be subject to a cumulative rebate of one half per centum per annum for each year after the first full year during which any lamp has been used. One of the most important clauses, and one which has been the subject of much debate, runs as follows: "In the tenth and twentieth year after the date of this agreement the Vestry shall be entitled to refer to an arbitrator, to be appointed by the president of the Institute of Civil Engineers, the question whether the payment per lamp per annum fixed by this agreement should be varied in consequence of the adoption by the company of any improvement or method which has resulted in a substantial alteration in the cost of lighting the streets by electricity, and it shall be in the discretion of the arbitrator to vary such payment in any manner he may think fit; but no variation shall be made which shall cause the future profits of the company to be less than they were immediately prior to the adoption of such improvement or method. If, however, any increase in profit shall result to the company from the adoption of such improvement or method, such increase of profit may be apportioned between the company and the Vestry in such a manner as the arbitrator shall think fit to award, provided that such apportionment shall not apply to any profits which shall have accrued to the company prior to the date of such award."

New Issue.—The City of London Electric Lighting Company, Limited, this week made an issue of £200,000 4½ per cent. second debenture stock, at £100 per cent., redeemable at par in either of the following events—viz.: (1) at the option of the company at any time after Dec. 31, 1910, on six months' notice; (2) in the event of a winding-up or of the security from any other reason becoming enforceable before Dec. 31, 1910. The stock forms part of the additional amount of £400,000 which the directors were authorised to borrow by a resolution passed at an extraordinary general meeting of the company held on July 11, 1900. It will bear interest at the rate of £4. 10*s.* per cent. per annum, and will be redeemable, on six months' notice, at the company's option at any time after Dec. 31, 1910, at £100 per cent. It will rank *pari passu* as a second charge by way of floating security upon the undertaking and business of the company and its property present and future (excluding its uncalled capital for the time being), subject only to the first charge to secure the £400,000 5 per cent. debenture stock already issued by the company, and the premium of £100,000, payable on redemption in respect thereof. In the event of a sale to the local authority, the net proceeds of sale will be applied (subject to the redemption of the £400,000 5 per cent. first debenture stock at £125 per cent.) to the redemption of the second debenture stock at £100 per cent., and in the event of a winding-up, or of the security from any other reason becoming enforceable before Dec. 31, 1910, the stock will be redeemed at a like rate. Power is reserved to create further second debenture stock, ranking *pari passu* with the present issue, to an amount not exceeding the sum of £200,000. The present issue of debenture stock is made in order to provide for the large capital expenditure necessary to enable the company to cope with the constantly growing number of lamps and motors to be supplied. From the prospectus we note that on Dec. 31, 1899, the number of customers was 8 738, while during the present year, up to Oct. 3, further applications to the extent of 57,918 lamps have been registered, raising the total at that date to 508,856 8-c.p. lamps, of which 487,540 were then connected, representing 9,323 customers. This shows an average weekly increase of applications for 1,466 lamps during 1900. The gross revenue of the company has been as follows: £68 863. 19*s.* 3d. for the year ended Dec. 31, 1894, and £187,253. 16*s.* 7d. for the year ended Dec. 31, 1899. This represents a net revenue remaining after the payment of interest on first debenture stock, and the deduction of the actual cost of repairs and renewals of plant, etc., of £48,870. 18*s.* 11d. The recent revision of the rates charged to customers (which confers a distinct benefit on the long-hour consumer), and the large number of additional lamps supplied, will, it is estimated, increase the gross revenue of the company for the year 1900 to about £225,000. The annual interest on the present issue of debenture stock will amount to £9 000 only. The assets of the company are stated at £1,254,572. 16*s.* after deduction of the first 5 per cent. debenture stock inclusive of premium payable on redemption.

Ayr.—The Corporation have received a long report on the proposed change of electric lighting system by Mr. W. A. Chamen, electrical engineer of the Glasgow Corporation. The following are the principal portions of the report, for which we are indebted to the *Ayrshire Observer*: "With regard to the main question of the change of system of supply from high-tension to low-tension continuous current with a three-wire system, I am entirely of opinion that this should be done, and at once. You are in an exceptional position, having an opportunity of getting rid of one of your existing engines and alternators, for which you will receive an allowance of about £1,500 in consideration of your ordering from the makers, Messrs. Siemens Bros. and Co., an engine and dynamo, or alternator, whichever you may choose in place thereof. There is no doubt in my mind that you should decide immediately to make this new engine and dynamo of the continuous-current type, and as nearly as possible like the two which you have already ordered for the tramways plant so as to be interchangeable with them either for lighting or tramway supply. If you do this you will be in a position of having one continuous-current set of plant available for electric lighting, one ditto ditto for tramway supply, and a third set available as a reserve for either of these purposes. There can be no doubt that you will gain greatly by giving a supply of continuous current in the central area instead of alternating current. It will enable you to work with greater economy and to use accumulators, which will be of assistance for times of light load, and it will give your consumers the great benefit of being able to use electric motors without any of the troublesome conditions which arise when using motors with an alternating-current supply. You will probably find it convenient and economical as time goes on to increase your low-tension continuous-current plant, reserving the high-tension plant for the outlying districts, some of which, at any rate, are rather too far off to be satisfactorily reached with a low-tension supply. As regards the extent to which the low-tension supply should be at first adopted, I would say that Mr. Fuller's proposal to deal with High-street, Alloway street, Burns Statue-square, Kyle street, Newmarket-street, and Sandgate-street, together with the various offshoots from these streets, seems quite the right thing to do for a start; but there is no doubt that you will find it convenient to increase the radius later to anything between one and two miles. The principle upon which I would recommend you to proceed is to make all further new plant which you may require to meet increased demand from time to time of the continuous current type, and to utilise the alternating plant you already have for the purpose of supplying only the more distant consumers, who will presumably also increase in due course. In this way, when you increase your continuous-current plant, you will at the same time increase the area which you will supply with continuous current, while you will be retaining your existing alternating-current plant in economical use, and be saved the loss you would be likely to incur if you were to attempt to dispose of it now." The Corporation have agreed to adopt the change of system recommended by the report, and to order the low-tension engines from Messrs. Siemens, and have also instructed Mr. Fuller to proceed to Messrs. Siemens and arrange as to the plant and the price to be paid therefor, and authorising him to close matters unless Messrs. Siemens want any material change made on the existing proposal.

Nantwich. — The following report is before the General Purposes Committee of the Urban District Council, which has been compiled by the Electric Lighting Sub-Committee. The document, according to the *Nantwich Guardian*, described the

Digitized by Google

systems at work in the following towns visited—namely, Blackpool, St. Annes, Llanrwst, Chester, and Darwen. Though the works visited, the report continued, were nearly all considerably larger than any works that might be constructed at Nantwich, the principles involved in small works were the same as in large ones. The principal matters that would have to be considered in connection with the proposed works at Nantwich were: the site for a generating station, the best system to be employed, the extent of the area of supply, the capacity of the generating plant, the price to be charged for current, the question of free wiring, and lastly, the question of employing an expert to advise. With regard to the site of the generating station, where coal was the fuel used, it was a great advantage if a site could be obtained near a railway station or canal, in order that the cost of carting might be saved. A good supply of water should also be obtainable, to allow condensing operations to be carried out cheaply, without a large quantity of auxiliary machinery. The works should be central, and not cause a nuisance to adjoining property, and there should be means of getting in heavy goods. With regard to the works being a nuisance to adjoining property, it was clearly demonstrated at Darwen that those, even in conjunction with a refuse destructor, if properly carried out, could be placed almost in the centre of the town without any nuisance arising. The site in Wall-lane was central, and, if adopted, water for condensing purposes could probably be obtained from the river. With regard to the question of fuel, the sub-committee were of the opinion that it was advisable to construct a refuse destructor in connection with the electric light works, from which the greater portion of the steam required could be raised, and at the same time a great deal of carting, both of coal and refuse, saved; at present the latter had frequently to be carted long distances to a suitable tip. The quantity of refuse available was, they understood, about 15 to 16 tons per day. With a Meldrum destructor and a Lancashire boiler, no doubt 112 i.h.p. could be obtained, which would probably be found sufficient to supply the whole of the demand for some little time. The estimated cost of a destructor of the size required, with boiler, chimneys, and buildings complete, would be about £2,000. About half of this, or £1,000, would represent the actual extra cost of the destructor, as boiler, chimney, and buildings would be required in any case. A duplicate boiler should also be provided and arranged for hand-firing with coal. This could then be used as a reservoir for steam, and thus assist in steadying the steam pressure, which was apt to vary considerably when raised by destructors. With regard to the best system to adopt, they recommended the three-wire 500-volt (with continuous current) system, supplied to consumers at 250 volts; and the best method of laying the conductors was in wooden troughing filled with pitch. As to the extent of the area of supply, this, within reasonable limits, should be as large as possible, so as to get the greatest number of street lamps of the mains. It was also found that consumers, as a rule, would not join till they saw the cable actually laid. The generating plant should be sufficient for immediate requirements, allowing some margin for contingencies. In small works it was out of the question to have any of the plant idle, but ample provision for additional machinery should be made in the buildings. It was essential in small schemes like theirs that the works should be carried out with the utmost economy consistent with efficiency. There were two principal methods of charging for electricity—namely, the uniform price and the long-hour consumer rate. Both were extensively adopted. The uniform rate was the simplest, though the long-hour consumer rate was the most favourable to large consumers, who had to be encouraged. They thought that the uniform rate would be found the best—at all events, to begin with. As to free wiring, they found that this was not general, and where practised was being discontinued. With regard to the employment of an expert to advise, there appeared to be two methods—viz.: first, the appointment of a competent resident engineer, who had been employed in similar works, to prepare plans and carry out the works; second, the employment of an expert as consulting engineer to take the direction and be responsible for the scheme, with a resident manager to look after the technical and commercial part of the undertaking. They were not in a position to say definitely which of these methods was the better until the cost of each had been ascertained.

PROVISIONAL PATENTS, 1900.

OCTOBER 8.

17811. An improved electric arc lamp. Frederick Hungerford Bowman and Thomas Archer Rose, 9, Adam-street, Strand, London.

17829. An improved device for measuring upward pressures, and particularly for enabling the trolley arms of electric tramcars and vehicles being set to exert a certain upward pressure on the wire. Joseph Wilkinson, 8, Quality-court, Chancery-lane, London.

17846. Improvements in telephones. Charles Shore and Charles Heap, 6, Bank-street, Manchester. (Complete specification.)

17865. Improvements in the operating mechanism of electric controllers. Thorsten von Zweigbergk, Clun House, Surrey-street, Strand, London.

OCTOBER 9.

17904. Improvements in or relating to electric meters. John Ellis, 111, Hatton-garden, London.

17916. Improvements in dynamo-electric machines. Matthew William Wallbank Mackie and Egerton John Glyn, 77, Turnmill-street, London.

17917. Improvements in means and apparatus for relaying electrical currents. Hartwell William Webb, 9, Ellison-terrace, Streatham, London.

17929. Improvements in telephonic repeaters or relays and circuits connected therewith and therefor. Charles Adams Randall, 98, Prince of Wales Mansions, Prince of Wales-road, London, N.W.

17941. Improvements in or relating to electrical arc lamps. Henry Bevan Swift, 19, Southampton-buildings, Chancery-lane, London.

OCTOBER 10.

18000. Improvements connected with overhead trolley poles used in electrical traction. William Ellison Rowlands, 10, St. George's-crescent, Liverpool.

18001. Improvements in or applicable to switches for electromotors. Joseph Platt Hall, 70, Deansgate, Manchester.

18006. Improvements in conduits for electric conductors. Hosea Tugby, 47, Lincoln's inn fields, London.

18031. Improvements in telephone systems. Milo Gifford Kellogg, 24, Southampton buildings, Chancery-lane, London. (Complete specification.)

18036. Improvements in or relating to thermo-electric generators. Alfred Julius Boult, 111, Hatton-garden, London. (Albert Tissier, France.)

18044. Improvements in or relating to covering the conductors of multiple or other telegraph or telephone low capacity cables. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

18045. Improvements in distributing heads or terminal boxes for electric cables. George Edward Heyl-Dia and W. E. Hitch, 6, Lord-street, Liverpool.

18056. Improved encasement for electric cables. Eugen J. Kiss, 18, Southampton-buildings, Chancery-lane, London.

18058. Improvements in magnetic rotary motors. Emile Dinoire, 72, Cannon-street, London. (Complete specification.)

18059. Improvements in electrical earth lines. Giovanni Battista Marzi 72, Cannon-street, London. (Complete specification.)

OCTOBER 11.

18066. Improvements in electrical exercising apparatus. Alfred M. Crooker and Frank N. Macdonald, Fife House, Kingston-on-Thames.

18067. Improvements in electric stop motions for warping machines. Frank Ashworth Holt, 17, St. Ann's square, Manchester.

18099. Improvements in or relating to electrically-driven vehicles. Ferdinand Porsche, 111, Hatton-garden, London. (Complete specification.)

18114. Improvements in polyphase alternating-current transformers. Carl Schaller, 6, Lord-street, Liverpool. (Complete specification.)

18119. Improvements in connections for electric fuse-boards, switches, and like apparatus. Herbert Dudley Barlow and Leonard Barlow, 18, Southampton-buildings, Chancery-lane, London.

18127. Improvements in the distribution of electricity to a plurality of electromotors. Thorsten von Zweigbergk, Clun House, Surrey-street, Strand, London.

OCTOBER 12.

18156. An improved method of automatically regulating the flow of liquids, gases, electricity, chemicals, and powders. William Player Miles, St. Cuthbert's, Grove Park, Kent.

18175 An improved advertising clock either combined or not with an electric alarum or call. Paul Royer, 52, Chancery-lane, London. (Complete specification.)

18184. Improvements in shades of electric incandescent lamps. The Spiral Globe, Limited, and Ernest André Livet, 53, Chancery-lane, London.

18195. Improvements in or relating to incandescence electric lamps. Peter Kopp, 322, High Holborn, London.

OCTOBER 13.

18233. Improvements relating to electric terminals for cable connections. Robert Frederick Hall, 24, Temple-row, Birmingham.

18234. Improvements in electrical switches or contact breakers. Robert Frederick Hall, 24, Temple-row, Birmingham.

18235. An improved lighting device for electrically lighting miners' safety lamps. Lewis Noah Williams, Lloyd's Bank-buildings, Bristol.

18254. An automatic switch to be used on wires carrying electric currents for the purpose of cutting off these currents when the main wires break from any cause, or are otherwise interrupted. Patrick Browne, 36, Chancery-lane, London.

18269. Improvements in or relating to the electrolysis of fused chlorides or metallic salts. Edgar Arthur Ashcroft and James Swinburne, 111, Hatton-garden, London.

Digitized by Google

18281. Improvements in the control of electric motors and similar devices from several different points, and in the means therefor. Harry Ward Leonard, 46, Lincoln's-inn-fields, London.

18282. Improvements in the junction boxes for electric cables, and in forming branch connections therefrom. Joseph Alexander Jeckell, 46, Lincoln's-inn-fields, London. (Complete specification.)

18283. Improvements in junction boxes suitable for connecting electric conductors. Joseph Hetherington and the British Electric Transformer Manufacturing Company, Limited, 46, Lincoln's-inn-fields, London.

18284. Improvements in electric transformers. Arthur Francis Berry and the British Electric Transformer Manufacturing Company, Limited, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Nov. 3.

1899.

23389. Transmitters for Morse alphabet and printing telegraphy. Cerebotani and Moradelli.

23391. System of telegraphy. Lorrain. (Bedell.)

23909. Electric lighting of railway vehicles. Hill. (Date applied for under International Convention, April 14, 1899.)

24791. Boxes or cases for containing switches and mechanism connected therewith for electrical traction. Kingsland.

24792. Method of and means for carrying and connecting strikers to motor vehicles for mechanically operating electric switches. Kingsland.

1900.

622. Incandescent arc and other lamps. Bonhivers.

6540. Electric railways on the conduit system. Stein and Freund.

10974. Electric accumulator electrodes or plates. Ricks.

12672. Manufacture of glass by electrical heating, and apparatus therefor. Voelker.

12673. Manufacture of glass by electrical heating. Voelker.

13969. Insulated electric conductors. British Thomson-Houston Company, Limited. (Emmet.)

13973. Insulated electric conductors. British Thomson-Houston Company, Limited. (Emmet.)

14275. Electro-chemical or copying telegraphs. Dymond. (Kopier Telegraph Gesellschaft mit beschränkter Haftung.)

14281. Telegraphy by means of alternating currents and imperfect contacts. Ferrié. (Date applied for under International Convention, Jan. 9. 1900.)

15918. Electrical phase transformation. British Thomson-Houston Company, Limited. (Lunt.)

15919. Electric rotary transforming apparatus. British Thomson-Houston Company, Limited. (Davis.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Oct. 13	614	550	+ 64	14,511	12 619
Birmingham Trams.	,, 13	4,698	4,435	+ 263c	179,258	170,448
Blackburn Corp'rat'n	,, 5	476	420	+ 56	15,876	18 080
Blackpool Corporatn.	,, 11	466	295	+ 171	25,613	18,952
Blackpool-Fleetwood	,, 13	333	349	- 16	18,404	18,308
Bradford City Trams	,, 14	539	374	+ 165	14,577	11,377
Bristol Tramways Co.	,, 12	3,328	3,045	+ 283	—	—
Carlisle Tr'mw'ys Co	,, 13	180	—	—	3 045f	—
Central London Ry.	,, 13	5,421	—	—	52 931c	—
City & South London	,, 14	1,647	1 031	+ 616	22,884	14 235
Cork E. T. and L. Co.	,, 11	427	392	+ 35	17.053c	15,632
Dover Tramways ...	,, 13	218	200	+ 18	8 676	8,275
Dublin & Lucan E.R	,, 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	,, 12	3,819	2,189	—	—	—
Dublin S.D. Electric	,, 12	834	851	—	—	—
Glasgow Corporation	,, 13	9,191	9,275	- 84	—	—
Halifax Corporation	,, 14	761	626	+ 135	22,597	17,639
Hull Corporat'n E.S.	,, 12	2,152	—	—	36,009a	— c
Liverpool Corporat'n	,, 6b	8,648	7,094	+1,554	313 705	274,515
Liverpool Overhead	,, 14	1,510	1,524	- 14	25 782	24,603
St. Helens Tramwys.	,, 10	—	—	254	—	—
Sheffield Corporation	,, 14	2,539	—	—	—	—
Southampton Trams	,, 11	735	376	+ 359	—	—
Southport Corporat'n	,, 13	199	—	—	2 399a	—
Swansea Tramways..	,, 5	447	263	+ 184	7,093	4,462

a Since April 1. b Partly electrical. c Since Jan. 1. e From July 30. f From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	⅜-½
British Insulated Wire, Ord., 1-40,000	5	–	11-12
—— 40,001-70,000	5	–	10½-10¾
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5¾-6⅛
—— 5 per cent. Mortgage Debentures	100	–	96-103
British Electric Works, Ordinary, 50,001-95,000	1	–	⅜-½
—— 6 per cent. Cum. Pref., 1-50,000	1	–	⅜-½
—— 4½ per cent. First Mortgage Debentures	108	–	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4⅜-4⅝
Brush Electrical Engineering, Ordinary	2	–	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	–	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	108-111
—— 4½ per cent. 2nd Debenture Stock	100	–	103-104
Callender's Cable, Debentures	100	–	110-114
—— Ordinary	5	–	12½-12¾
—— 5 per cent. Pref.	5	–	5-5⅛
Crompton and Co.	8	–	2⅝-2¾
—— 5 per cent. Debentures	—	–	99-102
Edison and Swan United, Ordinary	9	–	1⅝-1⅞
—— 5 per cent. Debentures	5	–	3¼-4⅛
—— 4 per cent. Deb. Stock, Red.	100	–	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	..	98-100
Electric Construction	1	–	2-2⅛
—— 7 per cent. Cumulative Pref.	2	–	2⅜-2½
—— 6 per cent. Perp. 1st Mort. Deb.	100	–	102-105
W. T. Henley's Telegraph Works, Ordinary	5	–	12½-12¾
—— 4½ per cent. Preference	5	–	5-5¼
—— 4½ per cent. Debentures	100	–	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	–	20-21
—— 4 per cent. Debentures	100	–	99-102
Telegraph Construction and Maintenance	12	–	34-38
—— 5 per cent. Bonds	100	–	101-104
Telegraph Manufacturing, Ordinary	5	–	10½-11½
—— 5 per cent. Cum. Pref.	5	–	5-5¼
Willans and Robinson, Ordinary, 1-80,000	5	..	10¼-11⅛ xd
—— 6 per cent. Cum. Pref., 80,001-90,000	5	–	6¾-7½ xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	101-104
Brompton and Kensington, Ordinary	5	–	7-8
—— 7 per cent. Preference	5	–	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	–	6-6½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	–	5⅛-5⅜
Chelsea Electricity Supply	5	–	6¾-7¼
—— 4½ per cent. Debentures	100	–	110-113
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	–	12½-13½
—— 5 per cent. Debenture Stock	100	–	124-129
County of London and Brush Provincial, Ordinary	10	–	8¼-9¼
—— 6 per cent. Cum. Pref.	10	–	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	–	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4¼-5
—— 4½ per cent. First Mort. Deb.	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9¾-10¼
London Electric, Ordinary	9	–	1⅞-2¼
—— 6 per cent. Pref.	5	–	4¼-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	–	112-115
—— 3½ per cent. Mortgage Debenture, Red	100	–	98-101
Notting Hill Electric Lighting	10	..	14½-15½
Oriental, 1879	1	..	1⅜-1⅝
—— £5 Shares	5	–	7¼-7⅝
—— £4½ Shares, New	4½	..	6¼-6⅝
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	–	8¼-8¾
River Plate Electric Light and Traction, Deb.	100	–	75-85
Royal Electrical Company of Montreal	$100	–	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	95-98
South London, Ordinary	8	..	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	..	8-9
Westminster, Ordinary	5	–	12-13
—— 80,001-109,437	5	–	11-12
Electric Railways.—			
Central London, Ordinary	10	..	10½-10¾
—— Pref. Half-Shares	5	..	5-5¼
—— ,, ,, deferred	5	..	5-5¼
City and South London, Consolidated Ordinary	100	..	58-61
—— Ordinary	10	–	5-6
—— 4 per cent. Debenture Stock	100	–	120-125
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, '96	100	..	130-135
Liverpool Overhead, 5 per cent. Pref.	—	–	12-12½
Waterloo and City, Ordinary	100	–	94-97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	14-16
Brisbane Tramway	100	..	101-103
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary	10	..	13½-14¼
—— 6 per cent. Cm. Pf. 30,001-60,000	10	–	12-13
—— 5 per cent. Perpetual Debenture Stock	100	–	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	4⅜-5
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	3¾-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	104-107
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	..	9¾-10¼
New General Traction, Ordinary	5	–	3¼-3½
—— 6 per cent. Cum. Pref.	5	–	4¼-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	18-19
—— 5 per cent. Cum. Pref.	10	–	10¼-10½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	–	11¼-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	–	9¾-10¼
—— 4½ per cent. Debenture Stock	100	–	104-107
Telephones.—			
National Telephone, Ordinary	5	–	4⅞-4⅝
—— 6 per cent. Cum. First Pref.	10	–	13-15
—— 6 per cent. Cum. Second Pref.	10	–	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	–	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	–	97-100
Oriental Telephone and Electric Company	1	–	⅜-½

Digitized by Google

NOTES.

The Zeppelin Airship.—Much has been said in the daily Press with respect to the airship invented by Count Zeppelin, but as tests do not seem to have been made when circumstances would be against its success, it yet remains to be seen how far the balloon is navigable. It is interesting, however, to note that between the two cars is a triple signalling arrangement and electric bells, and also signals for switching in or off the motors. There is also stated to be a telegraph and telephone.

Ship and Shore Telephones.—The Hamburg-American liner "Augusta Victoria" has, we learn from the American Press, been equipped with an automatic telephone pay station, which enables passengers to use local or long-distance telephones up to the time of sailing. Just before the lines are cast off a plug is removed from the telephone, cutting off the connection. If the scheme is found to work satisfactorily, it is proposed that other steamers of the company shall be similarly equipped.

Personal.—We are pleased to note that Mr. T. W. W. Melhuish, who has for 14 years acted in Vienna as manager and chief engineer of the central electric lighting station of the Imperial Continental Gas Association, has recently been appointed consulting and inspecting electrical engineer to the association and some other companies in which the association is interested. Owing to this change he is about to remove to 23, Boulevard Militaire, Brussels, as this town is more conveniently and centrally situated as regards his new duties, in which we wish Mr. Melhuish every success.

A Northampton Telephonic Novelty.—There have recently been made in Northampton a number of sanitary improvements in various portions of the town, amongst these being several underground conveniences. In the attendant's office in one of these underground lavatories, that at Woodhill, there has, we learn, been installed a penny-in-the-slot telephone, and consequently, in addition to its original purpose, the further convenience of a public telephone call office has been added. The idea seems to us to be new, and makes a very practical departure in connection with municipal work.

A Ceylonese Railway.—Having regard to the advance of electricity both for lighting and traction purposes in India, it is rather astonishing to learn that in Ceylon the governor has recommended the use of electric traction on the Uda-Pussellawa Railway, but that the consulting engineers of the railway have reported against the proposal as a new-fangled idea. We hope, however, that those having charge of the railway system will have a more complete investigation of the question of electrical traction, when they would probably decide against the engineer's advice, and have electrically-propelled trains.

House-Moving by Electricity.—A novelty in moving has, we learn, recently taken place in Wellsville, Ohio. As is well known, in the United States many of the houses are built so that when the owner is tired of one locality he can move into another by taking his house and wheeling it off to the desired spot. This has formerly been an occasion when the aid of traction engines has been necessary, but in places where electric trolley lines exist the traction engine is not given so much work. The house at Wellsville was moved into a street in which was an electric car line. Two of the cars were coupled to the house, which in this way quickly arrived at its new destination.

Calcutta Electric Supply.—Towards the end of last month India was visited by very heavy rain, and at Calcutta no less than 30in. fell in two days. This, as might be supposed, would not tend to improve the condition of the electric light mains, as the streets were cut up, and in many places subsidences took place. For some reason a serious fault developed in one of the electrical mains, necessitating the cutting out of half the Calcutta supply, and the lights and fans in one area were not working. The fault was, however, found as soon as the streets were in a condition to allow it, and supply was shortly resumed over the whole system. Considering the whole state of affairs, it reflects very creditably on the Calcutta Electrical Supply Corporation that they managed to keep even half of the supply available for use.

The Society of Model Engineers.—The seventh monthly meeting of the Liverpool branch of the Society of Model Engineers was held on Saturday, the 13th inst., in conjunction with the inaugural meeting of the Balfour Institute, at which the Right Hon. the Earl of Derby, K.G., was present. A good collection of models made by members of the society was on view, including, amongst others, two large and well-finished model steamers, the "Majestic" and the "Hawk," the former being an exact counterpart in miniature of the White Star liner of the same name (shown by Mr. Rimmer), a large horizontal engine, dynamo, and boiler (by Mr. Dawson), a launch engine and boiler (by Mr. Croker), etc. The models, which were greatly admired by the members and visitors, were inspected by Lord Derby and a number of other well-known gentlemen.

A Telephonic News Distributor.—There is, we gather, in Budapest a news telephone, which, we should think, would cause great dissatisfaction amongst the owners of daily papers. The object of this telephone is to keep its 6,000 subscribers supplied with all the latest news. The service has a main wire 168 miles in length, and it is connected with private houses and various public resorts. From 7.30 in the morning until 9.30 in the evening, 28 editions of news are spoken into the transmitter by 10 men possessing loud, clear voices, working in shifts of two. The news is classified and given in accordance with a regular programme, and the service has been eminently successful. We are not informed how much extra the subscribers have to pay for these 28 feasts of news daily, but we should imagine that they would find it better to buy a newspaper which they could read quietly at any place rather than go to their telephone at stated intervals and have the news shouted at them.

Meteorological Observations.—In an article dealing with the meteorological observations with kites, *Pearson's Magazine* mentions the good work done by Major-General Baden-Powell in connection with the use of kites for military purposes in place of the cumbrous army balloons. In the Trappes Meteorological Observatory, France, kites are also used for making observations. Most of their work is done by pilot balloons, but recently Hargrave box kites from 6ft. to 8ft. in height have been tried. These kites are secured to a windlass, upon which nearly 11,000 yards of steel wire are wound. The windlass is driven by an electric motor, which raises or lowers the kite as required. An instrument fixed at the ground end of the wire shows the length of wire paid out, and also the angle of its inclination. Within the box kites are placed instruments to measure the temperature, pressure of the atmosphere, and hygrometric condition of the atmospheric strata which have been traversed.

Glasgow and West of Scotland Scientific Society.—We have received the programme for the eighth session of the Glasgow and West of Scotland Technical

Digitized by Google

College Scientific Society. The president for the session is Mr. David Home Morton, and the hon. secretary is Mr. Andrew Stewart, 13, Barrland-street, Glasgow. The meetings, which are held on Saturday evenings at 38, Bath-street, Glasgow, commenced on Saturday last, Oct. 20, with the presidential address. Including this meeting, there are 14 meetings in the session, the next being on Nov. 3, when Mr. T. J. Nicholls will read a paper on "Theory, Technique, and Practice." Other interesting papers and discussions are on "Slow-Speed Engine Design," by Mr. A. M. Downie; "The Organisation of a Workshop," by Mr. H. P. Jackson; "The Overstraining of Iron," by Mr. Jas. Muir; "Boiler Shop Machine Tools," by Mr. R. Mitchell; "Diatomite," by Mr. R. B. Stewart; "The Progress of Electricity Supply," Mr. J. G. Scott; etc. On Feb. 16 the annual social meeting is to be held, and in April, May, and June various engineering and electrical works are to be visited. It would appear from the list of papers that the session will be one of unusual interest, both to the members and the friends whom they invite.

The Rating of Incandescent Lamps.—The paper by Prof. A. J. Rowland, which we are now reproducing in our columns, calls attention to what the professor considers are errors in the usual methods of rating incandescent lamps, on account of the great differences which exist between the horizontal and vertical candle-power in such lamps. His arguments are worthy of careful study, but we think he neglects too much the illuminating effect which is obtained by reflection. For instance, in an ordinary room with a light wall paper, and when the ceiling is newly whitewashed, a large proportion of the illumination of any particular part of the floor is due to reflected light from the walls and ceiling. While this is the case, the actual distribution, or rather radiation, from the incandescent lamp, is not quite so important as the author would lead one to believe. It reminds us somewhat of the extravagant claims which were made for the candle-power of searchlights. The figures in these cases were got by supposing that the whole of the light emitted from the arc was concentrated in a straight beam, which then had millions of candle-power. Thus, while we agree with Prof. Rowland that in the majority of cases the light from incandescent lamps should be thrown downwards, we do not think that the faults are quite so grievous as he makes out.

Medical Electrical Appliances.—It will be remembered by those who listened to the paper which Dr. L. Jones, of St. Bartholomew's Hospital, that he stated that an easily portable medical electrical apparatus was badly needed. This was one of the great reasons why electricity was not used to a much larger extent than at present in medical practice, and surgeons had to rely upon their own hands in cases where an electrical saw would be of immense advantage. Messrs. Isenthal and Co., of Mortimer-street, W., now claim to have produced an apparatus which is suited to the use of doctors and surgeons. The apparatus consists of a transformer for cautery work and surgical exploration lamps. The instrument uses continuous current, and is stated to have an efficiency of 80 per cent. No attention is needed, and the instrument may be connected to a wire of any size. On a 200 volt circuit no more than half-ampere is used, and the weight of the apparatus is no more than an ordinary accumulator. The conductors can be easily fitted to an ordinary electric lampholder, and two sliding rheostats for the simultaneous use of cauteries and lamps are provided. The apparatus is lower in price than the ordinary outfit for cautery work, the price complete being only £12. Granted that the machine performs the work and has the advantages claimed for it by the makers, it should be a step towards giving Dr. Jones the apparatus for which he asked.

Municipal Telephones. — At the autumn general meeting of the Association of Municipal Corporations, held on Tuesday at the Westminster Palace Hotel, the first business was to receive the report adopted at a conference of corporations interested in the telephone question on July 31 last, which stated that a sub-committee was appointed to obtain information respecting municipal telephones. The committee consisted of representatives of Manchester, Salford, Bolton, Hull, Plymouth, Sunderland, Huddersfield, Wigan, Southport, and Eastbourne. Expert assistance was obtained, and subsequently a deputation, consisting of the chairman of the committee and the vice-president of the association, was appointed to interview Mr. Hanbury with a view of eliciting further information. In reply, Mr. Hanbury said the Government would give a fair consideration to any request for a postponement of interest and sinking fund charges for a period of, say, three years. That if the Government acquired the plant at the termination of the license, he saw no reason why they should not acquire it at a price, and the money to be paid to furnish the means of paying off the borrowed capital. With respect to the withdrawal or modification of the royalty of 10 per cent. on the gross receipts, Mr. Hanbury could hold out no prospect of such relief at present. The adoption of the report was moved by the Mayor of Huddersfield, and agreed to.

Electric Lighting in St. Marylebone.—The Vestry of St. Marylebone is evidently determined to have no deathbed repentance on the question of electric lighting. On the one hand, it might be said that they will leave the new borough council, which is to replace the Vestry, a free hand in dealing with the electric lighting of the district. It must be remembered that this free hand will be seriously hampered by the way the Vestry conducted its negotiations with the Metropolitan Electric Supply Company in the past. What with agreements to purchase which have not been ratified by the Vestry, valuation disputes, and a general obstructive policy, the Metropolitan Company can but have a poor opinion of the administrative ability of the St. Marylebone vestrymen. As an example of the obstruction, we see that at their last meeting, which was held on Tuesday last week, the Electric Lighting Committee again recommended that the consent of the Vestry should not be given to the Metropolitan Electric Supply Company laying mains in Edgware-road and in certain other streets. We had hoped that the Vestry would have repented of its evil ways before departing this life, but such is not the case. What the ultimate result will be as far as electric lighting is concerned it is difficult to foresee, but we hope that the new borough council will elect a strong electric lighting committee able to develop a businesslike policy, and to secure the support of the other members of the council in carrying that policy through. If this had been the case with the practically defunct Vestry of St. Marylebone, there is no reason why there should not have been a municipal supply at the present time.

Institution of Mechanical Engineers.—The first monthly meeting of the session was held in the Institution House, Storey's-gate, on Friday evening last, when Sir William H. White, the president, occupied the chair. Mr. E. Worthington, the secretary, read a communication from the Society of German Engineers, Berlin, stating that German engineers recognised the necessity of having a reliable technical dictionary in the three

Digitized by Google

languages—German, English, and French—that the society would be glad if scientific societies in England and France would give their assistance in the production of such a dictionary, and asking if the Institution of Mechanical Engineers would appoint members to assist in its production. It was stated that the council had decided that the institution as a body could not take any action in the matter, but had informed the German society that the proposal would be placed before the members with a view to obtaining individual assistance. The President said that there was no want of sympathy on the council's part with respect to the movement, and the only question was as to the best way of giving effect to the suggestion. Prof. Smith said the matter was important. There was great need for such a dictionary, which should also be published in Italian as well as the three languages suggested. The President said that the names of any members willing to assist would be communicated to the German society, and a note on the subject would be circulated amongst the members. A paper by Mr. Bryan Donkin, entitled "Observations on an Improved Glass Revealer, for Studying Condensation in Steam-Engine Cylinders, and Rendering the Effects Visible," was afterwards read by the secretary. The customary discussion followed.

The Electrical Boom.—There is no doubt that exceptional activity is being shown in the construction of new electrical manufacturing works in this country. One result will be that, unless the old-established businesses are prepared to extend their borders, they will find that they are seriously hampered in their competition with their new rivals by the inconvenience of works which have been erected piecemeal, and by machinery which is not of the latest date. As an example of the large new works being started, we have the Westinghouse Company erecting large works near Manchester, and the British Thomson-Houston Company are also erecting manufacturing works near Rugby. These will compete with the other firm engineered by Americans, and called the English Electrical Manufacturing Company, who have already commenced active operations in their new factory near Preston. We are therefore pleased to note that these three firms are not to have a monopoly of new machinery and conveniences in the arrangement of their buildings, as the old-established firm of Messrs. Siemens Bros. have also decided to move their manufacturing works to the Midlands. For this purpose land has been secured near Stafford, on which the new works are to be erected at an early date. We understand that great care is being paid to the design of these works so as to facilitate the manufacturing of dynamos and motors in quantity and at the cheapest possible rates. The arrangement of the various departments will also be such that there will be a minimum waste of time in transferring the goods from one department to the other. The cable works of the firm will not be moved from Woolwich, and the space set free by the transfer of the manufacturing department will enable a much larger quantity of cables to be turned out in the larger space available.

Midland Engineers.—A joint meeting of the members of the Chesterfield and Midland Counties Institution of Engineers and the Midland Institution of Engineers is to take place next Thursday, Nov. 1, at the Blackwell Collieries. On this occasion several of the collieries belonging to the Blackwell Company are to be thrown open for inspection by the members. Two routes have been arranged, the first of which is to Alfreton, Shirland, and Blackwell (A winning) Collieries, and the second to Alfreton and Blackwell (B and C winning) Collieries. At 2.30 p.m. a luncheon is to be given the members by the directors of the colliery company, and at 3 p.m. a joint meeting of the members of the institutions is to take place. At this meeting a number of papers which have already been published, dealing with mining engineering, will be discussed. With respect to the collieries to be visited, we learn that in A winning of the Blackwell Colliery the screening of the coal is done mechanically. The ventilation is effected by a Guibal fan, 45ft. in diameter and 12ft. wide. Electric lighting is used both on the surface and underground. Some of the boilers in this winning are heated by waste gases, the other boilers being of the Lancashire type. In the B winning of this colliery the electric light and main and tail rope engines are now in course of erection. In both the Alfreton and Shirland Collieries electric light is used above and below ground, but in the latter colliery electricity enters to a greater extent than in the others. Thus coal-cutting electric generating plant is used in the Shirland Colliery, it consisting of one pair of Robey horizontal engines with two 10ft. driving and fly wheels, two dynamos, one being a compound-wound underhung four-pole machine, producing 180 amperes at 420 volts and 600 revolutions. The other is a compound-wound underhung two-pole machine producing 175 amperes at 420 volts with 450 revolutions. The coal-cutting machines are four Clarke and Stevenson's machines with 4ft. 6in. undercut, and one "Garforth" machine with 5ft. 6in. undercut. Two electric three-throw pumps are also used in this colliery.

British Canals.—Mr. C. C. Capel, in a letter to the *Journal* of the Society of Arts last week, calls attention to the large number of canals in the British Islands which are allowed to fall into disuse. He suggests that these old canals should be restored, and that the falls of water on them should be used for the generation of electricity, which, he considers, could easily be obtained in this way at a very cheap rate. We quite agree with the author as to the way in which certain canals have been allowed to fall into disuse because they competed with certain railway companies, who, having acquired the controlling power in the canals, have deliberately neglected them. There is no doubt that a number of these, if in repair, would be able to transport goods by electric power at a rate which would be very much lower than is charged on the adjoining railways. We would, however, join issue with Mr. Capel on the other question—*i.e.*, the utilisation of the fall of the canals for electrical power generation. Even in the winter there is not the fixed amount of useful power in an ordinary canal which the writer would lead one to expect, and, as a rule, the power available in the dry weather is almost negligible. It must also be remembered that the cost of establishing any water-power scheme, if considered in comparison with the possible output, is always high for small installations. In the same way, with a transmission line, the actual cost of erecting the line is to a certain extent independent of the size of the conductors which are carried, and hence the capital charges in a small installation become prohibitive if the power is to be transmitted to any considerable distance. As an example of this, we would point to the various mills throughout the country which are situated on small streams where from 10 h.p. to 50 h.p. can be obtained. It will be found that these mills, in spite of the fact that their power costs them next to nothing, are not able to compete with the large steam flour mills. We would therefore warn Mr. Capel that, as far as power is concerned, there is little to be expected from our canals We quite agree with him that as a means of traffic for heavy goods, and also for excursion purposes, it may be well to repair certain of the old waterways.

The Paris Accident.—On Friday last the new Metropolitan Railway of Paris, which, it will be remembered is

Digitized by Google

engined by electric locomotives, was the scene of an accident which we are afraid will shake the confidence of the travelling public in the equipment of the line. From the various reports which have reached us we gather that the fault was due to defects in the signalling arrangements. The line is worked on the absolute block system, but we believe that the signalling is done automatically by the passage of the trains along the line. It happened that a certain train was stopped as it approached the station up a considerable incline. Before the driver was able to prevent it the train ran back a short distance, and it is presumed that in so doing it reversed the danger signal, which it had previously caused to be given behind it. The next train, therefore, proceeded on to the section, and ran at full speed into the rear of the standing train. The result was that about 30 people were injured, and two of them seriously. The driver of the train which ran into the standing one was naturally in the position of most danger, and his injuries are expected to be fatal. The confusion resulting on this accident was made worse by the extinction of all the lights in the tunnel, so that the passengers were absolutely in the dark. We have not by us a record of the exact means used in lighting the tunnels, but this accident shows how important it is to have the lighting independent of the supply to the trains, and also to have it so arranged that an accident to the wiring cannot easily occur. In fact, it would be almost worth while to have a duplicate system of wiring, so that alternate lamps in the tunnels are on independent circuits. If the accident was due to the fault of the block system above referred to, there should not be much difficulty in rectifying the mistake in the system used by which such a reversal of the danger signal is possible when a train runs back along the line. We regret to find that the Metropolitan electric line in Paris is not giving such satisfaction as our Central London line. We hear, too, bad reports of the character of the rolling-stock, and also as to the want of punctuality of the system.

Electricity in India.—The *Gazette of India* recently published the draft of a new set of rules under the Indian Electricity Act. In these considerable modifications of existing rules have been introduced. Commenting on the subject, our contemporary, *Indian Engineering*, says that it would be extraordinary if the rules made for England suited all the conditions of India. It also thinks that the protection of the Board of Trade has been somewhat too inclusive, and instead of helping on the electrical industry in England, has rather kept it back. This is not, however, without its advantages, as while others have experimented and either gained or lost considerably England has gone on steadily, noting the good and bad points in other systems and utilising the best of them. In this way our contemporary thinks that the English work of the last few years has been more solid, safe, and lasting and less unsightly than any other in the world. As to the transmission of power, the power schemes in England are mentioned, and the cost of insulating if the Board of Trade rules are enforced commented upon. This cost of insulating, the writer thinks, would give the quietus to any scheme involving distance transmission in India. The Swiss method is spoken of, where conductors are carried overhead, and all the companies do is to put danger marks on the poles carrying the cables, whether they are bare or insulated. The new Indian rules pursue an intermediate course by stating that in towns and elsewhere the Government thinks fit the wires are to be insulated up to the Board of Trade standard. As to the power to be carried by any particular high-tension wire, the Board of Trade limits are thought to be unnecessary, and in the new Indian rules, as far as aerial lines are concerned, it is left for each local government to settle the matter according to climatic conditions. The limit of 300 kw. has been fixed for lines that are not aerial, this probably being fixed owing to the fact that it is advisable to have duplicate lines, in case one supply were stopped owing to heavy rains or other causes. The rules respecting the prevention of electrolytic action owing to currents used for traction purposes, have in these Indian rules been made stricter than in England, but these rules can, if necessary, be modified at the discretion of the local government.

The Nobel Prizes.—The formal rules and regulations respecting the awarding of prizes under the Nobel bequest have now, we learn, been drawn up and published. The three bodies selected to award the Nobel prizes are the Royal Academy of Science at Stockholm, the Swedish Academy at Stockholm, and the Carolin Institute of Medicine and Surgery at Stockholm. The first award will take place on Dec. 10, 1901. The prizes are to be awarded as follows: to the person having made the most important discovery or invention in the department of physical science; to the person having made the most important discovery and having produced the greatest improvement in chemistry; to the author of the most important discovery in the department of physiology or medicine; the author having produced the most notable literary work in the sense of idealism; to the person having done the most, or the best, in the work of establishing the brotherhood of nations, for the suppression or the reduction of standing armies, as well as for the formation and the propagation of peace conferences. The award for physical science and chemistry is to be made by the Swedish Academy of Science, that for medicine or physiology by the Carolin Institute, that for literature by the Swedish Academy, and for the work in the cause of peace by a committee consisting of five members elected by the Norwegian Storthing. As stated in the will of Dr. Nobel, nationality will not be considered, the worth of the papers, etc., alone being taken into consideration. Each of the prizes must be awarded at least once every five years. In order to be admitted to the competition, every written work must have been published by means of the printing press, and it is also necessary that intending competitors should be proposed by some qualified person, no attention being paid to requests from competitors themselves. At the solemn *réunion* which takes place on the anniversary of the death of the donor, Dec. 10, the corporations will make known publicly their decision and bestow upon the laureate a cheque for the value of the prize, a diploma, and a gold medal bearing the effigy of the donor with an appropriate inscription. The laureate is obliged, unless prevented by unforeseen circumstances, to give during the six months following each *réunion* a public lecture on the subject of the work crowned. The lecture will be given in Stockholm, or for the peace prize in Christiania. Decisions in regard to the prizes are without appeal. The prizes, it would appear, are well worth winning, those which will be distributed in 1901 amounting in all to £80,400, or £16,080 for each division.

Accumulator Traction.—The leading article in the current issue of the *Elektrotechnische Zeitschrift* deals with the report of Dr. M. Kallman on the competition between electrically-propelled vehicles which took place in Berlin last spring. We have previously referred to this competition, and applauded its thorough character; it is, therefore, interesting to learn the results obtained. It will be remembered that each vehicle was tested on 50 different issues. We now learn that the best of the competing vehicles was awarded 41·71 of the possible 50 points, while the second

Digitized by Google

and third best received 39 71 and 38 53 points respectively to their credit. These figures show, as our contemporary remarks, that according to the view held by the special commission delegates to conduct the trials, the best vehicles actually attained to a high degree of perfection. As especially significant, Dr. Kallmann mentions that breakdowns during the six days over which the trials extended, when the vehicles were subjected to a heavy demand, were remarkably few. As regards the weights of the batteries employed, it must be mentioned that the battery taking first honours in this respect had a weight of 121lb. per kilowatt-hour, while the least favourable case was that of a battery weighing 286lb. per kilowatt-hour. The mean value for the 13 vehicles taking part in the competition was 165lb. The initial cost of these batteries varied in the case of the passenger cars between £50 and £100, and in the case of the freight cars between £60 and £125. The costs of the complete cars, including batteries, varied between £185 for the smallest and £450 for the largest passenger cars. In regard to the freight cars, this cost varied between £225 and £400. It follows, therefore, that the cost of the battery equipments of the several vehicles amounted to between one-third and one-sixth of the total cost, and Dr. Kallmann expresses the opinion that the cost of the battery for a passenger car to travel 19 miles with one charge will amount in the future to about £50. So far as concerns the maintenance and renewal of the batteries, one firm guaranteed 250 charges and discharges. A much more favourable offer was made, however, by another firm, which asked for an annual sum amounting to 30 per cent. of the initial cost of the battery, for which it undertook to maintain, and if necessary renew, the battery for three years without further compensation. Upon the assumption of a yearly total mileage of 9,500 miles, Dr. Kallmann calculates the annual maintenance cost of a battery at only ·48d. per mile. The smallest consumption of energy per ton-mile at the mean speed amounted to 91 watt-hours for a passenger car, a far better performance than previous records are able to show. At the highest speed the consumption increased to 135 watt-hours. However, in the majority of cases the demand did not vary greatly with the speed, which makes Dr. Kallmann come to the conclusion that, in order to obtain the greatest commercial economy of energy, the electrically-propelled car should be driven at the highest speed consistent with public safety. By the high speed the consumption of energy per car mile is not considerably increased, while the number of passengers which may be transported in a given time naturally increases with the speed. The best freight car showed a consumption of energy amounting to 123 watt-hours at low speed, 126 at mean speed, and 134 at the maximum speed. With regard to the size of motor best adapted for the weight to be propelled, Dr. Kallmann gives it as a rule that the capacity of the motor should amount to approximately 1 kw. per ton of the rolling weight. In respect to steering and braking, the cars competing varied considerably in efficiency. One car was pulled up when travelling at a rate of 11·1 miles per hour over level asphalte pavement within the space of 12ft. 3in., the same car travelling at a speed of 11½ miles per hour over a paved road being pulled up within 16ft. 6in.

Rhodesian Rubber.—A report has been prepared by Mr. Lyttleton Gell for the British South African Company with respect to the rubber industry in their territories. The report, which is published in the *Board of Trade Journal*, states that it has now been ascertained that extensive tracts in North-West and North-East Rhodesia produce natural rubber of high commercial value, while in South Rhodesia indigenous rubber is reported in abundance in the Sabi Valley and along the Zambesi. There is also good ground for believing that valuable foreign species can be cultivated in the district. The native methods of extraction are at present very destructive and the methods of preparation faulty, and this impairs the market value of South African rubber. It is urged with respect to the administration of the rubber industry that the indigenous rubber should from the first be recognised as State property, and not be abandoned to private exploitation. The problems to be faced thus are the measures necessary to preserve the existing sources of the rubber, the methods of obtaining a revenue from the industry, the future development and expansion of the industry, including the suppression of detrimental methods of extraction and preparation, and the policy towards proposals of exploitation. In other African territories regulations are in force which offer suggestions, although the rules are not very rigidly enforced. Thus in the Congo State no unauthorised extraction of rubber is permitted. The industry is largely worked by the State, but private concessions for limited periods are also granted. In each year a certain number of new trees must be planted in proportion to the amount of rubber extracted. The felling of rubber trees is absolutely prohibited, and extraction of root rubber is forbidden. At Lorenco Marques a monopoly of the production and trade in rubber for 25 years has been granted over the unoccupied State lands. The concessionaires pay a rent of about £44 per annum, and undertake to plant 20,000 trees in two years. They further pay a duty of 2½d. per kilo for seven years, rising to 4d. per kilo for the remaining eight years. They are exempt from all other imposts, and have the option of retaining the land at the same rent at the expiration of the monopoly. The monopoly does not restrain the cultivation of rubber on private property and its export by private persons. The Mozambique Company forbids any individual to purchase rubber from natives, or to extract it through agents, without a special annual license, which costs £3 per annum. A sum of 1s. 6d. per kilo must also be paid before rubber can leave the district in which it is collected. The system in Lagos is based upon a theory that the ownership of forests is vested in the local tribes under their chiefs. Within districts under the control of such chiefs no person may collect rubber without a license, for which he pays £5 to the "native chiefs" and 2s. for each load of rubber. No tree may be felled except with special permission, and on payment of 5s. per tree. The report concludes that there should be no hesitation in recommending that immediate regulations should be framed for North-West, North-East, and Southern Rhodesia for the protection of wild rubber which should embody certain well-ascertained principles—*i.e.*, a minimum age and girth should be established, below which a tree must not be tapped, the measurements being adapted to different species and localities. The intervals at which trees may be tapped should also be regulated. Subject to local modifications, it would be safe to forbid tapping the same trees, or the same area, in two successive years. A general regulation will be required that rubber may only be collected by tapping; that no tree may be cut down, and no roots grubbed up and boiled. A general regulation is desirable providing for the plantation of young rubber trees in forest land by persons extracting rubber. If in special districts the extraction of root rubber is permitted, the rate of replantation must be high, not less than two to one. With regulations following somewhat the above lines, the rubber industry in Rhodesia should become a very important commercial undertaking.

Digitized by Google

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Continued from page 557.)

The Armature Reactions.

In accordance with two of our fundamental principles—the discoveries of Oersted and Faraday—all modern dynamos are built to consist of two parts: an electro-magnetic part, comprising the magnets, yoke, pole-pieces, and field coils; and an inductive part, termed the armature. The field magnets (Fig. 3) consist of soft iron or steel wound with many turns of copper wire, so as to make a powerful electromagnet when a current flows along these turns. This current is usually, but not necessarily, supplied from the armature of the machine. The armature, which is placed between the poles of the magnets, consists of a mass of soft iron, which, in the case of a drum machine, may be keyed directly to the shaft. If, however, the armature is of large diameter, it is usual to cut away the centre of the armature core and key the iron on to the shaft by means of a spider; while, if the armature is to be ring or Gramme wound, this must be done whatever be the size of the armature. Upon this armature are wound various turns of wire insulated from and coupled up in series with each other, and having at equal intervals connecting pieces or lugs leading down to the commutator, whence the current is collected, as a uni-directed (or direct, as it is commonly termed) current. It is not necessary that all the inductors be in series with each other, as sometimes, in

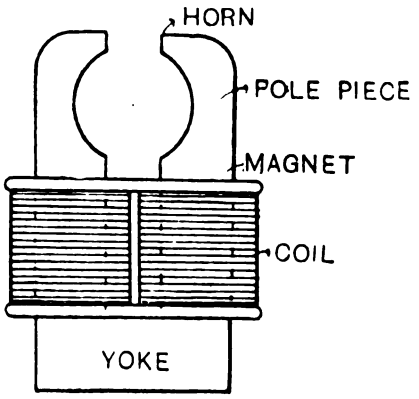


Fig. 3.

order to get a requisite cross-sectional area, two or more wires are wound in parallel to make one complete inductor, or the winding may be of the duplex, triplex, or other multiple type.

The method by which the current is generated is at first glance found to be simplicity itself. The coils on the armature are made to cut the lines of force passing between the poles of the electromagnets. It is in order to make the path of these lines as easy as possible that the armature core is made of soft iron. The lines of force proceed from the north pole of the magnet through the air-gap, which must exist as space to wind the armature wires in a smooth-core machine and as clearance between the revolving and fixed portions in all classes of machines, then through the iron of the core, across the second air-space and thence into the south pole of the magnet, and complete their circuit through the iron of the magnets and yoke. The usual practice is to make the armature revolve and the fields stationary, but this is not essential, and so long as there is relative motion of the coils and lines, either armature or magnets may revolve, or both may do so in opposite directions. The amount of current generated will depend upon the E M.F. and the resistance of the outer circuit; this is evident from our third principle that $C = \frac{E}{R}$. Hence, if E be only large enough or R small enough, C could be made of any desired magnitude, except that, in addition to Ohm's law, C is ruled by two other factors—viz, that every wire grows hot when a current is passed along it, and that the final temperature to which it will attain depends inversely upon the amount of cooling surface it has, and also directly upon the square of the current it carries, so that with a wire of any size a limit will be reached for the safe working current. If the current be increased, the wire will first get so hot that the cotton insulation will be burnt off, and if the current be still further increased the wire will fuse and melt. The second factor which rules the amount of current which can be taken from any armature will be dealt with in the section on the limits of load.

The value of the E M.F. which will be generated by any armature depends upon the number of turns of wires in series on the armature, the number of lines of force cut by these turns per unit time, and is given by the formula

$$\frac{E \times 10^8 \times 60}{N \times C_a} = \phi,$$

where N = revolutions per minute;
C_a = armature turns in series;
ϕ = total number of lines of force cut.

If N = 100, C_a = 100, and ϕ = 1,000,000, E will = 1·33 for a two-pole dynamo. Hence, if the value of E be required higher—and for direct-current dynamos this may be anything between four volts and 1,000 volts or more—one or more of the values of ϕ, C_a, or N must be increased. For dynamos of small output the increase would be largely in N and C_a, but for dynamos of large output, while N might be as high as 300, the great increase should be made in the value of ϕ.

However simple the above description of how the current is generated in an armature may appear, it is soon found

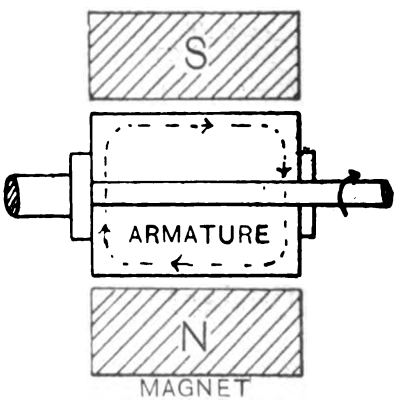


Fig. 4.

in practice that innumerable difficulties must be overcome before a satisfactory result can be obtained, and these difficulties are due to what are known as the armature reactions, but it will be found upon examination that all these reactions are due to causes produced by our fundamental principles, and can be foreseen and so guarded against.

From our second primary principle we learn that if a wire be moved so as to cut lines of force a current will be induced in it at right angles to the lines of force, and at right angles to the direction of motion, and from our third primary principle we know that the value of this current will vary directly as the E M.F. and inversely as the resistance. If, now, the wire be bent round so as to form a coil closed on itself, and then revolved in a magnetic field so as to cut the lines of force, it will be short-circuited on itself, and the current which will circulate around it will be enormous, even at a very low voltage, since R will be practically negligible. If, then, the core of the armature be made of one solid piece of soft iron, it would act as a coil of wire of large cross-section short-circuited on itself, and a current would flow along the dotted line in Fig 4; and the amount of this current would be so great that not only would the iron get hot, but also it would absorb nearly all the driving power, and if the dynamo gave a current at all to the external circuit, its efficiency would be ridiculously low. Since the E M F. will be very low—as there are only two inductors cutting the lines of force—very little will stop the flow of the current, and the usual method adopted is to build up the core of thin sheets of charcoal iron (preferably about No. 26 Birmingham wire gauge), having their laminations parallel to the flow of the magnetic flux due to

Digitized by Google

the field, and at right angles to the flow of the induced current, and each plate being insulated from its neighbour by means of shellac, varnish, oiled paper, or other insulating material. If these laminations are made thick, a current will flow through each lamination, but, according to the thinness of the plates, this eddy or Foucault current will grow less and less, until, by using plates thin enough, it can be brought to an indefinable amount, although in practice it is not found desirable to use plates less than the gauge mentioned. Considering that it is on these two primary principles which cause these Foucault currents that all modern dynamos are built, it does not require practical experience, but only simple reasoning, to see that, unless means are taken to prevent their production, Foucault currents will be induced in the armature core; their value could also be readily calculated if necessary, knowing the thickness of the laminations, the magnetic flux, and the amount of iron in each of the circuits, and, therefore, their resistance. These Foucault currents will also arise in the inductors or wires wound on the armature core if they have any considerable width and are solid, for it is evident that if the speed of the armature is constant, the peripheral space traversed by any one inductor will always be the same, but the number of lines cut for each element of peripheral space will vary, for referring to Fig. 5, where the lines of force are shown dotted, it will be seen that when an inductor is at A or B it is slipping through the lines, while at C or D it is cutting the maximum quantity per unit

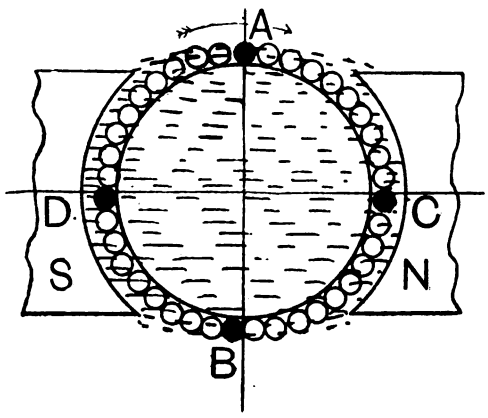


FIG. 5.

length, and that the number cut per element of time increases from A to C, then decreases from C to B, and increases again from B to D, and the cycle is completed by decreasing to its minimum at A. If the numbers of these lines cut per each successive element of time are plotted in the form of a curve on paper, it would be found that the resultant was a true sinusoidal curve. Upon examining this variation in the number of lines cut per unit element of time, it will be seen that the front or leading edge of any inductor is cutting lines at a faster rate than the trailing edge when travelling from A to C and from B to D, and at a slower rate when travelling from C to B and from D to A; hence there will be a difference of potential between the two sides, and an eddy or Foucault current will flow along the width of the inductor. If the inductor be very narrow, these eddy currents may become of slight moment; but if the bar be wide, they will be of the utmost importance—in any case they will have an appreciable effect on the heating of the armature. It may be urged that the difference of potential between the two sides will be so microscopic, even with thick bars, that a practical designer may neglect the effect, and consider the phenomenon as one interesting for a professor in a laboratory fitted with accurately measuring instruments, but of no importance in a commercial sense. But this is not the case at all. The student must remember that the resistance across the width of the bar is almost infinitesimal, and since $C = \frac{E}{R}$, it will therefore only require E to be of very small dimension for the value of C to be enormous. In order to minimise the effect of this difference in potential, various methods have been adopted. One is to wind the armature with several strands in parallel, but insulated from each other. The worst of this arrangement is that if the insulation, which need be only very slight so as to increase the value of R across the width of the bar, consisted of shellac or other varnish, as soon as the armature became hot it would melt and run out, while if the insulation consisted of cotton or other covering for the individual strands, not only would it be costly, but it would also occupy much valuable space. However, in October, 1886, Mr. R. E. B. Crompton took out a patent (12,880, Oct. 9, 1886) for a compressed strand having a twist over each other at or near the centre, so that as the compound inductor passes through varying portions of the field the E.M.F. in each portion may be the same. It will be readily apparent that as the foremost strand in one half of the inductor is the rearmost strand in the other half, any Foucault currents will be neutralised. This invention has been found of such great value that the patent rights have been maintained up to the present date, and all manufacturers use it for their large smooth-core machines, obtaining it from Messrs. W. T. Glover and Co., Limited, who make it under royalty.

The two phenomena due to armature reactions to be next considered must be taken together, and are due to the magnetic tendency of the current flowing through the armature coils, and are known as the back induction and cross magnetisation due to the armature current. Fig. 6 is a diagram of an armature placed in a magnetic

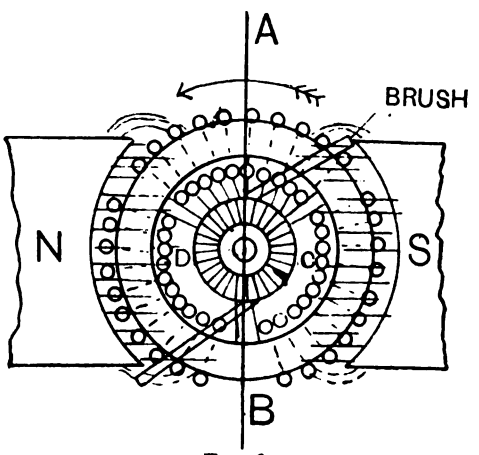


FIG. 6.

field, the line A B being drawn at right angles to the direction of the flow of the lines of force and equidistant from the horns of both field poles; this line may be called the neutral line. If, now, the armature be revolved, and the brushes be lowered on to the commutator, it might be supposed that the brushes should rest on those segments which are connected to the coils through which this neutral line passes, but in practice it will be found this is not the right position, and that to obtain sparkless commutation a forward lead must be given to them—*i.e.*, the brushes must be shifted to a position one or more bars in advance of the neutral line; in a motor a backward lead will be found requisite. If the north and south poles and the direction of rotation be as shown in the diagram, we shall with a right-handedly wound armature have a positive brush at the top—*i.e.*, a brush where the current is positive to the external circuit—and a negative brush at the bottom. Hence in the armature the current will flow from the bottom to the top, and will divide equally between the two sets of coils on the right hand and left hand of A B. Further, as shown in the diagram, the lines of force will not all flow across the air-gap in straight lines, but some will take at the horns an arcing path, creating a fringe, gradually varying from normal density to zero density between the horn and the neutral line. Now consider a coil in series C, which is coming up to the positive brush. This will be carrying a current in, say, a right-handed whorl When it passes into series D of coils, which are revolving away from the brush, the current will be flowing in a left-handed whorl, or, in other words, the current will be stopped and reversed in direction all within the minute period of time that the brush is covering the commutator section to

Digitized by Google

which the coil is connected. In the introductory portion, however, stress was laid on the truth of Lenz's law, that the action of self-induction was such as to maintain a current which is stopping and to oppose a current which is commencing. The law will then act in its full force in this case. It will first of all oppose the stopping of the current flowing in the right-handed whorl, and will equally as strongly oppose the starting of the current flowing in the left-handed whorl, and this action, known as the self-induction of the coil, will not only be the only magnetic force acting on the coil, as we presume it to be lying in a perfectly neutral plane, but also its force will be intensified by the iron of the armature core, round which the coil is wound. The result will be that the coil will pass into the D series utterly unprepared for its new work, and disastrous sparking will be the result, which could have been foreseen from first principles without the aid of experimental practice. The heavier the current carried by each series of coils, the stronger will be the self-induction of each coil as its current is first broken and then reversed. Now, the condition for sparkless commutation is that each coil, when it passes from under the brush shall have a current flowing in it equal in magnitude and direction to the current flowing in the coils which it is about to join. The only method of securing this is to let the reversal take place in a field of sufficient strength and direction as will generate in the coil while under the brush the required current. At the moment when the brush is passing over the mica insulation which is placed between two commutator segments, the coil which is connected to these two

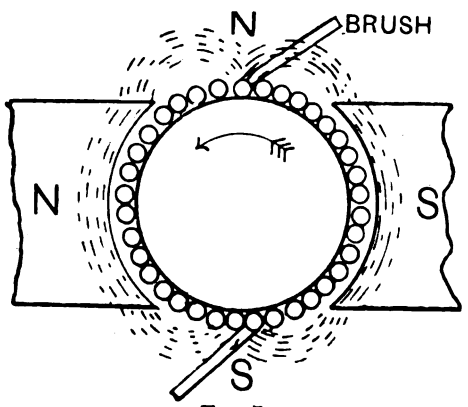


FIG. 7

segments is short-circuited on itself—that is, the two ends are joined together by the brush contact and practically isolates the coil from both the C and D series, so that any current which may be generated in this coil will flow round and round the coil. As the resistance of the coil is excessively low, a very low E.M.F. will create a large amperage, or, put in another form, the cutting of a very few lines of force per second will generate an E.M.F. sufficiently great to create a current equal to that flowing in the other coils, but as the output of the machine as a whole is increased, the amperage in the individual coils will increase, and a stronger E.M.F. will be required for reversing the current in the short-circuited coil, or more lines of force will be necessary to be cut per second by this coil, and so the coil under consideration must be placed in a stronger field. This is done by moving the brushes in a forward direction (in a dynamo) and short-circuiting the coil a little later. It may be advisable to mention here that since there is no obligation to bring the end windings out straight to the commutator lugs, they may, and often are, twisted through a certain angle, so that the angular position of the brushes on the commutator is nothing. The important point is the position the short-circuited coil itself occupies. Although the exact position in which the brushes of every dynamo must be placed is found by trial, a knowledge of the fundamental principles would teach that for any large variation of load the position must be altered, although it might be necessary to make a long and wholly unnecessary calculation to indicate the exact position, which can readily be found by trial.

If a shunt-wound dynamo be built for a large current output, it will be found that it will require a certain definite increase in speed to maintain the normal E.M.F. at full load to that which is requisite to maintain this E.M.F. at light or no load; the reason for this increase may be somewhat involved, but it is easily traceable to the three first principles. Consider for a moment Fig. 7, which represents diagrammatically a dynamo with a drum-wound armature running on open circuit; here the brushes are shown as resting on the neutral line. If now the load be largely increased, a forward lead must be given to the brushes as shown, perhaps somewhat exaggerated in Fig. 8. If the armature were held in one position, and a large current passed through its coils from the bottom to the top brush, assuming the armature be wound in a right-handed manner, it will be easily seen that the armature coils form a solenoid round the armature core, which, being of soft iron, increases the magnetic effect, and hence a north pole will be formed at the top and a south pole at the bottom, while the lines of force due to this magnet will flow through their external field practically as shown by the dotted lines in Fig. 7. This external field is called the cross-induction, or cross-magnetisation due to the armature, and is the condition which would obtain if the machine were to run at full load with the brushes on the neutral line. But it has been shown that with heavy loads a forward lead must be given as in Fig. 8, and a new condition is by this very fact brought into being; the armature coils can now be divided into two series. Draw a vertical line from the top brush, A to C, in Fig. 8, and also from the bottom brush, B to D; then the coils laying between A C and B D may be considered as a solenoid

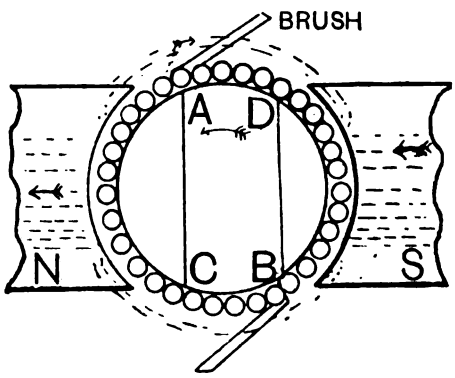


FIG. 8.

tending to form a north pole at the top and a south pole at the bottom, while the coils between A D and B C may be considered as a solenoid tending to form north and south poles at the sides opposite the centres of the pole-pieces, but it must be noted that in dynamos this induced north pole will be opposite the north pole of the magnet, and the south opposite the south pole. The effect of this arrangement is to weaken the field or forward induction, for, as shown in Fig. 8, the lines of force due to this armature reaction will flow in their external field in an opposite direction to the lines due to the magnetic field. Since the E.M.F. generated in any armature varies as the number of lines of force cut per unit time, it is evident that at heavy loads the E.M.F. will be less than at light loads, owing to this weakening of the forward induction; and since the strength of a solenoid depends upon the number of ampere-turns it is also evident that the heavier the load the greater will be the back induction, as it is called, of the armature, since a greater lead will be requisite, and hence not only a larger number of coils will be thrown into the A D, B C series, but also a heavier current will flow through them, both of which conditions are the factors which make the ampere-turns of the solenoid causing the back induction. If, then, former experience has taught what will be the probable angle of lead of the brushes at full load, a knowledge of the three fundamental principles added to a slight calculation will show what will be the rise in speed required in any specified shunt machine to maintain the E.M.F. of open load with a full load, or if a constant speed and E.M.F. are required at all loads, will show the number of series-turns required on the field in order to compound the machine properly.

Digitized by Google

Although it has been stated above that the cross-induction and back induction would arise were the armature held stationary and a current passed through its coils, yet the student will readily see that these conditions also obtain when the armature revolves; the induced poles are fixed as to place and not as to any individual coil, and consequently the flow of the field flux, as shown in Fig. 6, is only correct for an armature running on open circuit, but with a dynamo working with full load the final distribution of the lines of force will be obtained by superposing Figs. 7 and 8 on Fig. 6. This has been done in Fig. 9, which represents the normal arrangement of the lines in a machine running on its full load, as in ordinary circumstances the field flux would be maintained by increasing the magnetising power of the field coils, either by compounding or cutting out shunt resistance. The effect of the back inductance is not shown, and Fig. 9 is really a superposition of Fig. 7 on Fig. 6.

It will be seen that the result of the cross-magnetisation due to the armature being superposed upon the forward induction is that the final field is very much distorted. At the leading horns, A D, the directions of the two lines of force are opposite, and they become assimilated, while at the trailing horns, B and C, the directions are the same and the lines of force augment each other, and the field is intensified. This weakening of the field at the leading horns is a disturbing element in finding the exact position for the brushes at full load, as the

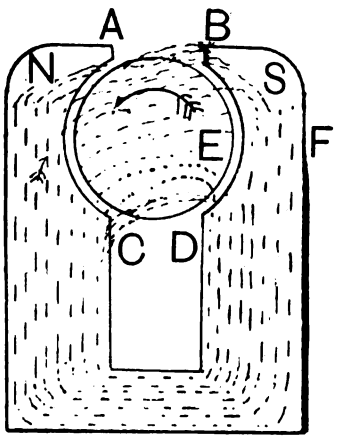


FIG. 9.

field does not uniformly increase as it would were it not for the cross-induction, and also as the brushes are given a more forward lead owing to the heavy load, not only is the strength of the solenoid creating this cross-induction increased, owing to the greater number of amperes flowing through the armature, but also the positions of the poles of this solenoid are brought nearer to the leading horns, and consequently the field under these horns is still further diminished. The great disadvantage of this weakening of the field at these points is that if the brushes were fed too far under the polar tips they would soon come into a very dense field, which will generate in the short-circuited coil a current far in excess of that carried by the D series of coils, and disastrous sparking will ensue, as will be seen when we treat of the theory of commutation. Hence it is most important that there should be no sharp line of demarcation between a neutral field and a dense field, but rather a gradual shading off of the field. Various devices, such as boring the poles elliptically, have been suggested and tried in order to secure a suitable magnetic fringe at the horns, and some of these methods will be dealt with in a later chapter.

When dealing with the cross-magnetisation, we assumed that the armature was held stationary and a certain current passed through its coils, and Fig. 7 shows the lines of force flowing equally through the two poles. This is what in practice would occur; if, however, one pole-piece were removed, the reluctance of this path would be enormously increased, and practically all the lines would flow through the other pole, and the external field would not bifurcate, as shown; if in place of removing one pole-piece its cross-sectional area were greatly diminished, the external field would divide, but unequally, and the strengths of the two paths of the external field would be inversely as the reluctance of their respective paths. This is only an extension of Ohm's law, that $C = \frac{E}{R}$, applied to magnetism, and may be written $\phi = \frac{M}{\rho}$, where

ϕ = lines of force;
M = magnetomotive force;
ρ = magnetic reluctance.

In Fig. 9 it is shown that in one pole the cross-induction flows through the neck, E F, with the forward induction and against the forward induction in the other pole. If, now, this neck is made of such a cross-sectional area that it is saturated by the forward induction alone, it is evident that there will be great reluctance for additional lines, and consequently the cross-induction will flow in preference through the other pole, with the result that not only will there be a distorted, but also an unsymmetrical field, and the field under horn A will be considerably weaker than that under B, and the field under horn C much stronger than that under D. If then the brushes are set across a diameter of the commutator, it will be impossible to give them such a lead as will give freedom of sparking on both lines, and in order to secure sparkless commutation the brushes must be set across a chord. The bad effects of doing this will be apparent, as the volts induced in coils A and B will not be equal, as more coils will be in series in one set than in the other. A similar phenomenon which will obtain with multipolar machines if all the poles have not the same strength will be dealt with later.

(To be continued.)

BUENOS AYRES.

A long illustrated article, contributed by Mr. William Hulke to the *Elektrotechnische Zeitschrift*, describes in detail the electricity supply works of the Compañia General de Electricidad de la Ciudad at Buenos Ayres.

Incidentally we learn that Buenos Ayres has a population of 780,000 persons, and is supplied with electricity for lighting and power purposes from four different supply stations. One of these, La Primitiva, owes its existence to local enterprise, while a second, the River Plate Electric Company, is of English origin. A third, the Deutsch Ueberseeische Elektricitäts Gesellschaft, was founded by the Allgemeinen Elektricitäts Gesellschaft, of Berlin. The fourth—namely, the station with which we are now concerned—is that owned by the French company first mentioned, which entrusted the electrical work in connection with the undertaking to the Union Elektricitäts Gesellschaft, of Berlin. For the most part, the houses in Buenos Ayres consist of only one storey, and in consequence the town naturally extends over a very wide area, over which the consumers of electrical energy are scattered. The installation of the company in question was put down mainly for the purpose of supplying electricity for lighting, provision, however, being made at the same time to facilitate the connection of motors to the system, besides which the supply of energy for traction purposes had also to be taken into account. Having regard to these circumstances, the mono-cyclic system of supply was adopted. For lighting purposes this system is said to enjoy, in common with the single-phase system of supply, the advantage of easy regulation of the line voltage. It also enables the use of synchronous motors. For traction work the mono-cyclic alternating currents are transformed into continuous currents, synchronous motors direct coupled to continuous-current generators being emp'oyed. But in the future it is intended to instal rotary transformers. There are eight boilers of the Belleville type installed, each capable of generating 66,000lb. of steam per hour at a pressure of 15 atmospheres. In the engine-room are four compound horizontal engines capable of developing 550 h.p. to 770 h.p. each when running at 125 revolutions per

Digitized by Google

minute, or with increased admission 850 h.p. to 1,000 h.p. In addition to Corliss gear and very sensitive governors, provision is made whereby the admission to the low-pressure cylinder may be cut off by hand. To each engine is coupled direct a mono-cyclic dynamo designed for an output of 500 kw. at 3,150 to 3,450 volts terminal pressure, with a frequency of 50. The necessary exciting current at 140 volts pressure for these machines is furnished by two steam dynamos of 30 kw. capacity each, running at 300 revolutions per minute. There is also a motor-driven set installed, consisting of a 30-kw. continuous-current generator coupled direct to a eight-pole three-phase induction motor, designed for a terminal pressure of 230 volts. A second set of similar type has been provided to furnish exciting current for extension plant in course of erection. From the station the current generated is conveyed by means of seven feeders to the primary network of mains, in connection with which latter are 50 sub-stations in which the primary current is transformed down to 230 volts for distribution. Cables of the three-core type are used for the feeders and primary network. The three cores comprising each primary cable are separately insulated with impregnated yarn and paper, then twisted together, and finally protected by a double covering of lead and iron armour. Two of the cores serve to conduct the main current, while the third, of smaller sectional area (about 35 to 40 per cent. that of the lighting cores), serves exclusively for motor load. The secondary current is distributed on the three-wire system, with 230 volts across the outer conductors, each of the three wires being equal in sectional area. The cables are so proportioned that both small single-phase and rotary-current motors may be connected direct to the secondary network. The single-phase motors are self-starting, but to drive one of the small rotary-current motors a single-core auxiliary cable is laid in addition to the ordinary secondary cables to the nearest sub-station, in which a small power transformer of 5 kw. to 10 kw. capacity is installed, this being connected up with the larger lighting transformers. Large motors are supplied direct from the primary network through special transformers. The street-lighting is by means of arc lamps, each lamp being supplied from the secondary mains through a separate transformer, with 13 amperes at 30 to 33 volts pressure.

The accompanying illustrations (Figs. 1, 2, and 3) show the general arrangement of one of the transformer sub-stations. Each of the stations is placed below the street level, the entrance where possible being from the side-walk. In order to economise the secondary distributing cables, the sub-stations are situated near street crossings so far as possible. The walls of each chamber are formed by a double lining of brickwork, with an air-space between the outer and inner linings, the inner surface of the outer lining being, moreover, coated with asphalte.

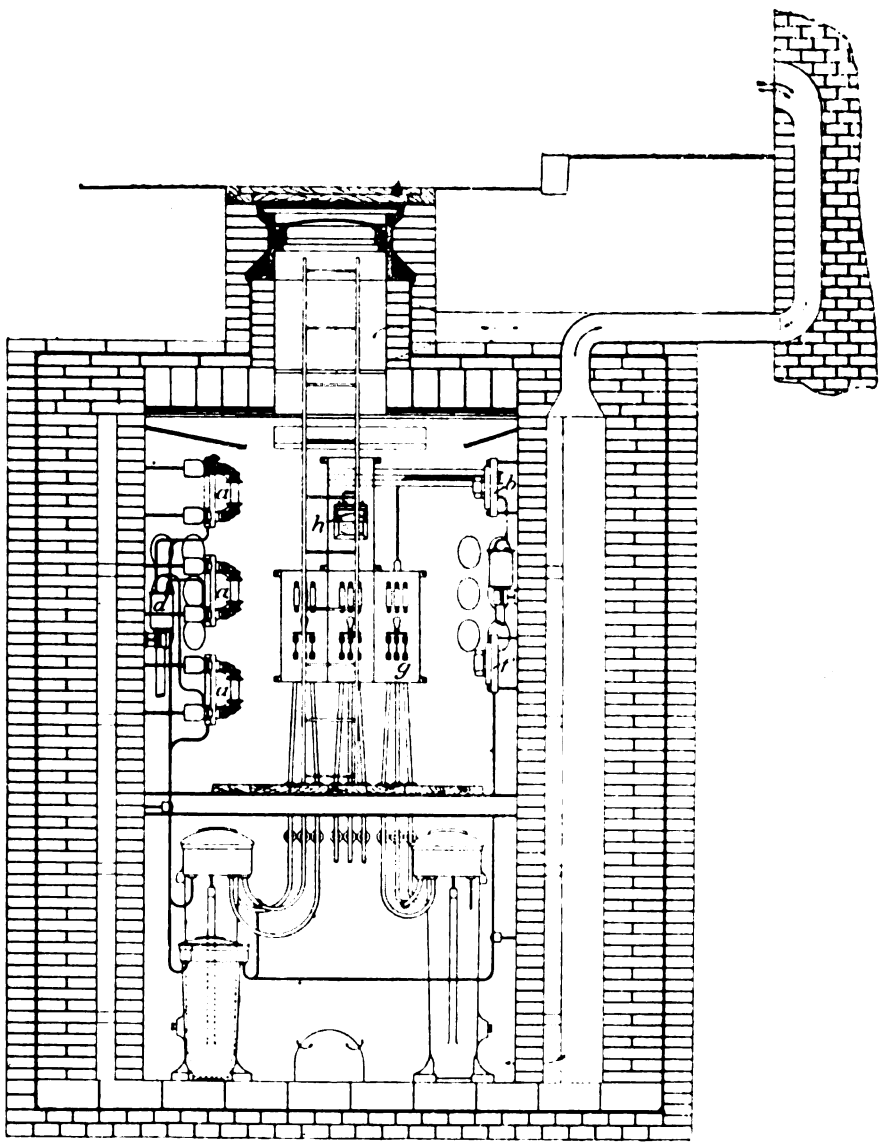


FIG. 1.—Section of Transformer Chamber, Buenos Ayres.

In the case of the sub-stations situated below the sidewalks the covers rest upon two strong I-girders, while in the case of those under the roadway three such girders are provided. Excellent provision for ventilating the chambers has been made as shown. The transformers employed have capacities of from 15 kw. to 30 kw. Their primary and secondary windings are connected respectively to the switchboards, *a* and *b* (Fig. 1). For the primary side three marble panels, *a* (Fig. 2), are provided, each of which carries four or five fuses, *c*. The three conductors from

Digitized by Google

the primary terminal, *d*, of each cable are connected to terminal pieces on the switchboard, and thence connected through the fuses to three 'bus bars, *e* (Fig. 2), which in another small marble panel, *f* (Fig. 1), is placed underneath these panels and provided with a 'bus bar, besides one to three fuses, through which the current is conducted from

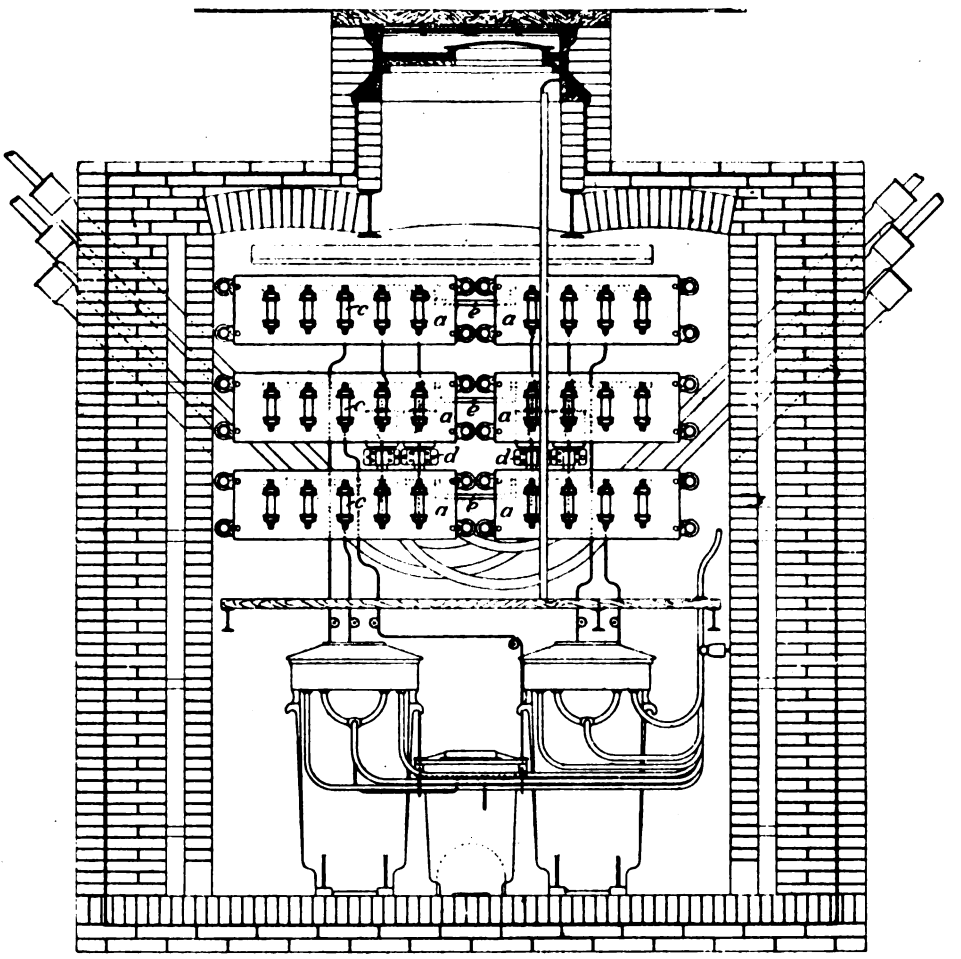


FIG. 2.—Section of Transformer Chamber, Buenos Ayres.

their turn are connected to the corresponding pole of the transformer. Opposite the primary switchboard the secondary switchboard, *b* (Fig. 1), is arranged. This is likewise of marble, each panel being provided with three 'bus bars and 12 fuses, so that four secondary circuits may be connected to each panel. Two such panels placed side by side are the rule, the 'bus bars of like sign being connected in parallel. Where energy for power purposes is required, the auxiliary transformer to the single-core cable mentioned elsewhere.

In conclusion, it must be remarked that the description gives the impression of a very complicated system of distribution—one, in fact, which it would be difficult to reconcile to ordinary conditions. It would be interesting to know the total loss of energy involved by the complicated system of transformers adopted.

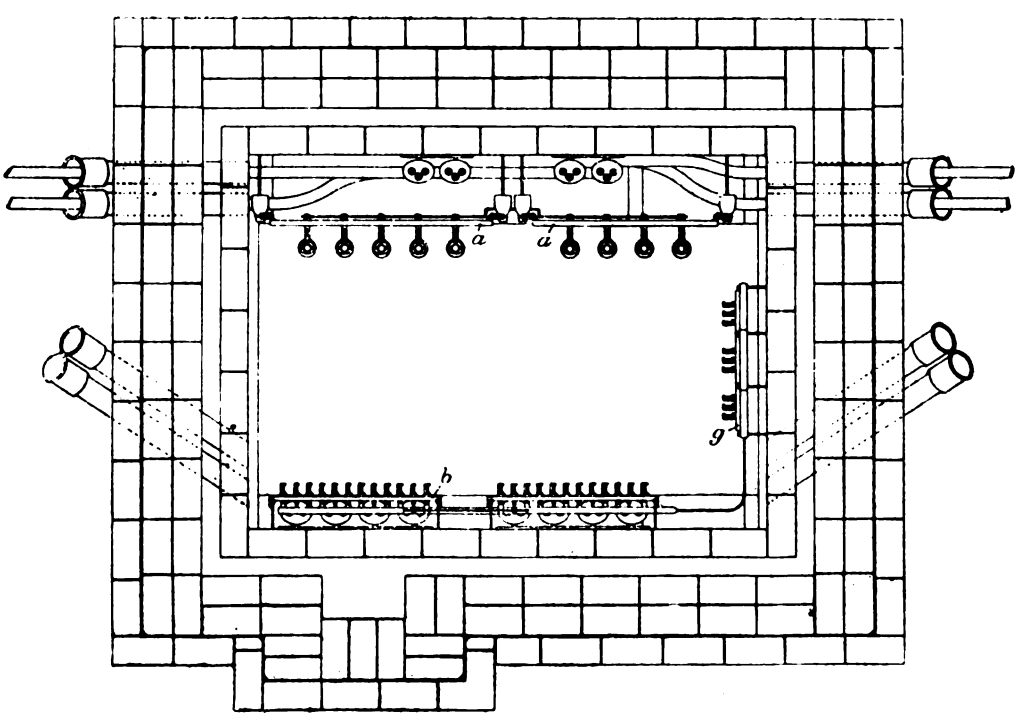


FIG. 3.—Plan of Transformer Chamber, Buenos Ayres.

Digitized by Google

AN IMPROVED GLASS REVEALER.

The following is an abstract of a paper read on Friday last by Mr. Bryan Donkin before the Institution of Mechanical Engineers on "Some Observations on an Improved Glass Revealer for Studying Condensation in Steam-Engine Cylinders and Rendering the Effects Visible." The devices described by the author are an improvement on an earlier type of revealer made by him some years ago. As will be seen from the illustrations (Figs. 1 and 2), the revealer consists practically of an extension of the steam-engine cylinders, so arranged as to enable the observer to see whether condensation is actually taking place or not. In the improved revealers the inner glass cylinder is made thinner than formerly, and the connecting pipe between the instrument and cylinder is made of both

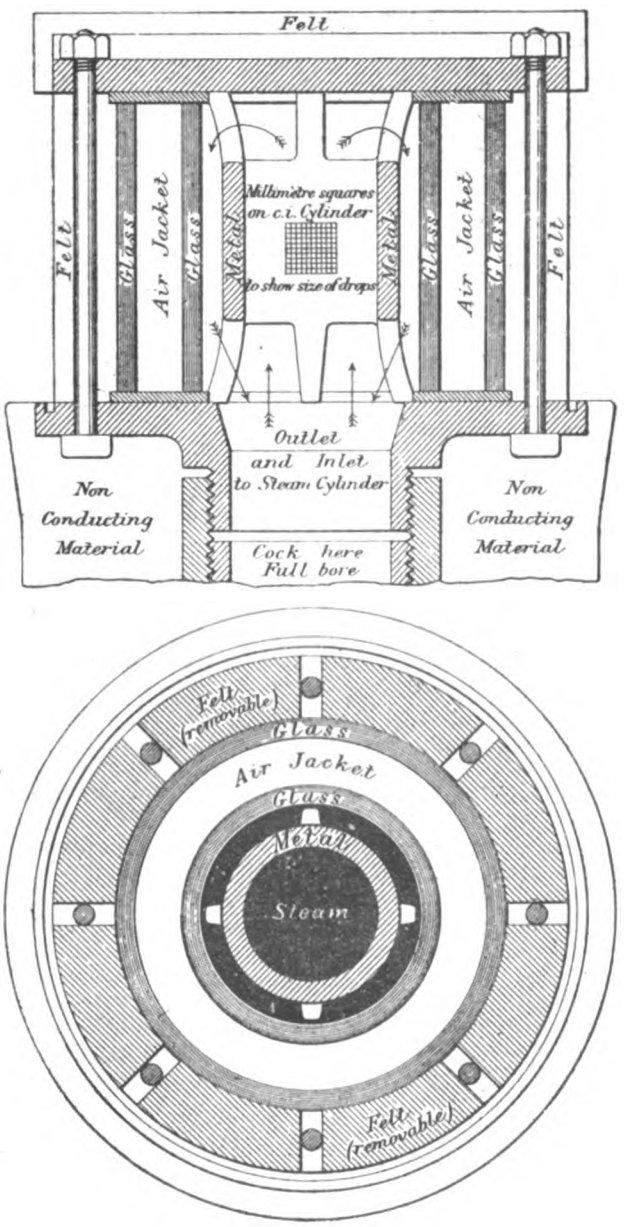
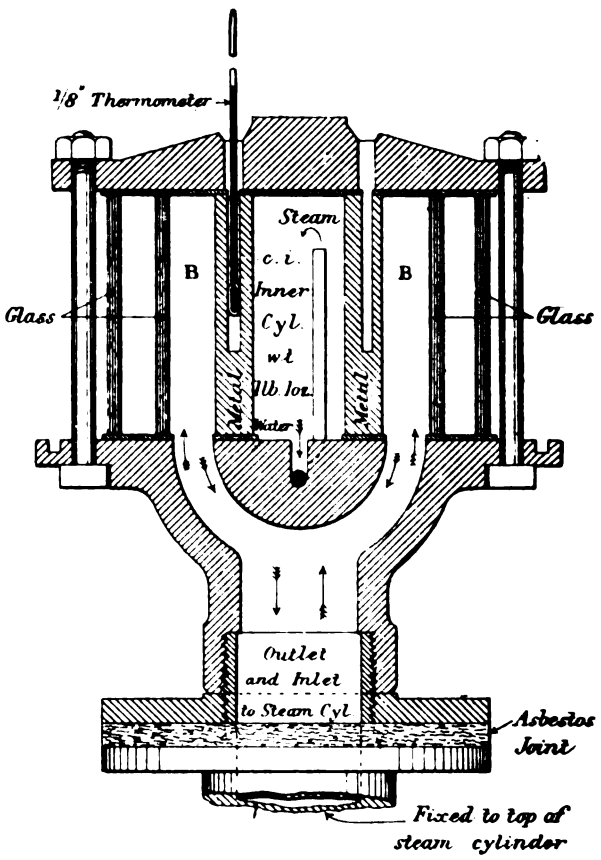


FIG. 1.—Glass Revealer of Steam-Engine Condensation, designed by Mr. Bryan Donkin.

short and straight. This pipe is also made of a large area, and provided with a cock of considerable diameter, so that the connection between the cylinder under observation and the steam-engine cylinder is ample. All the external metal and glass surfaces are well covered with non-conducting materials to diminish radiation, in order that the behaviour of the steam in the revealer may be as near as possible the same as that in the steam engine cylinder. The author thinks that with the precautions he has taken, the effects in the condensation in the revealer may be between 85 and 95 per cent. of the actual truth. The construction of the glass walls of the revealer is such as to enable the condensation to be easily observed and even photographed. These modifications have resulted in the minute globules of water formed on the glass wall being much smaller than with the older type of instrument. When the glass cylinders are properly warmed, the diameter of the globules is from 0·04in. to 0·08in., and even then after working for 10 or 15 minutes the diameter becomes less. Tracing the operations through and commencing with the steam stroke, the first result observed when the steam is admitted to the revealer is a light and not very dense cloud or white fog coming up from the engine cylinder. This is precipitated upon the



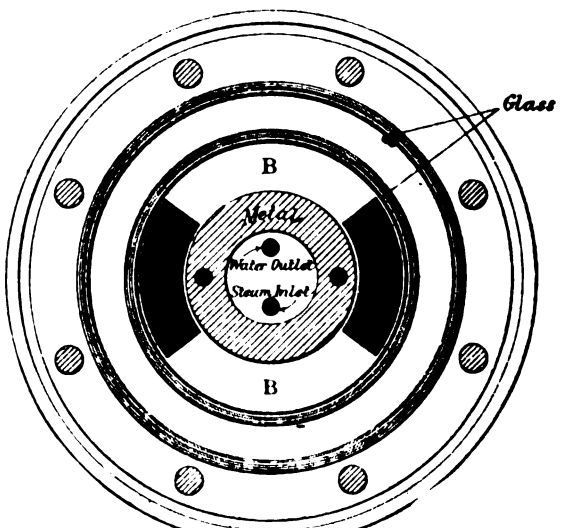


FIG 2.—Another Type of Revealer.

hot internal glass and cast-iron walls, and is seen as very fine globules or particles of moisture or condensation. This cloud is sufficient to obscure a light placed on the opposite side of the revealer. Re-evaporation then rapidly follows before the end of the steam stroke. On the opening of the exhaust valve the cloud passes quickly off into the cylinder, and the glasses become quite transparent. A good illumination renders the incoming and outgoing clouds of mist quite visible. Each time the steam enters, a large number of very small globules, at about equal distances from each other, are immediately seen upon the glass walls. These are from 0·002in. to 0·0016in. in diameter, or less, and are distributed in a fairly uniform manner over the surfaces. The time occupied by

Digitized by Google

the deposition of the globules, and their re-evaporation, is perhaps a tenth of a second. Before the end of the steam stroke, the duration of which is about half a second, and before the exhaust valve opens, the smaller globules, $\frac{1}{25}$mm.

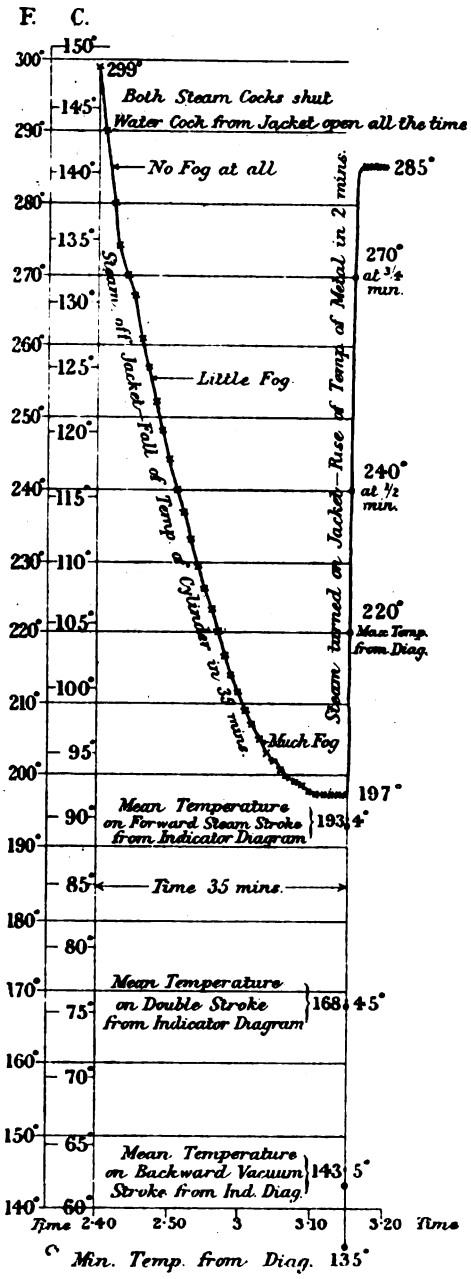


FIG. 3.

in diameter, are all evaporated. During the exhaust stroke the larger globules are also re-evaporated, but not so quickly. The internal surfaces are sometimes quite dry, and at other times a few drops of moisture remain on them. To facilitate the study of these minute condensed globules or wet particles on the inside of the inner glass, a microscope is used, and the glass and iron walls well illuminated.

The author concludes that the size of the globules is determined by the difference of temperature between the walls and the steam, and this is supported by the experimental evidence obtained from comparing the action of the revealer when placed on the low-pressure cylinder and a high-pressure cylinder of a compound engine. The globules, when the revealer is placed on the high-pressure cylinder, are much larger. Artificial cooling of the cylinder produces the same result. In order to obtain the exact diameter of these globules, cross lines, vertical and horizontal, were marked across the cylinder, as seen in Fig. 1. The observations obtained also show that the idea is not feasible, that there can exist a thin film of condensation water on the internal surfaces of steam-engine cylinders, as with a very wide range between the temperatures of the walls to the working steam the deposited moisture is still in the form of globules.

Another development is illustrated in Fig. 2. In this a small cast-iron cylinder is fixed in the centre of the revealer, and so arranged that boiler steam can be introduced inside it to raise its temperature, provision being made to drain the water away. Cold water can also be passed through it continuously to reduce its temperature. The mean temperature of this inner cylinder is taken by means of a mercurial thermometer about 2½mm. (0·1in.) in diameter, placed in a hole in the centre of the wall. The steam from the engine cylinder passes at each stroke into and out of the annular space, B B, between the cylinder and the inner glass. The fog or condensation on the walls can be observed through the glass cylinder by the eye or a microscope. In this way the cylinder can be either heated by steam or cooled by water, and the fog effects noted for different temperatures of the small cylinder inside the revealer. To get the mean temperature of steam in the steam-engine cylinder, indicator diagrams are taken, and the mean temperature calculated from the pressures. Thus, when all the conditions are constant, the temperature attained by the inner cylinder can at any time be compared with the mean temperature of the steam touching its walls.

The author proceeds in his paper to describe in detail experiments which were made with these instruments in December, 1899, and May of the present year. We have not space to describe these experiments in full, but his interesting conclusions are as follows: In spite of any deposit of moisture on the cast-iron surfaces of the cylinder, the heat-absorbing properties are always greater than the heat emission to the exhaust. The experiments also point to there being no interference caused by water on the surface of the cylinders to the passage of heat from the cast-iron cylinder walls. Some experiments on the radiation which take place from such an instrument when connected to a steam-engine were also made. The results of the experiments are given in tabular form and are handy for reference. At the end of the paper there was also read a communication from Mr. Nadal, an Ingenieur des Mines of France, whose experience has been considerable with this class of experiment. He confirms Mr. Bryan Donkin's conclusions and adds some most interesting figures of his own. Amongst these we notice that he calculates from experimental data that the wet metallic surface of a certain revealer was able to observe 36 calories per square foot per second per degree Fahrenheit difference in temperature between the steam and the metal surface in contact with it. On the other hand, the emitting power of the dry metallic surface calculated in the same way is only about 0·1 calorie.

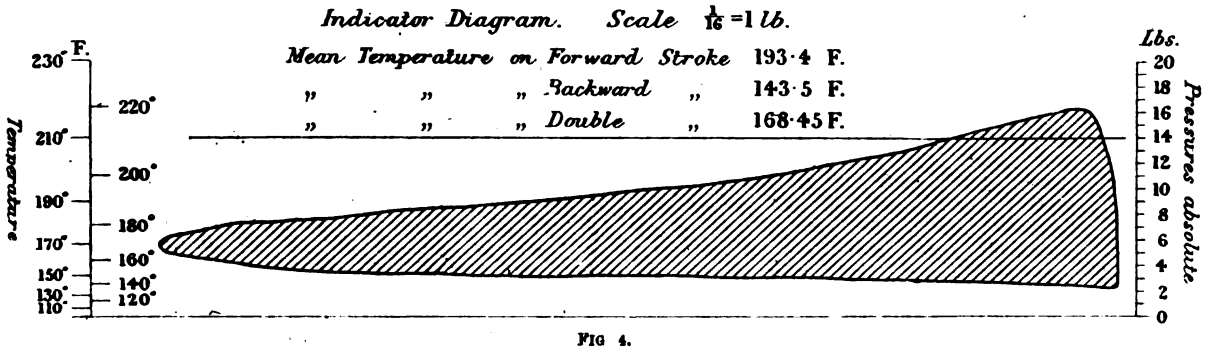


FIG 4.

Digitized by Google

SOME REMARKS UPON A HITHERTO UNRECOGNISED PLANETARY LAW.

BY R. C. SHETTLE, M.D.

In a treatise which I published in 1897, entitled "The Origin of Matter and Force," I pointed out that matter took its origin in the quantitative condensation of an original, unformed stuff, or eogen, having eqnal density throughout its mass; that the quantity in each condensing unit gave origin to the physical properties of matter, and that the uncondensed residuum of this original stuff constituted the ether, some of it pervading all space, some of it being condensed upon the surfaces of the formed units by the attractive force which they, as matter, necessarily exercised. Having thus shown the basis upon which my superstructure rests, I proceed to demonstrate the existence of a great planetary law, under the influence of which work was done upon the earth, changes of temperature were effected, its solid surface became clothed with grass, and its waters so associated with the more solid matter as to bring forth animal entities according with the nature of primary combinations or germs.

I assume: (1) That the earth consists of a vast number of minute units of various forms of matter aggregated under the influence of gravity, with eogen condensed upon the surfaces of the material molecules. (2) That the space which exists between the units of a molecule, between the molecules themselves, or between the larger units of the celestial system, is occupied by primary stuff or eogen, differing only in degree of attenuation. (3) That the earth, previous to its surface being covered or inhabited by various forms of vegetable and animal life, had essentially a bare, rugged surface, and was of oblate-spheroidal form—a form produced by its axial rotation. (4) That the earth's surface, in addition to biological formations, is covered with an atmosphere of finely-divided particles of matter, the density of which is regulated by the laws of gravity. (5) That the changes effected in material conditions and modifications of stress by the motions of the earth, in connection with its solar and planetary relations, give rise to all terrestrial phenomena.

My present aim is to show that the sun and the earth, or other planets of like material condition, so act upon each other and upon the residual eogen or ether as to reveal a very important planetary law, determining the particular mode in which phenomena are produced, either upon the planet's sunward surface or in its atmosphere, or generally, whereby light is evolved, temperature affected, and inorganic matter converted into a form adapting it to the requirements of the vegetable and animal kingdoms of Nature.

The law to be recognised may be stated as follows:

1. The sun and its planets rotate axially in the same direction in a vast ocean of ether. It is assumed that the rotation of each, in proportion to its mass motion, causes the ether to move in the same direction, thus creating an ether vortex around each rotating mass.

2. As the axial rotation of the sun and planets is in the same direction, the effects of the dominating solar vortex upon the planetary vortex must vary, according as the two vortices take the same, or oblique opposite directions, on opposite sides of the planet; for whilst on the dark side of a planet the two vortices are in the same direction, on the sunward surface of a planet the direction of the solar vortex is opposed to that of the planetary.

3. The character of the work done, or, in other words, the nature of the phenomena evolved upon a planet's surface, varies with the relative direction and intensity of the two ethereal vortices, these being more particularly determined by the position of the planet in relation to the sun.

To accomplish my object, it is necessary to somewhat precisely define the material conditions and the means by which work is effected, phenomena appear, and the law is manifested. The material conditions are as follows: (1) there is the sun, the prime centre of our planetary system; (2) there is the earth, with its atmosphere; (3) there is the residual uncondensed eogen or ether. The forces employed are: (1) The direct stress of solar terrestrial density—*i.e.*, gravity; (2) the vortical or suction force (due to rotary or other motion of the sun and its planet), which each mass of matter, in proportion to its extent of condensation, or its density, exercises upon the ether in accordance with the affinity of matter for ether previously mentioned. The general results of these material conditions, and the forces generated by motion, are, perhaps, better realised by confining attention: (1) To the sun as a material unit rotating axially in a vast sea of ether, which ether is undergoing vortical motion under the suction stress of the central body. (N.B.—The ether of the solar system now being considered is supposed to be similar to that originally extending throughout the space within which the sun and the various units of the material universe were formed). (2) To the consideration that the earth and other planets or units of the system by their rotation are creating other vortices (each in proportion to its magnitude and motions) in this same solar ocean of ether. (3) To the fact that as the axial rotation of each secondary unit is in the same direction as that of the sun, the interference with that part of the great primary vortex motion caused by the sun which each planet encounters will depend upon the mass motion of each planet, the density of its atmosphere, and the relation which it bears to the sun.

It will be well to state how these forces stand related to each other, and to the matter with which they are associated under variations of distance.

1. *The Direct Solar-Terrestrial Stress of Gravity.*—This has two sources of origin: (1) solar; (2) terrestrial. Gravity is known to exercise an attraction in proportion to the product of the involved masses divided by the square of the distance. Consequently, as the intensity of the attraction decreases in proportion to the square of the distance from the body creating it, the intensity of the stress, which may be regarded as emanating from the centre of any mass, is vastly greater on the surface of the body originating such attraction than on the surface of the distant body affected. The effects of solar-terrestrial gravity, nevertheless, determine certain definite relations in the intensity of gravity acting on the surface of the earth, as, for instance, in the case of the tides.

2. *The Vortical, or what may be called Suction Stress.*—This is the direct effect of suction upon outlying ether. But it must be remembered that as the two bodies severally exercising force are in motion, there is the resultant of two elements—viz.: (1) the static (identical with gravity), and (2) the dynamic, due to the earth's motions. The intensity of both varies. The resultant is essentially a force which took its origin in variations of density, coupled with varying rates of motion, and its tendency is to restore equilibrium and rest.

Confining attention now to the earth and its influence upon the solar vortex, and to the influence of the solar vortex upon the earth, we see that every change in the relative distances between the two bodies must be attended with varying results, both with regard to motion and to influence on the surface of our planet. To rightly estimate these effects, it will be well to consider the variations as due to the greater or less proximity of the earth to the sun in its orbital path, as shown by Kepler's second law. Kepler's second law runs as follows: "The areas described, or passed over, by the radii vectores of a planet round the solar focus are proportional to the time taken in describing them." In other words, *the planet moves faster as its distance from the sun diminishes*, its greatest proximity being in mid-winter of the northern hemisphere.

Now, at first sight, this law appears to upset all that we are taught about the solar origin of the phenomena of heat and vegetable and animal life, because temperature is highest in the middle of summer, and in the northern hemisphere the processes of vegetable and animal life are carried on with greater activity during our summer months, when the earth is most remote from the sun. We must remember also that the northern summer corresponds to the southern winter, so that changes in the earth's distance from the sun at different times of the year cannot be the only, or, in fact, the chief agents in the production of the seasons. These apparent anomalies have been ascribed to various causes. It is inferred that the greater amount of energy (heat, light, etc.) manifested in summer time is due to the fact that the sun's influence is more direct or vertical in the equatorial regions. Unquestionably the relative positions of the sun and the earth in that, as in other respects, must be important factors in the evolution of the phenomena in question, but not, I venture to think, as generally explained—viz., that the heat transmitted as energy only through intermediate space reassumes the form of heat only when it impinges upon the earth. The present statement of facts will, it is believed, go far to prove that the doctrine of "conservation of energy" applies most completely to the sun as well as to its planets and the evolution of their phenomena, under which there is practically no loss of energy; but, on the contrary, that the increase of heat, and increased biological activity during our summer, are due to work done upon the earth's surface *under a certain balancing, blending, or counteracting of the solar-terrestrial vortical forces* more especially originated by mass rotation at the time when the northern hemisphere of the earth is more particularly exposed to the influence of the sun. It is difficult to precisely define the part which each element of force exercises in effecting axial rotation of the earth, because both density and vortical forces appear to have an important influence in its production, and in maintaining the earth's orbital motion.

As the distance between the earth and the sun is increased by about 3 per cent. at the June solstice, the intensity of the solar vortex, diminishing inversely with the square of the distance, will be slightly reduced; but at the same time the northern pole and hemisphere of the earth are being every day more fully exposed to the influence of the solar vortex. The intensity of the earth's vortex (the product of its own motion) is constant. It is then evident that, as the earth recedes from the sun, the relative intensity of the forces must be proportionately changed. And as the two forces are acting in opposite directions, or nearly so, upon the atmosphere and

Digitized by Google

surface of the earth, the deduction appears to be justified that the work done upon the sunward surface of the earth is due to the resisting influence which these two obliquely vortical forces, acting in opposite directions, exert upon each other and upon the molecules of terrestrial matter, when neither force can entirely overcome the other. The results appear: (1) in increased molecular motion generally, of which rise of temperature, or heat, is the measure; (2) in proportionately increased biological activity, growth, stimulus, etc., but as all these phenomena are more or less intimately associated with molecular motion, even if not absolutely dependent upon it, the molecular motion may be said to cause increased vital activity, and thus their intimate relations to solar stress are clearly traced. *Note.*—The same general principle applies to the solar system of planets. A planet has its form, its orbital and other motions, as well as its special phenomena determined by the character of its component matter, upon which its density and its solar attraction depend. The earth as a planet is spinning upon its axis like a top, but whilst the temporary motion of the top has resulted from the rapid unwinding of the string, the sun's pull upon the earth is continuous. How this affects the motions of the earth will now be dealt with, as well as the precise manner in which "nutation" results from the action of stress.

The forces concerned exercise two distinct forms of pull: (1) That from density, more or less direct from its origin in one mass to its action on the other. (2) That from axial rotation, giving rise to vortex motion, whose strands, or limbs, or areas of diffusion are ever widening according to a well-defined law, and the confines of which, as already stated, when of solar origin extend far beyond the area of the solar system; while vortex motions of planetary origin become lost, or merged in those of the greater power, as they become enfeebled by distance or are associated with those of the sun.

The sun and the moon are doubtless the two bodies whose influence more particularly determines the axial inclination of the earth, for, owing to the moon's proximity, such axial inclination must certainly be somewhat modified by that luminary. At the present time, however, it will suffice to state that the *axial* inclination of the earth is due to the density

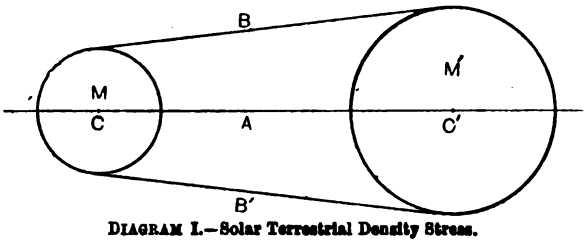


DIAGRAM I.—Solar Terrestrial Density Stress.

stresses of the various bodies with which it is associated, and that its orbital as well as its axial motions are the effects of the vortical motion of the ether induced by the sun. The modification of that motion by vortical force of lunar origin may be considered further on.

Two diagrams are given to represent the influence of mutual static and dynamic forces upon two opposite bodies and upon the intermediate ether. No. 1 shows solar-terrestrial *density*, or gravitational stress, in a static form. No. 2 is intended to represent the two bodies, M and M', rotating axially, and, by their axial rotation, throwing the surrounding ether into vortex motion. In both I. and II. the centres of the stress-creating bodies are at C and C', and the line A which passes through C and C' marks the line of the greatest intensity. This stress diminishes laterally towards lines B and B', where it ceases (Diagram No. I.). With regard to the static effects of the density stress of the masses, it is only necessary to state that each mass attracts the other in proportion to its mass and inversely as the square of the distance.

Turning now to the vortical motion of the ether as originated by each mass, Diagram No. II. graphically represents the direction of the stress induced by the suction force of the two axially rotating bodies. This rotation around C' is indicated by the arrows D and D', and around C by the arrows *d* and *d'*. Each body in proportion to its density is acting like a suction engine upon the surrounding ether, because the central force of cohesion under which matter was formed far exceeds any external force which can be brought to bear upon it to tear the matter asunder. It necessarily follows that each mass, in proportion to its mass when thrown into motion, tends to impart that motion to the surrounding ether, and the vortices in the ether become thus a natural sequence of axial rotation. The direction of these vortices of the ether is shown in Diagram No. II. by arrow points on the lines S, S^1, S^2, S^3, and E E, the lines S having solar and the lines E terrestrial origin. The intensity of the vortical forces, like gravity, is, of course, greatest at the seat of origin, and diminishes inversely with the square of the distance from that seat of origin, and in relation to the work done by solar vortices upon the mass and surface of the planet, as we recede from the sun and approach the planet *the intensity of the solar vortices diminishes and the intensity of the terrestrial vortices increases.* The solar vortex emerging from the sun acts upon the surrounding ether until this reaches the earth's atmosphere, when owing to the great affinity of ether and matter, the ether seizes upon the particles and tends to drag them in the direction of the solar vortices marked S. But the vortical motion created by the rotation of the earth has now to be dealt with, and this tends to carry the atmosphere with it. By reference to Diagram No. II. it will be seen that at *d'* on M, these solar-terrestrial vortical forces on the sunward surface of the earth act and react upon each other obliquely in more or less opposite directions. In doing this the particles of matter are rotated axially, provided the intensity of the two opposite forces is sufficiently balanced. But as the work done upon the earth appears to be most intimately associated with the adjustment of their potentials, the mode in which this is effected requires to be very clearly shown; more especially as the normal rotation of every unit of matter (of any dimensions) appears to be accomplished upon the same principle. At the same time the mode in which current electricity (or current ether) acquires its helical direction will be described.

It will be recognised (1) that as each mass is rotating axially whilst immersed in the ethereal ocean, the stress due to the density of each mass is drawing the ether through, and out of the other (see Diagram No. II.); (2) that the axial rotation of each mass in an inclined plane which is not coincident with the plane of the ecliptic, determines that the ether current should acquire the helical direction as it passes through the two stress-creating bodies, because each mass, by the inclination of its axis of rotation, imparts leverage, screw or helical motion in relation to stress. The mode in which these helical currents of ether, or electricity so-called, are caused to assume a right and a left hand direction has now to be shown. The terms right and

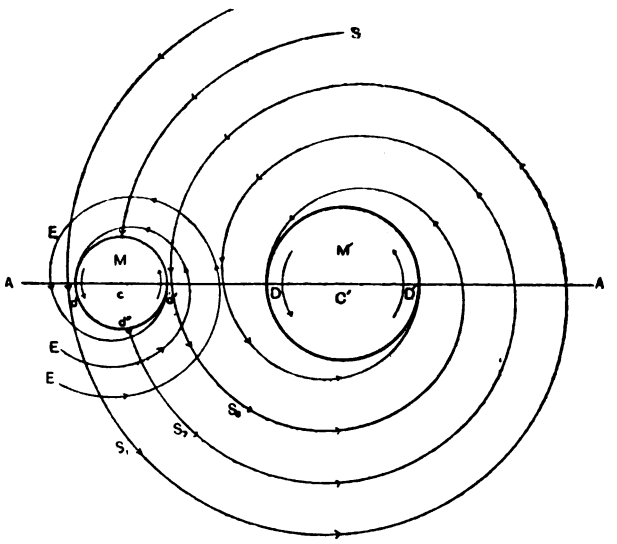


DIAGRAM II.—Solar and Terrestrial Vortices.

left hand direction imply a point of departure from which the lines take opposite directions. With respect to the earth and the sun, this occurs at a point on the earth's surface at which the sun is directly overhead, and if the observer imagines himself standing upon such point with his face directed to the west, and his two arms extending to the north and to the south respectively, he will perceive that the axial rotation of the earth originates right-hand helical currents proceeding towards the north pole, and left-hand helical currents towards the south pole—*i.e.*, that solar stress currents will pass over and through the northern hemisphere in a right-hand helical direction, and over and through the southern hemisphere in a left-hand helical direction, and in so doing will give rise to the phenomena of north and south polarity; in fact, *the normal magnetic polarity of the earth will be established thereby*, whilst the magnetic potential of the earth will be determined by the quantity of helical current energy, which, in consequence of the earth's rotation, traverses the mass at any given moment. (3) It will be observed that as the sun and the earth are both rotating axially in the same direction, the vortical currents created by such rotation are of the same helical denomination in both bodies, whether above or below the equator in either body, but the twist would be more extended in proportion to their mutual relations—*i.e.*, when moving round a sphere they would take the circular course, and exhibit phenomena resulting therefrom; but after leaving the mass, they would become more extended and linear under centrifugal force, and the phenomena would be proportionately modified. The influence of particular helical currents upon other helical currents of the same and of opposite direction must now be considered.

The influence of helical currents is all-important in the evolution of certain natural phenomena. In the laboratory

Digitized by Google

right and left hand helical currents and the attendant phenomena may be reversed at will. A right-hand helix may be changed into one of left-hand direction, or *vice versâ*, *absolutely proving* that the phenomena of positive and negative electricity, or of north and south magnetic polarity, are partly due to the direction of the moving ether. Perhaps the most ready and simple method of realising the effects of these helical ether currents upon each other, and on the matter with which they are associated, is to wind two rather stout wires round a ½in. rod, one in a right and the other in a left hand direction; then, when the rod has been removed, to divide each helix into two equal portions by cutting it across its length. There will then exist two right and two left hand helices, and taking them as models of electric currents, the effect of such currents, when acting upon each other under various relations and directions, may be ascertained. Thus, if one right-hand helix be placed end on to another right-hand helix, they may be readily screwed into each other, and so the force of attraction (other things being equal) will be in proportion to the number of helices acting upon each other from the same direction. This represents the forces engaged in the production of the phenomena of magnetic attraction. The same principle applies to the two left-hand helices. But if a right-hand helix be placed end on to a left-hand helix and similarly moved, the two terminals of the wires will act in oblique and opposite directions upon each other. This represents the conditions when a pair of *like* magnetic poles are brought together, and is representative of magnetic repulsion and of the phenomena shown by iron fillings scattered around like magnetic poles. Such facts render the somewhat complicated mutual influences of helical forces less difficult to understand.

The points which have been established are as follows: (1) That the sun and the earth, or any two distinct forms of matter, owing to their density, are mutually exercising stress upon the intermediate ether as well as upon each other. (2) That by their axial rotation, and in proportion thereto, they are creating vortical motion in the surrounding ether. (3) That axial rotation of each body upon an inclined plane causes the currents of ether which pass through the two bodies to assume helical directions. (4) That the sun and the earth, owing to the currents of ether moving in and around them, act as two magnets placed nearly parallel to each other, with their two north poles pointing in one direction and their two south poles in another. Although there may be great disparity in the sizes of the sun and of the earth, the north pole of one tends to repel the north pole of the other; and as the same principle applies to the south poles, each body, in proportion to its mass and the helical currents moving in it, tends to maintain the vertical position of the other. (5) That, speaking generally, the amount of the work done by the sun upon the mass of the earth under the influence of these forces varies with the distance between the masses.

It is now necessary to describe the nature of the work done by these forms of solar stress upon the earth during both winter and summer solstices, and to show how the effects differ under variations of distance. Subsequently I shall endeavour to define the cause of the earth approaching the sun from shortly after the June solstice until it has attained its greatest proximity in the beginning of January, and of its receding again from the sun from the beginning of January until shortly after June 21.

1. *The December Solstice.*—During the December solstice, when the earth's proximity to the sun is greatest, the intensity of solar stress, of both static and dynamic forms, is also greatest, and the principal effect of solar force is at such time increased velocity of the earth's orbital motion, with accompanying phenomena. These effects are the direct result of the increased surface density occasioned by the intensity of the solar vortex forces repelling, or driving back on to the surface of the earth, the vortex forces originated by its own motion. An inspection of Diagram No. II. will show how this is brought about. Thus, as before stated, at d' on M the solar terrestrial forces are shown by the arrows to be acting in opposition to each other, and in consequence of the disproportion in the intensity of the two forces, that of solar origin being much greater than that originated by the earth, the terrestrial forces are concentrated upon the surface of the earth, and the friction between the two vortices (solar and terrestrial) is increased in proportion to the pressure exercised. The earth's orbital motion is also most rapid at this time. It must, however, be remembered that the *temperature* effects due to the changing distance of the earth from the sun in different parts of its orbit will be dominated by the effects produced by the inclination of the axis, as this determines which hemisphere will be most exposed to the solar vortex at any particular time. The effects of difference in the intensity of vortical forces may be illustrated by the phenomena of magnetic repulsion. Thus, if two north poles of unequal potential are placed together, allowing a small space between them, and the north pole of a smaller magnet be introduced into this space, it will take up a position which is *not* midway between the two bars, but is nearer to the *weaker* one. This same principle of action is shown in the case under consideration, by the intensity of the solar vortices repelling and pressing the terrestrial vortices on to the surface of the earth. Again, at d on M (Diagram No. II.), at the dark side of the earth, the solar and terrestrial vortex forces are seen to be acting in the same direction, and as a consequence they combine to promote accelerated orbital motion of the earth, and also by pressure to prevent molecular motion. It will be seen by looking once again at Diagram No. II. that each of the lines of force, S (1, 2, and 3), tends to promote motion of the earth in its orbit: (1) is acting, as already shown, in the same direction as that of the earth's rotation as well as in the direction of its orbital motion; (2) is giving a direct pull in the direction of orbital motion, or nearly so; and (3) is pulling also in the same direction, but in opposition to the axial rotation of the earth. Of course, the intensity of each of these pulls will vary with the distance from the sun at which they are exercised upon the surface of the earth's mass, therefore the pull at d' exceeds the pull at d and at d'', but the orbital motion appears to be maintained mainly by the direct stress of density which imparted the axial inclination to the mass of the earth, and in so doing created motion in a definite direction. These appear to be the principal material conditions for the phenomena which characterise the December solstice.

2. *The June Solstice*.—This, or more exactly 11 days later, is the epoch at which the earth is most remote from the sun. Our theory involves a reference of phenomena experienced on the sunward surface of the earth to the mode in which solar and terrestrial vortices of force act and react, and so work upon each other and upon the molecules of matter with which they are associated under a certain and definite equilibrium of these forces without appreciable loss of solar energy. The mode of producing phenomena may be explained as follows: The fact that the earth's axial inclination is maintained by the density stress which each mass of the solar system exercises upon it is unquestionable; and it will be readily seen that the same principle applies equally to all the earth's component molecules, both throughout its mass and in its atmosphere. Therefore, it is that each of these molecules is held in a definite position, whilst it is subjected to the influence of helical lines of stress both from the sun and the earth. The general principle by which axial rotation of the molecules is set up and maintained by these solar terrestrial vortical forces when evenly balanced has been stated. Attention has also been directed to the fact that these vortical forces are not only capable of driving other weaker forces back upon themselves, but also of causing them to reverse their direction; consequently, in the December solstice, the vortices of terrestrial origin are driven back upon the earth, but now at the June solstice, as the distance from the sun is increased, the solar force is diminished with all its resulting effects, and the earth's orbital velocity is reduced to its minimum value. We must again point out that the dominating cause of the changes of the *seasons* is the inclination of the earth's axis, which causes the northern and southern hemispheres to be alternately more exposed to the effects of the solar vortex. *Temperature* effects due to the earth's changing distance, though really existent, serve only to modify this. But whilst disparity in the intensity of solar-terrestrial vortices is the cause of variations in the velocity of the earth's orbital motion, we have to acknowledge variation of distance as one element in producing the varying velocity.

We have also to consider the gradual changes in the position of the earth's axis of rotation, for it has been recently shown that the position of the mechanical axis of the earth varies slightly within the mass of the earth itself, and this in addition to the slow but constantly progressive conical motion of the axis which gives rise to the precession of the equinoxes. I conclude that the fundamental cause of these important modifications in the rotation of the earth is some slight departure of the earth's centre of gravity from the centre of figure or form. The usual method of referring the cause of precession to the earth's equatorial padding or protuberance only, and regarding the spherical globe of the earth as considered without this padding as absolutely unaffected by the causes which produce precession, seems to ignore the inequalities of structure and density which must exist within the mass of the earth itself.

Natural phenomena appear to favour such a conclusion, and the opinion is supported by phenomena observed when various forms of matter are suspended in the "field" of an electro-magnet, when every form of matter exhibits a characteristic axial inclination as the resultant of the mode in which each substance deals with the lines of force, or the force with the substance. Under such circumstances, since the same law applies to the largest celestial bodies as to the units of which they are composed, the deduction appears obvious that the source of these very important phenomena is to be traced to some slight deviation of the physical centre from the mathematical centre of form as described above. The seasons are connected with the difference in the length of the day and night, and variation in this has naturally been traced to the position of the earth's axis with respect to the sun. The movement of the axis of the earth generates an imaginary cone whose apex is at the centre

Digitized by Google

of the earth, and produces the "precession of the equinoxes" without modifying the inclination of the axis to the ecliptic. This complete movement is known to be accomplished in about 26,000 years. Its effect is to make the solstices occur at different parts of the earth's orbit. "Nutation," or the so-called "nodding" motion of the poles, or axis of the earth, is effected in about 18⅔ years. Changes in axial direction are slight; the maximum does not reach 10″ of arc. The movements of rotation and translation round the sun, with their effects, are simultaneously carried on by the earth; it will therefore be perceived that all these important changes in the earth and its surface condition are brought about by some modifications of the motions of the earth and of its position, and particularly of the direction of its axis, with respect to the sun. But the question has not been answered as to *what gives origin to these changes of axial direction*; and as they are all performed with mathematical regularity, they ought to be traceable to a definite cause. From what is involved in this "scheme" of the universe, I venture to propound the following—viz., that it is due to some more or less *slight* departure of the earth's "centre of form," or mathematical centre from the physical centre.

The solar-terrestrial vortical forces have, it appears to me, many very important offices to fulfil in the evolution of natural phenomena over and above the influence which they exert upon the motions and temperature of the earth. By reference to Diagram No. III. it will be observed that they are always crossing each other, and it would appear that they not only do this, but that they form two helical currents which move from opposite directions one within the other, upon the same plan as in the induction electric machine. In referring to that method of originating

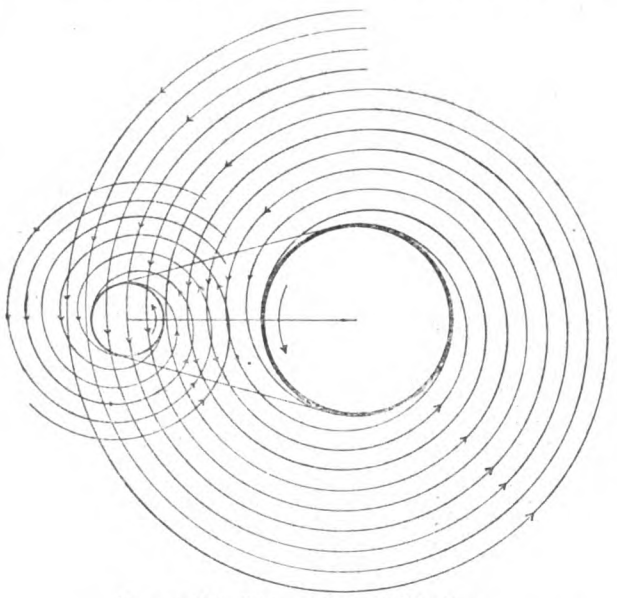


DIAGRAM III.—Solar and Terrestrial Vortices.

currents of electricity in my paper in the *Electrical Engineer* for Aug. 24, 1900, I have shown that these currents rotate and polarise the atmospheric particles with which they are associated, and so originate the phenomena of light. Unquestionably, as it appears to me, they are intimately associated with all the particles in the crust of the earth which they tend to rotate and combine in proportion to their freedom of motion. If this be so, they tend to maintain biological phenomena, and, the primary germs having been supplied, they would determine the conversion of suitable pabulum into the sap of vegetable organisms, or the various forms of mineral and other matter into the blood corpuscles of animal life, in accordance with the character of those primary germs; the shape of the corpuscles testifies to the rotary motion which they have undergone in the process of their formation.

The formation of the individual atoms of the chemical elements is also to be ascribed, according to the views set forth in this paper, to the quantitative condensation of the original eogen while undergoing rotation, the "atomic weight" of an atom depending simply upon the quantity of eogen condensed during its formation, and the physical and chemical properties of the atom depending partly upon the layer of "bound ether" condensed upon its surface, and partly upon the form which the atom acquired during rotation by which the conditions and degree of condensation were governed. In this way, it is suggested, the properties of different kinds of mineral matter originated. Nor does it appear to me that the mode in which the inorganic earth became clothed with grass and inhabited by animal forms is much more complex, provided only the same principle were active in these other kingdoms of nature. Thus in the mineral kingdom the great simplicity by which a pure fluid primary stuff was converted into the several different forms of matter has been noted. Possibly by allotting to each germ the power of taking to itself a certain and definite quantity of each requisite form of mineral matter, the whole conjointly under the influence of solar-terrestrial forces, would possess characters determined by the quantity of each form of mineral matter, and by the nature of the structure into which that matter was wrought.

The steps of the entire process by which this is brought about may be clearly stated: (1) Each mineral unit has its own specific character and polarity, the direct lines of solar-terrestrial stress causing the polarity to assume a direction more or less parallel with such lines of stress, and with the stress proceeding from other units with which it is associated; at the same time the solar-terrestrial vortical forces, acting upon the principle of the induction whirl electric machine, as previously explained, rotate the unit under consideration. This principle applies to the formation of all kinds of mineral matter. (2) But each biological germ is compound in its nature—*i.e.*, several forms of mineral matter enter into its composition; consequently the polarity of the biological germ, which in the seed shows itself more especially in the relative direction of the radicle and plumule and other vital properties, is the resultant of the polarity of all the mineral units; and it is under the influence of solar-terrestrial vortical forces that changes are effected in their material condition, and a new line of polarity is set up, which is the resultant of the polarity of each and all the mineral constituents, and results in the polarity of the so-called germ cells, or biological units.

This, as it appears to me, was the method of creation by which the earth brought forth grass and various forms of animal life. But precisely the same regulating influence as to the quantity of each kind of matter adapted to each description of germ was essential to their complete formation, as in the case of the separation of the primary stuff into definite quantities for the formation of the different kinds or species of mineral matter. It should, however, be added that the process was, in all probability, progressive, and that whilst we are now regarding, in both vegetable and animal kingdoms of nature, the germs as being formed under most favourable conditions it was otherwise at first, the ultimate change being effected by a higher grade of evolution. This does not, however, modify in the least the intrinsic character of the biological germs which would be dependent initially upon the quantity of the respective mineral substances in each, although it would necessarily considerably affect the conditions under which the germs existed.

It is perfectly impossible in a paper like the present to do more than just touch, in the briefest possible manner, upon the far-reaching effects of these vortices of force; but the material universe itself seems to have been brought into existence, in the manner I have attempted to define, by rotation (and condensation) of the primordial eogen, and subsequently the same characteristic form of energy appears to have been utilised by the Creator in the maintenance of that universe in its entirety and harmony.

FORTHCOMING EVENTS.

FRIDAY, OCT. 26.

Physical Society.—At 5 p.m., at Burlington House, exhibition of experiments illustrating certain phenomena of vision, by Dr. Shelford Bidwell, F.R.S.; and papers on the "Concentration at the Electrode in a Solution, with special reference to the Liberation of Hydrogen by the Electrolysis of a mixture of Copper Sulphate and Sulphuric Acid," by Dr. J. S. Sand; and "Electromotive Force and Osmotic Pressure," by Dr. R. A. Lehfeldt.

Institution of Junior Engineers.—At 8 p.m., annual general meeting at Westminster Palace Hotel.

MONDAY, OCT. 29.

North-East Coast Institution of Engineers and Shipbuilders.—At 7 p.m., at Newcastle-on-Tyne, first general meeting of graduates' section. Inaugural address by Mr. H. B. Donaldson on "The Construction of a Modern Merchant Steamship."

THURSDAY, NOV. 1.

Civil and Mechanical Engineers' Society.—At 8 p.m., ordinary meeting. Paper on "Patent Law," by Mr. G. F. Emery.

Rontgen Society.—At 8 p.m., ordinary meeting. Presidential address by Dr. J. B. MacIntyre.

Chemical Society.—At 8 p.m., ordinary meeting.

SATURDAY, NOV. 3.

Institution of Junior Engineers.—At 3 p.m., visit to the Millbank Station of the London Hydraulic Power Company, Millbank-street, Westminster. (Postponed from Oct. 27.)

Glasgow and West of Scotland Technical College Scientific Society.—At 7 30 p.m., at Glasgow. Paper on "Theory, Technique, and Practice," by Mr. T. J. Nicolls.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	577	The Electrical Engineers (R.E.) Volunteers	597
The Philosophy of Dynamo Design	582	Light Railways	599
Buenos Ayres	585	The Electrical Transmission Company's Switch Gears	600
An Improved Glass Revealer	588	Electrical Heating for Buildings	601
Some Remarks upon a Hitherto Unrecognised Planetary Law	590	Questions and Answers	602
Forthcoming Events	593	Leeds Electricity Accounts	604
Maintenance and Guarantees	594	Legal Intelligence	605
Correspondence	595	Companies' Meetings and Reports	605
Glasgow and West of Scotland Technical College Scientific Society	596	Contracts for Electrical Supplies	605
The E. L. B. System of Lighting	596	Lighting Notes	607
The Factors which Determine the Design of Monophase and Polyphase Generators	597	Traction Notes	609
		Provisional Patents	611
		Traffic Returns	612
		Companies' Stock and Share List	612

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

MAINTENANCE AND GUARANTEES.

There has been recently a genuine attempt made to remove one cause of friction between consulting engineers and the contractors with whom they have to do. We refer to the model form of general conditions issued by the Cable Makers' Association, in which a limit of time was fixed beyond which cable-makers were not to guarantee their goods. This would seem at first sight to be a faulty policy, as it would prevent the contractor who has great faith in the lasting power of the materials supplied by himself guaranteeing the same in accordance with his personal knowledge. We take it that the real object of the limitation is to prevent onerous guarantee clauses which involve risks impossible to foresee being forced on electrical contractors in general. This is no new phase in the contracting world, and we suppose that a better instance could not be given than that of electric accumulators. In the struggle for orders the manufacturers of these accumulators have been induced in years past to compete the one against the other with respect to their charges for upkeep. It has, of course, been inferred by some that the manufacturer who will for the least annual sum maintain his accumulators must have in consequence the best type. Unfortunately, this has not always been the case, and it will be remembered that one large public company was seriously misled and financially ruined by acting on this supposition. In fact, contractors were induced to offer absurdly low rates for maintenance in order to secure orders with an immediate profit. In the other branch of electrical engineering referred to above—*i.e.*, cable manufacture—the conditions were becoming even worse, as manufacturers were continually asked to guarantee their cables for a long period without any annual remuneration whatever. The beginning of this was distinctly due to one firm of cable-makers offering freely a five-year guarantee. The others, in self-defence, were obliged to follow suit. In our opinion, the majority of the guarantees so given were valueless, and they certainly helped to open up endless opportunities for dispute, which does no good to either the contractors or to the electric light undertakers using the cables. It was only when this rod prepared by cable manufacturers came to be applied rigorously by certain young engineers that some defensive step had to be taken. There is no objection whatever to a manufacturer undertaking to maintain his cables, engines, dynamos, or any other electrical apparatus for a given number of years, provided that he receives remuneration for so doing. He can then ensure the users, not only against faults due to manufacture or erection, but also against the faults which arise from the working of the plant in question. The items for repairs which are found in the accounts of our electric lighting stations would thus be guaranteed at a fixed annual sum, out of which the contractor would expect to make a reasonable profit. We do not say that this course would be advisable, but it shows how unreasonable it is for engineers to expect electrical contractors to include in their original contract sum the annual repair bills which are to be expected for the next

Digitized by Google

five or ten years. These are distinctly not the risks to be included in a contract for the supply of machinery, but rather are in the nature of an insurance by which unduly heavy charges in any one year can be avoided. Another issue of the same question is that the repairs necessarily vary per year, and the engineering knowledge and organising ability of a central-station engineer largely influences the amount required to be spent each year. It is therefore unreasonable to ask the supplier of plant to take in his contract risk the repair items for a period of years, when the engineer who specifies the contract and demands the repairs as required may indirectly cause certain of them. In conclusion, it is the engineer's duty to run and maintain the works and mains after they are taken over from the contractor—and the time at which they are taken over should not be unnecessarily long—and we are glad to see that certain manufacturers are refusing to take up this duty. The engineer should in no way try to shirk his responsibility.

CORRESPONDENCE.

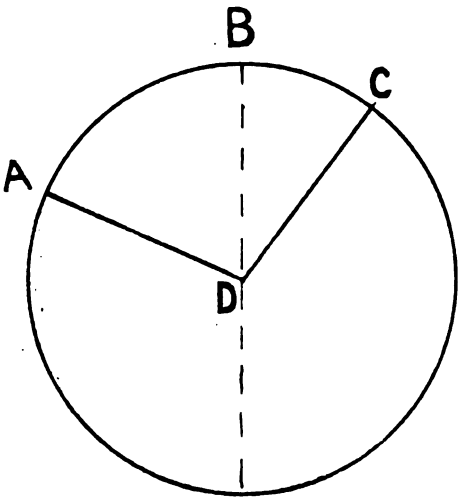
"One man's word is no man's word,
Justice needs that both be heard."

ELECTROMAGNETIC INDUCTION.

SIR,—As this letter offers experimental proofs of my contention which Mr. Johnston and others have disputed, you will probably agree to print it, although the discussion has certainly lasted too long. I have nothing more to say concerning Dr. S. P. Thompson or other authorities, except that Mr. Johnston is altogether unjustified in saying that the passage I have quoted from "Dynamo-Electric Machinery" referred solely to the case of "a closed coil moving entirely in a uniform magnetic field." Dr. Thompson neither says nor implies that this is so.

The experimental proofs I am about to offer are so obvious that it is a wonder they have not long ago occurred to myself, to Mr. Johnston, or to the editor of *Lightning*, the latter of whom severely criticises me in his journal, and refuses to let me reply. They are as follows: (1) send a current through the primary of a transformer, and you get a current in the secondary; (2) suddenly stop a current in any circuit, and you get a momentary induced current. Both these results are readily explained on the theory that ascribes induction to a variation in the magnetic field embraced by the circuit; but they are inexplicable on the popular theory which ascribes induction to a cutting of magnetic lines by the conductor. In the case of the transformer, how can there be any cutting between magnetic lines *inside* the core and conductors *outside*? And in the other case, can it reasonably be asserted that the magnetic lines set up by the original current rush across the conductor when the current is stopped, cutting it on their way and thus inducing another current? It may be well to mention that the lines of *leakage* in a transformer are prejudicial to its efficiency, so that the lines which cause the current must be those inside the core, which could not possibly be cut by the conductors that are outside.

If I may trouble you to reproduce this diagram, I shall be able to answer Mr. Johnston's challenge to explain the action of a unipolar dynamo on the *variation* theory. Let the circle be the rim of a wheel armature in a unipolar dynamo, and let A D, D C be any two spokes on opposite sides of the line B D, B and D being the points at which the sliding contacts are made. When the wheel revolves clockwise, assuming that the magnetic lines are flowing through the wheel towards the observer, the motion of D C evidently causes an increase in the number of lines in the space B D C, giving rise to a current from C to D (clockwise); and the motion of A D evidently causes a *decrease* in the number of lines in the space B A D, giving rise to current from A to D (counter clockwise). The action of the dynamo is thus perfectly explained on the theory I defend. The editor of *Lightning*, who questioned the possibility of explaining such a dynamo on this theory, declines to print the explanation just given, but tells his



readers that I have sent him a "quite erroneous explanation." This is scarcely the treatment one would expect from a scientific and fair-minded man.—Yours, etc.,

W. F. DUNTON.

THE PATH OF THE SUN.

SIR,—From a letter in your issue of the 19th inst., I conclude that Mr. Sandeman considers that I have criticised him unjustly, and attempted to discount the value of his theory as to the path of the sun on the strength of my individual opinion. Since this is by no means the case, may I claim your indulgence for a few lines?

Mr. Sandeman complains of my treating as a fallacy his statement that the revolution of the nodes of the sun produce a conical motion of the earth's axis amounting to 47deg. I did not treat his statement to this effect as a fallacy, since "it is impossible to reply to an oracular assertion." When Mr. Sandeman states that he believes "the sun to revolve round the earth in 25,800 years, that he holds the earth in a firm grasp as a consequence of the gravitational action on the protuberance, and as he progresses round the earth, takes it round with him" ("Path of the Sun," p. 85), though one may dispute his contention that "there is no evidence to show the opinion to be erroneous," we must at least admit his right to hold this or any other view if he so chooses. What I stigmatised, and still stigmatise, as a fallacy is his argument that since the revolution of the nodes of the moon produce a small motion of the earth's axis about the position it would occupy if undisturbed, *therefore* the revolution of the nodes of the sun will produce a conical motion of the earth's axis, amounting to 47deg., about an axis perpendicular to the ecliptic.

I must admit myself to be completely at a loss to understand Mr. Sandeman's contention that "a calculation cannot prove the nature of a movement," and that "to prove anything relating to a quality, condition, or attribute by figures is impossible." Any quality, condition, or attribute of a body which can be measured, and thus known quantitatively, can be made the subject of calculation. The motion of the polar axis of the earth is a case in point. I must regretfully decline the "palm of superiority" which Mr. Sandeman offers me, since a complete calculation of the precessional motion of the earth's axis has already been effected. This may be found in full in "Rigid Dynamics," by E. J. Roath, M.A., F.R.S., etc. (Macmillan and Co.).—Yours, etc.,

EDWIN EDSER.

Putney, Oct. 22, 1900.

GOSFORTH.—The Board of Trade have confirmed the Gosforth and Ponteland light railway order.

Digitized by Google

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

The opening meeting of the eighth session was held in the large hall of the college last Saturday, when Mr. Henry A. Mavor, M.I.C.E, M.I.E.E, past-president, occupied the chair.

Mr. DAVID HOME MORTON, M.I.C.E., M.I.M.E., delivered his presidential address on "The Standardisation of Machinery." Nature, the president said, did not standardise, inasmuch as no two creatures were exactly alike, nor in her infinite wisdom did Nature make each individual symmetrically perfect, no matter how perfect the female form might appear. In some cases man, however, found it an ever-present necessity to do what Nature declined to do, and he had reached a degree of perfection which, while in no way indicative of finality, was a striking testimonial to his mechanical genius. The object of all industrial production was gain to the producer, and the greater the margin between the prime cost and selling price the greater the gain, hence the necessity of introducing every means which could be devised in order to reduce the cost to the producer. Our American and Continental friends had in this, as in some other respects, beaten us, but for many years past our most progressive British firms had recognised the value of standardisation and acted accordingly, while even our most backward firms were now recognising the necessity of setting their house in order if they were to have any place at all in the industrial world. Complete standardisation was not possible, owing to the repairs and renewals for existing machinery, and owing to the man who, usually spending other people's money, must have something different from anything which had been made before. The man who would cultivate standards must be strong, and it would be well for him to be philosophical, for in his declining years he might see the silly gander and the donkey wandering aimlessly over his well-ordered garden. When he was no longer able to take an active interest in the management of a business, his successor might, with a view to asserting his own individuality, but more often displaying inferior mechanical skill and organising ability, depart from the established order, and set up other standards on perhaps an ill-considered basis. The man who saw his work thus ruthlessly swept away after it had probably passed through the evolutionary process associated with such work, must console himself with the reflection that, after all, the loss was not his, and that time only would prove the merit of any standards, old or new. The adoption of systems of standardisation, if success was to be won, must be accompanied by the common-sense working of the systems. Passing to details, the Whitworth standard, from which the Sellar's or United States standard for screw threads differed but little, was a step in the right direction. But even that was not ideal, giving as it did in the larger sizes a thread too coarse for the highest class work, thus pointing to the need of reconstructing the standard. There was nothing to prevent flanged connection being standardised, both time and money being saved, by the use of standard drilling templates, particularly for the smaller and more common sizes. Valves and valve-chests were full of lessons in standardisation, while plummer blocks, or chairs or pedestals lent themselves not only to standardisations of dimensions, but also to nomenclature. Many firms made a speciality of shafting and gearing, and from them it was recommended that the buyer should purchase his requirements. So, too, with many of the details. Standardisation of complete machines was simply a fuller development and the logical sequence of the standardisation of detail. Many works in the United States, and not a few in this country, had done well in producing engines, machinery, etc., in standard series, as instance Willans, Belliss, Tangyes, Robey, Babcock and Wilcox, and many others. All these firms, not content with the result of past efforts, had spent and were spending freely of their gains in order to produce results still more satisfactory, and to make their position in the commercial world as nearly impregnable as it is possible to be.

At the conclusion of Mr. Morton's address, a few remarks on the subject were made by several gentlemen present. A Japanese member of the society, in a speech made in excellent English, pointed out the difficulty which younger nations experienced from the want of international standards. He thought that a standard system of weights and measures ought to be one of the first objects of civilised countries. The metric system, he thought, was especially suited for international trade, and he hoped that some effort would be made to secure a reliable basis common to all trading countries. Britain, in the East, laboured under a serious disadvantage in this respect.

The CHAIRMAN said that not only were the machines as made in his own works standardised, but by the introduction of definite methods of shop organisation a surprising saving in the working expenses had been obtained, with an equally great improvement in the accuracy with which shop records could be kept.

At the conclusion of the proceedings Mr. Morton was awarded a hearty vote of thanks for his interesting and valuable contribution to the literature of a difficult and important subject.

THE E. L. B SYSTEM OF LIGHTING.

On Friday last the Electric Lighting Boards and Strips Company invited the Press to a private view of their system of lighting. The electrical boards in question consist of a number of copper conductors stretched in a network over a certain area, and insulated from each other by hardened asbestos. On top of the conductors is placed indiarubber, asbestos, and cork, the latter forming the surface of the board. The lamps used have a specially-prepared collar, which has two phosphor-bronze spikes as the terminals of the filament. These spikes are pressed through the layers of cork, indiarubber, etc., until they reach the conductors underneath. The spikes are set such a distance apart as that wherever they are pressed into the board two opposite poles are found. The asbestos insulation between the conductors is very thin, but is hardened so that a spike cannot enter it and thus cause a short-circuit. The conductors themselves, in order that the spikes make good contact, are formed of small bundles of wires in the same fashion as flexible wires are constructed. The system can be applied to very narrow strips for running along a room or elsewhere, and can be made as a kind of cable for decoration purposes. In order to prevent the lamps from being shaken out on wall or ceiling strips which are subjected to much vibration, the lamps are supplied with a detachable clip, which is twisted round and grips under the edges of a beading, which is run along the top and bottom of the strip. It is claimed by the company that by this system of wiring the ordinary method now used of wiring each individual point will be to a great extent superseded. There is no doubt that in some instances such a system would be of great use, but we do not think that in certain of the applications for which the company think it very suitable it will oust the present method of electric lighting by means of lamps on flexible cords. The method is claimed to be in the long run considerably cheaper than the ordinary wiring system, but it remains to be seen how a board will work after a year or two's wear. There is, we should think, a possibility of the cork surface crumbling out, and a general renewal being found necessary. For theatre signs it is claimed, and with good reason, that this system is much more convenient than the old. This would be so more particularly in the case of a provincial theatre, where a different piece is acted every week. In this case the lights could be easily shifted from forming the name of one play to form that of another. For temporary work, such as decorations on special occasions, the system should also be found very convenient. The system is also specially recommended for showcase work, and for those willing to go to the expense of fitting it would no doubt be found very convenient. Lamps connected with flexible wires could, however, in most cases give an effect which is quite as good. Another point in connection with the pushing in and pulling out the lamps is that there is great danger of

Digitized by Google

persons who do not understand the matter catching hold of the bulb of the lamp and pulling, in which case it would probably come away from the socket. There is, however, one would think, a successful future before the system, which in certain cases would undoubtedly prove more convenient than the ordinary system of wiring. The Electric Lighting Boards Company gave illustrations at their factory in Dean-street, Soho, of the various uses to which their system can be put. The offices of the company are, however, at 7, Pall-mall, S.W.

THE ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS.

At the present time, when volunteers have proved to the general public that that portion of the auxiliary forces is no mere pastime for a number of men, but a very real item in the defence of Great Britain, it is interesting to electrical engineers to note that recruiting for their own special corps, the Electrical Engineers (R.E.) Volunteers, commences next Thursday, Nov. 1. The men are examined and enlisted at the headquarters of the corps on Tuesdays and Thursdays, commencing with the above date. The members of the corps have done really good and useful work out in South Africa, and their example should cause a large number of members of the electrical profession who have not joined to do so at once. As may be remembered, the object of the corps is to bring together a body of men having adequate knowledge of applied electrical science, and to train them in the application of their knowledge to the defence of their country. The principal duty will probably be to supply officers and men to assist their comrades in the regular Royal Engineers in working defence electric lights at the defended ports, but their special technical knowledge will also be used in many other ways. The conditions of service are much the same as for the Volunteer Royal Engineers, and to qualify for efficiency a man must attend a considerable number of drills and have passed a certain electrical course. In the Submarine Miners' corps, to which the conditions in Electrical Engineers' corps are very similar, a man must attend 78 submarine mining drills and have had eight days' continuous training. He must for the first year's service have passed the requisite examination. For men with over three years' service a less number of drills are required. The uniforms of the rank and file are found by the corps, but the officers have to purchase theirs. Towards this expense, however, we believe a grant is made by the War Office which almost covers the cost. When in camp the corps would receive the ordinary pay of the regular Royal Engineers, together with special working pay when engaged in following their professional work as volunteers. We would strongly recommend, now that the corps is open to take recruits, that any members of the profession who can do so should join, and the working drills and instruction given would probably prove very useful in their private occupations as well as to the corps itself. The officer commanding during the absence of Major R. E. B. Crompton is Major R. Erskine. Any information which may be required by intending recruits can be obtained by writing to the officer commanding at headquarters, 13, Victoria-street, S.W., who will be pleased to send all particulars.

THE FACTORS WHICH DETERMINE THE DESIGN OF MONOPHASE AND POLYPHASE GENERATORS.*

BY B. A. BEHREND.

The path of the designer of alternating-current machinery has been beset with extraordinary difficulties. At a time when direct-current machines could be designed with an accuracy equalling that with which the dimensions of steam-engines can be predetermined, the designer of the alternator was still groping in the dark. The invention of the asynchronous single and polyphase motor, though stimulating and enhancing the interest attached to the solution of the problem, only increased, at first, the difficulties. It was found that alternators, which gave satisfactory results when working on non-inductive loads, were utterly worthless for induction motors. To the surprise of many a designer, the drop of voltage was so immense that by no increase of the exciting current could the voltage at the terminals be raised to its proper value.

An explanation of this phenomenon was afterwards easily given, and our periodicals were rife with mathematical theories to account for the observed phenomena. I am far from thinking that such speculations are without value—they very often hasten the approach of the final solution of a controverted question—but, as they usually abound with *a priori* assumptions which are by no means justified by experiment, they are like a double-edged sword in the hands of the designer. Long deductive arguments not based on the solid ground of experiment are premature, and the energy wasted on them would far more wisely be spent in widening our knowledge of experimental facts.

There was another factor which contributed to obscure the real points at issue—viz., the frequency of the alternating current. The frequency of alternating currents has not sufficiently been dealt with from the standpoint of the designer of the alternator or motor, but only from the standpoint of the light-installing engineer. He held that the frequency, or number of complete periods per second, ought to be, for his transformers and lights, at least over 50, and frequencies of about 80 did not belong to the exceptions, but were rather the rule. Now, such high frequencies may be justified as long as the alternating current is dissipated altogether in heat or light, in which case the greater inductive drop accompanying the higher frequency, being in quadrature with the current, is not fatal. As soon, however, as inductive currents were taken from these machines with high frequency, the voltage at the terminals dropped beyond control, betraying the unsatisfactory design of the generators.

In America the designers resorted to an expedient, curing, so to say, the symptom, but not doing away with the real evil—viz., they compounded their generators—while in Switzerland and also in Germany, the only countries in Europe that took part in the development of polyphase work, other ways were chosen. We can hardly think of a country more favourable to the development and spread of so flexible a system as the polyphase current system than Switzerland. A rich country, abundant in water power, covered with villages and fine hotels, full of small industries, needing light and power over comparatively large areas, Switzerland has proved a hotbed for the growth of the polyphase currents; and it was in the Oerlikon Engineering Works in Switzerland that the author had the opportunity of investigating the principal factors which determine the design of alternating-current machinery. The following article contains some of the results at which I have arrived.

I propose to deal with the problem in the following manner: We shall first mention the factors which are necessary to predetermine the static characteristic of the alternator. We shall then turn to the methods by which the dynamic characteristic can be determined, and shall discuss them in the light of a series of experiments. The last chapter will be devoted to the influence of the frequency, of the pole-pitch, and of the air-gap on the drop. The results there attained will furnish us a simple and very useful method of designing alternating-current machines.

I.—The Static Characteristic of the Alternator.

This section may be briefly treated, as Mr. Gisbert Kapp's excellent works on the subject give all information desirable. Some points here touched upon are inserted only for the sake of completeness. The following formula gives the value of the effective E.M.F., e, which is induced in the armature possessing z active conductors:

$$100\, e = k \sim z\, F\, 10^{-6} \text{ volts} \quad . \quad . \quad (1)$$

In this formula $\sim$ stands for the frequency—that is, the number of complete periods in one second; z, as said above, is the number of conductors or wires that are cut by the lines of induction; F is the number of lines of

* From *Electrical World and Engineer* (New York).

Digitized by Google

induction emanating from each pole, in C.G.S. units; k is Mr. Kapp's coefficient, dependent upon the ratios of the width of the coil and the width of the pole to the pitch of the poles. The following table contains the value of k for different arrangements, after Kapp:

Width of coil / Pitch of pole		0	1/3	1/2	2/3	1
Width of pole / Pitch of pole	1/1	2	1·76	1 64	1 69	1·16
	2/3	2·40	2 31	2 13	1·94	1·49
	1/2	2·83	2 50	2 32	2·12	1·64
	1/3	3 46				

If the leakage at the edges of the poles—the fringe of the magnetic field—is properly taken into account, the values of k in the table give very good results for machines with revolving poles of alternately varying sign, as well as for inductor generators. There is very little difference in the determination of the static characteristic of machines with revolving poles in which each pole is excited by a single coil, and of ordinary direct-current machines; hence the great mass of experience that direct-current engineers have accumulated, can at once be utilised by the designer of this type of alternating-current machines. The so-called

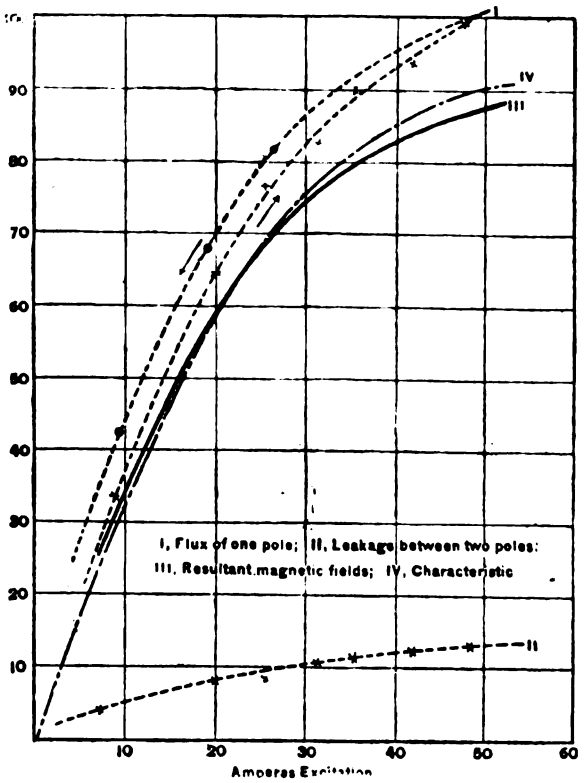


FIG. 1.—Leakage Test Curves.

Lauffen type has practically disappeared from the market because of its immense leakage and other drawbacks connected with the revolving circular coil. I need, therefore, not dwell upon the bitter experiences with this machine. I should like, however, to make some remarks about the inductor generator, which still enjoys a better reputation than it deserves.

From the standpoint of the electrician these machines are inferior to those with alternating poles on account of the leakage between two adjoining pole-horns, which conditions I shall immediately illustrate by some curves. From the standpoint of the mechanical engineer the high induction in the air-gap—which must be kept small on account of the leakage—causes even with very slight eccentricity of the revolving part such immense one-sided magnetic stress that the shaft has to be made far heavier than in the revolving-pole type, and difficulties with the bearings, if not very amply proportioned, are by no means exceptional.

I measured in 1897 the leakage in an 800-kilo-volt-ampere generator designed by Mr. Emil Kolben a year before in the Oerlikon Engineering Works. The method employed was one that Mr. Kapp had used a long time before for determining the leakage in direct-current machines. The method is based on the same principle as the instrument of the late Dr. John Hopkinson for determining the magnetic properties of iron. A coil was formed of some turns of a very thin wire which was affixed to a sheet of cardboard. The coil had the same dimensions as the armature coils, the pitch of the coil being equal to the pole-pitch. The ends of this exploring coil were connected to a ballistic galvanometer; in our case a sensitive Weston instrument was sufficient.

The air-gap of the generator was 0·5cm., the pole-pitch 23·5cm, the width of the pole 23·5cm., equal to the pole-pitch. While the inductor of the generator was standing still, the field was excited, the exploring coil was placed between a pole-horn and the armature, and then pulled out. The deflection of the galvanometer is thus proportional to the total number of lines of induction entering the armature from one pole-horn of the inductor. The coil was then placed between two adjoining pole-horns and again pulled out. The deflection measures the leakage field, which acts in an opposite direction to the main field.

The curves in Fig 1 show the result of these tests. The abscissæ of the curves represent the exciting current, the ordinates the deflection of the galvanometer. The two curves, measured as described above, are represented in broken lines, while the resultant magnetic field is represented by the full-line curve. The curve plotted thus —.—.—.—.—. is the static characteristic of the generator. The almost perfect agreement between this curve and the curve of the resultant magnetism is interesting to notice. If the resultant magnetism is set equal to 100, then the leakage field has the following values for different excitations:

Exciting current.....	10	20	30	40	50	amperes.
Leakage field	14·3	13·8	13·4	14·6	15·3	,,
Resultant field.....	100	100	100	100	100	,,

The leakage between adjoining poles is, therefore, about 15 per cent. of the resultant magnetism. In other words, the leakage field induces a counter E.M.F. in the armature coils equal to 15 per cent. of the resultant magnetism; besides, the cross-sections of the iron parts have to be proportioned for all these leakage lines. Hence, this leakage of 15 per cent. is equal to a leakage of 30 per cent. in a generator with alternately-wound magnets. It may be remarked that the leakage thus measured does not include all the leakage lines, as some are entering the frame holding the two armatures without passing through the armature coils. But this leakage field is not considerable, and may generally be neglected.

The leakage coefficient varies, of course, between certain limits in machines of the same type, but of different size. The factor is partly dependent upon the ratio of the air-gap to the width of the poles, partly dependent upon the absolute value of the pitch of the poles. I have never found the leakage factor under 20 per cent., this being the lowest value found in machines with an air-gap of $\frac{1}{16}$in. and a pole-pitch of 9in., while in generators with a pole-pitch of 5in. and an air-gap of $\frac{1}{8}$in. for slow speed, the leakage factor rose to the immense value of 45 per cent.

That the absolute value of the pole-pitch is of such paramount importance is quite clear if we bear in mind the fact that the magnetic resistance of the air-gap in direct-current dynamos with slotted armatures is hardly increased by the open slots. We cannot emphasise this point strongly enough, as a small pole-pitch has been the cause of the failure of many a generator, and as these machines chanced to be for high frequencies in the majority of cases, the failure was attributed to the high frequency, though, in fact, due to a too small pole-pitch. We shall return to this point in the section of this article discussing the short-circuit characteristic.

Fig. 2 will demonstrate the influence of a small pole-pitch on the static characteristic of the generator. Curve I. represents the characteristic of an inductor generator, running at a speed of 500 revolutions per minute and developing a three-phase current of 50 periods per second. The number of pole-horns is six on each side of the exciting coil. The pole-pitch is equal to the width of the poles—viz, 27·6cm. Curve II. represents the characteristic of a generator of the same type and size, running, however, at

Digitized by Google

a speed of 250 revolutions per minute, and being wound for 50 periods per second. The inductor has, therefore, 12 pole-horns on each side of the exciting coil, and the pole-pitch is 13·8 cm. The two characteristics ought to be alike, if the leakage in both machines were the same. The tremendous difference between the two curves is due entirely to the great leakage caused by the poles being too close together.

What has been said of the influence of the pole-pitch on the leakage in inductor generators holds good, with some qualifications, also of generators with alternating poles, though the increase of the stray field is not so immense as in the case of inductor generators, because the leakage lines do not induce a counter E.M.F. in the armature. While the leakage factor in the generator, the characteristic of which is represented by Curve II., proved to be about 45 per cent., the leakage coefficient for a generator with alternating poles and a pole-pitch of 14·1cm. was 30 per cent. for the same ampere-turns in the field. The air-gap of this generator was 0·35cm., while the air-gap in the inductor generator was only 0·3cm. These figures show clearly the superiority of the alternating-pole generator over the inductor generator.

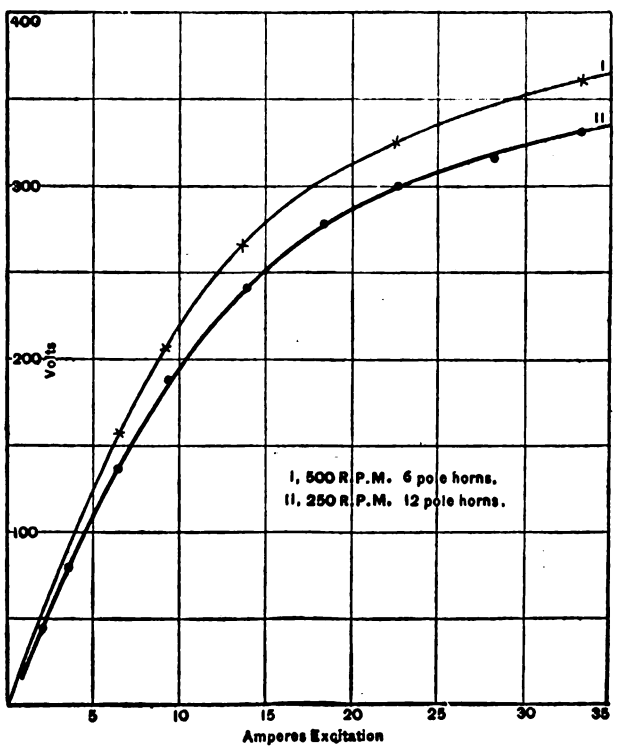


FIG. 2.—Curves showing Influence of Pole Pitch.

Thus, all our experiments in regard to the static characteristic impress upon us the paramount importance of a great pole-pitch, if we desire to keep the leakage within reasonable bounds.

II.—THE DYNAMIC CHARACTERISTIC OF THE ALTERNATOR.

That the determination of the dynamic characteristic of alternators is bound up with far greater difficulties than are met with in the determination of the static characteristic, need not be told to the designer of alternating-current machinery. Indeed, it is not very long ago that the obstacles in the way of the designer seemed almost insurmountable. To-day it must seem almost ludicrous to those who have taken active part in the evolution of alternating-current machinery, and who have eventually arrived at clear ideas, that the form of the wave of the E.M.F. was invariably made the scapegoat for mistakes in the design.

A great step toward the solution of these problems was taken when the short-circuit characteristic of the alternator was made use of, if I mistake not, first in 1895 by Dr. Behn-Eschenburg. From the theoretical standpoint his method could hardly be considered satisfactory; a great many objections might be justly urged against his theory. But as a method for determining the drop it has proved very valuable. Dr. Behn-Eschenburg had arrived at his result by treating the alternator like a transformer, in which case the method is correct. Everybody is to-day familiar with Mr. Kapp's admirable way of determining the drop of voltage in transformers. The simplicity of his method, the ease with which it explains phenomena so complex as the so-called "Ferranti effect," would make it most valuable to the designer of alternators, if it were applicable to these machines. The present author has contended for the past three years that we are justified in applying this method, in spite of its theoretical inaccuracy, to the calculation of alternators if we are only mindful of the assumptions on which the method is based. The following series of experiments will justify this position.

It is well known that the maximum drop occurs in alternating-current apparatus when the current lags behind the E.M.F. by one-quarter of a phase. Furthermore, it can easily be shown that for a power factor below 0·60 the drop is practically equal to the drop caused by a wattless current. In our investigation we shall therefore study the influence of wattless currents on the drop. A large drop is, of course, the most favourable for the verification of the theory. A small drop, as caused by currents in phase, or nearly in phase, with the E.M.F., is not suited for rendering a decision as to whether a theory which lays claim to the determination of the drop is correct or not. The use of wattless currents for the determination of the drop has the further advantage that the drop caused by the ohmic resistance of the armature may be neglected without any inaccuracy worth mentioning.

(To be continued.)

LIGHT RAILWAYS.

The Commissioners have held an enquiry into light railway schemes, one of which was promoted by the British Electric Traction Company for an extension of their order, authorised in the last session of Parliament—for the construction of light railways in the borough of Barnsley and in the townships of Monk Bretton and Worsborough—to establish a line from the terminus of that in the present order at New England, Worsborough Bridge, to follow the main road from Barnsley to Hoyland Common, passing through Worsborough Bridge and Birdwell, then turn to the left to Hoyland Nether, and to end in front of the town hall. The Great Central Railway Company opposed. The Commissioners stated they were willing to grant the order for the light railway, including the level crossing, but they thought a clause should be put in to the effect that any extra expense which the Board of Trade might put the Great Central Railway Company to in consequence of the light railway crossing their line should be thrown upon the promoters, at least to such extent as the Board of Trade thought reasonable.

The Commissioners have held an enquiry into the application of the Kidderminster and Stourport Electric Tramway Company for powers to construct a line from Kidderminster to Bewdley, with a branch to Franche. On Saturday the Kidderminster and Bewdley Corporation authorities received intimation from the secretary to the Commissioners that they would recommend the Board of Trade to sanction the construction of the line for the whole of the route for which the promoters asked powers.

At the last meeting of the Gloucestershire County Council it was resolved to contribute £15,000 towards the Witney, Burford, and Andoversford Light Railway.

The success which has already attended the Goole and Marshland Light Railway has led to an important extension scheme, which has now been completed. The Board of Trade sanctioned a branch railway from the main line from Goole to Luddington and Adlinfleet, leaving the main line at Eastoft. This has now been abandoned, and in substitution the directors have completed arrangements, by friendly agreements with the landowners, to extend the line from Luddington to Garthorpe, a populous township in both the West Riding and Lincolnshire, and not a great way from the River Trent.

The Commission held an enquiry at Swansea on Oct. 24 into the application for permission to construct the Swansea and District Light Railway, and they will resume to-day at the Royal Hotel, Cardiff, the public enquiry into the application in respect of the Rhondda Valleys Light Railway.

Mr. Nevins, the promoter of the light railway from and through Cheltenham to Cleeve Hill, has submitted to the Tramways Committee of the Corporation designs of the cars and rails proposed to be used on the line. It is hoped that the work of constructing the railroad will be commenced within the next two months. No arrangement has yet been come to with the Corporation for the supply of the electrical energy,

Digitized by Google

but the completion of the line is not likely to be delayed on this score, and the terms of supply will be readily settled under the arbitration clause should it be necessary to put it in force.

The Commissioners held an enquiry on the 25th inst. into the scheme for providing Llanelly with electric light and traction.

At a meeting of the General Purposes Committee of the Darlington Town Council on the 21st inst. objections to the recent order of the Light Railway Commissioners were considered. The order, which deviated very considerably from the conditions originally proposed, has caused a good deal of dissatisfaction amongst the members of the Council, and it was arranged that a number of objections should be formulated thereto.

THE ELECTRICAL TRANSMISSION COMPANY'S SWITCH GEARS.

We have received from the Electrical Transmission Company, Limited, of Albert Works, Hammersmith, a well-executed catalogue and price-list of their several specialities. An introductory attached explains that whilst the firm's special patent devices entitle their apparatus to consideration as being the most advantageous, electrically, offered on the market, their purpose is to only supply switch gear of a substantial character, made with the best materials and workmanship, and provided with an ample margin for contingencies of overload, etc. Amongst other patent devices of recent introduction dealt with in this catalogue may be mentioned the automatic motor-starting switches, constructed under the patents of Mr. Walter F. Jones, A.M.I.E.E., M.I.Min.E., engineer and manager to the company, which, it will be remembered, were fully described and illustrated in our issue of Sept. 14 last. As to the claim of substantiality put forward on behalf of the apparatus offered, the justification may best be judged from the accompanying illustrations taken from the catalogue. Figs. 1, 2, and 3 illustrate respectively single, double, and triple pole switches with fuses of the firm's "K" type. A price-list of these switches for voltages up to 250 is given. In the 500-volt switches the breaking distance is increased, and in the double-pole type for this voltage the two iron levers are connected by a black fibre bar, and not screwed to the handle as shown. Fig. 4 herewith illustrates a traction panel of the firm's standard make, equipped with "T" type switches. The special features claimed for these switches are as follows: They lie close to the panel both in the "on" and "off" position, so permitting

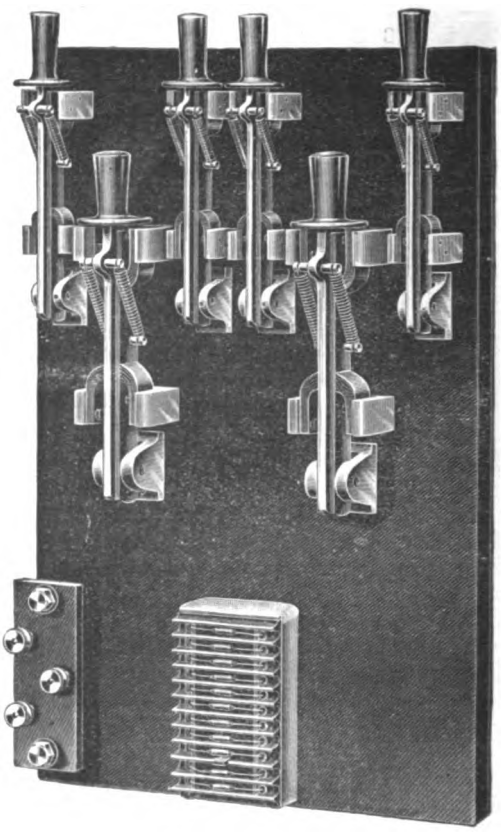
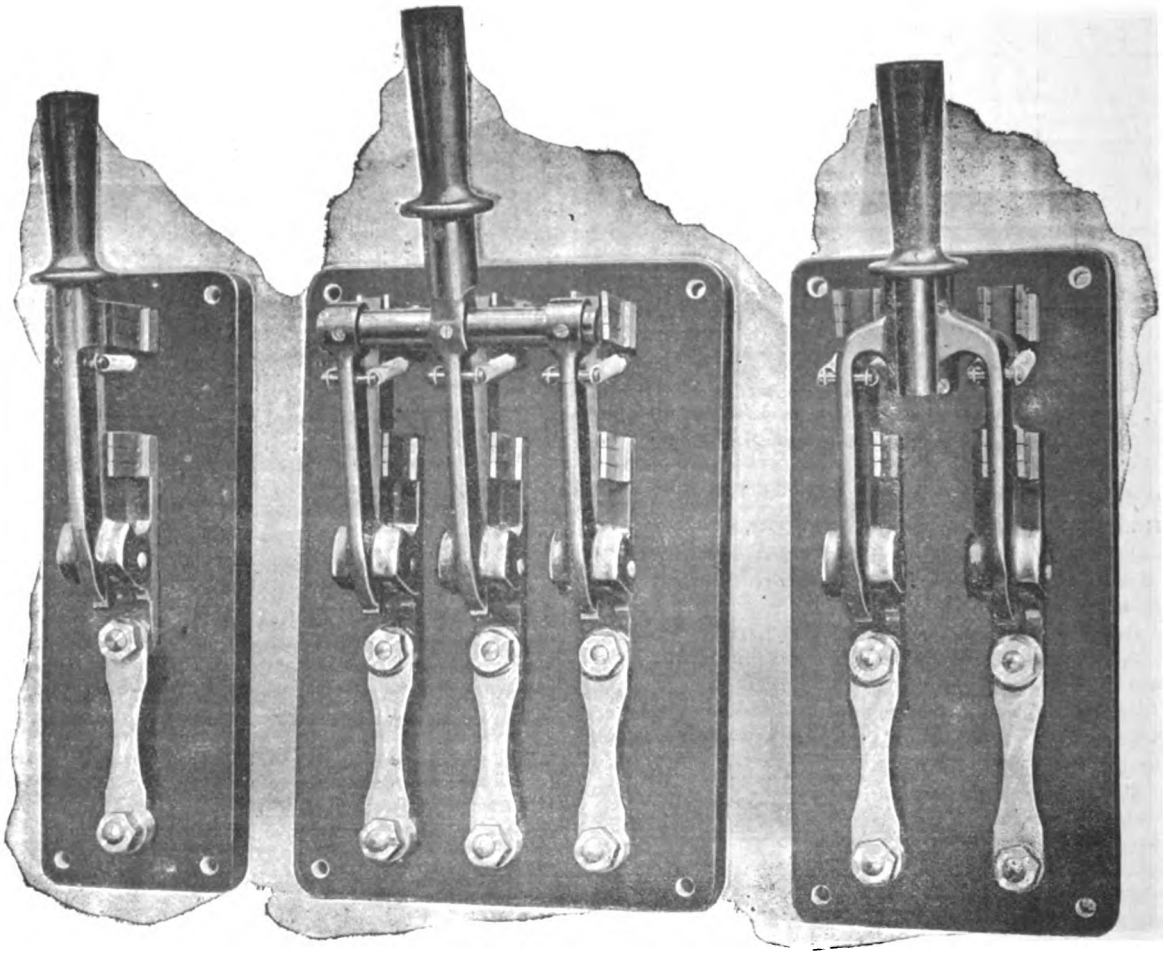


FIG. 4.—Traction Panel.



FIGS. 1, 2, AND 3.—Single, Double, and Triple Pole Switches with Fuses.

Digitized by Google

a small depth in the street section pillars; they have an excellent "quick-break' action, and are suitable for 500 to 700 volts; they are fitted with laminated copper contacts. These switches are also supplied mounted in cast-iron cases, with or without fuses, for cutting off the current from motors. Other types of switchboards and switches are described and illustrated, also arc lamps of the firm's manufacture, of which latter we understand a large stock is kept ready for immediate delivery.

ELECTRICAL HEATING FOR BUILDINGS.

The Prometheus Company, of Bockenheim, have for some time manufactured cooking apparatus and heaters of various descriptions which have met with great success both in this country and on the Continent, and their sole agents here, Messrs. O. Berend and Co., Limited, of Basinghall-avenue, London, E.C., are continually introducing new patterns of cooking apparatus and new applications of the patents owned by the Prometheus Company. Under this company's patents the electrical energy is converted to heat through resistances formed of thin films of precious metals, such as gold, platinum, etc., deposited on an insulating base of mica, enamel, or other suitable material; resistances up to 25,000 ohms can thereby easily be obtained. It is evident that the scope for the use of resistances of this description is practically unlimited where a heating effect is required, and these deposited on a mica base have lately been adopted for electric heating stoves or radiators. Although the use of electric energy for this class of heating has generally been considered too expensive, cases frequently arise where the advantages it affords far outweigh the question of cost; and where the cost of coal is high and electric energy can

FIG. 1.

be obtained cheaply, radiators of this description can be used to advantage. There is also a large class of users of electric energy to whom the question of cost is of no importance if greater comfort and convenience can be obtained; thus a mansion at Frankfort has now been fitted with these radiators throughout, and all other means of heating and warming abandoned. In hotels and other large buildings fitted with steam or hot-water circulating systems, it is often necessary to heat one or more rooms at a time when, as in spring or autumn, the main heating system is not at work. To start the whole system merely for the purpose of warming one or two rooms would be excessively inconvenient and expensive. There is in this direction a large scope for electric radiators, as the convenience of this class of heating for rooms not continually occupied, such as bedrooms, bathrooms, etc., scarcely calls for comment.

With the exception of the Dowsing luminous radiator, those now in use are cumbrous and heavy, having a large amount of metal, etc., in connection with the resistances, which absorbs a considerable amount of energy and time before they either radiate or emit heat; electric stoves or radiators should be designed to act as quickly as possible—in other words, the amount of metal and other heat-absorbing material in connection with the resistances should be reduced to a minimum. This is impracticable in the case of stoves or radiators in which the resistances are formed of wires embedded in enamel. This type requires a large mass or weight of inert material, which has to be heated before any external duty is obtained from the stove, and they are consequently very slow in producing any sensible increase in temperature. In the stoves designed by the Prometheus Company this point has received great attention, and it may be of interest to describe some of the factors on which the design has been based. A mica strip, $5\frac{5}{16}$in. long by $1\frac{3}{16}$in. broad and $\frac{4}{1000}$in. thick, coated, under the Prometheus patents, with a film of precious metal, had a resistance of 120 ohms, and at 110 volts absorbed 0 81 ampere, or 89 watts. The mass or volume of the mica is, of course, extremely small, and the resistance radiates practically 76 calories per hour immediately. An average room of 3,530 cubic feet capacity requires some 2,000 to 2,500 calories per hour to warm it, and 30 of these resistances would therefore be required. The weight of the mica strip is practically nil, and the terminals or connections can be kept very light. The combination, therefore, absorbs but little heat, and practically the whole of the energy is at once available. Compare this with similar resistances embedded in enamel and carried in metal frames and supports, and it will be seen that these strips possess great advantages as transformers of electric energy into heat energy. In practice, to ensure durability it is desirable that the temperature of the

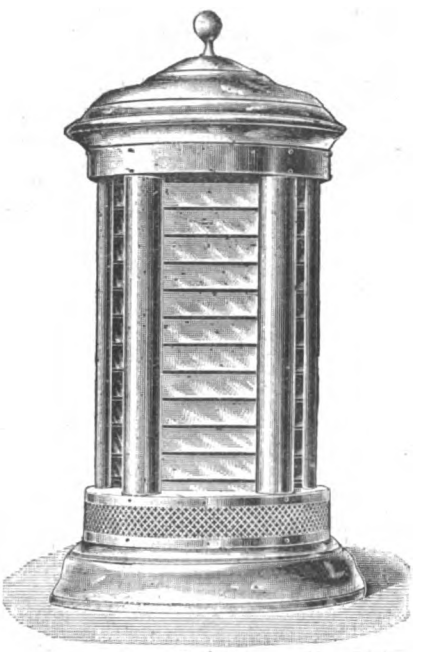


FIG. 2.

strips should not exceed 450deg. This corresponds to 70 or 75 watts per strip. At 90 to 100 watts the strips show dull red in the dark, and oxidation would then occur. As stated above, resistances up to about 24,000 ohms can be obtained on a strip measuring $5\frac{5}{16}$in. $\times 1\frac{3}{16}$in. $\times \frac{4}{1000}$in., and they can be connected in parallel in any number required to obtain the desired effect of the stove, and can be designed for any pressure of supply and for any temperature of the stove up to 400deg. C.

The stoves designed by the Prometheus Company for these strips are circular, thus affording the greatest strength for the least weight, the number of strips employed depending on the size of the stove. These strips are mounted in two rows on a frame fitting into the circular case; the outer row therefore radiate heat direct, and a continual current of air passes up and is heated between the two rows. As each strip is independent and connected to the circuit in parallel, any one can be replaced or removed without altering any connections. The smallest pattern of stove (Fig. 1) contains 12 strips, weighs 5lb, and takes six to eight amperes at 110 volts; the medium size contains 24 strips, and takes from 2 to 16 amperes at 110 volts, while the large size (Fig. 2) contains 48 strips and weighs 15lb. This and the medium size are fitted with the Prometheus regulator, enabling the stove to be used from quarter to full power in four steps. Under ordinary conditions the small size radiators will be sufficient

Digitized by Google

for heating rooms of from 700 to 900 cubic feet, the medium size for rooms of 1,400 to 1,800 cubic feet, the large size for rooms of 2,500 to 2,800 cubic feet capacity. The bases of the stoves remain quite cool, and they may therefore be used anywhere, and, as previously explained, they are practically instantaneous in their heating action when turned on. To give the stove a cheerful appearance when working, a ruby lamp is arranged behind the mica strips, and shines through and between them, shedding a cheerful light throughout the room.

Other applications for these strips, such as hot-combs for drying ladies' hair, hot-plates for use in the dining-room, foot-warmers, and the like, can easily be imagined, and they will doubtless entirely replace the existing cumbrous forms of heaters for these purposes—in fact, this invention only requires to be seen to be appreciated, and for new applications of same to be designed.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

319. Why is it not common to run compound dynamos with equalising cables coupling all series coils in parallel on town-lighting supply? Would not this be advantageous where many heavy motors were coupled to the lighting mains? Give reasons for and against.—ALEXANDER H. MCKAY.

320. In an alternate-current station where accumulators are charged by means of a direct-current dynamo driven by a synchronous alternate-current motor, what will be the increase in the cost per unit supplied due to the conversion and storage of the electrical energy and to capital charges on the additional plant?—P. T.

ANSWERS.

Question No. 313.—When testing an electric locomotive, both in the shop with a brake on the wheels and when pulling a train on the line, what are the quantities which have to be measured? In the latter case, does the draw-bar pull multiplied by the space moved over represent work comparable to the energy supplied to the motors?

Best Answer to No. 313 (*awarded* 10*s.*).—The simplest method of testing the approximate performance of an electric locomotive, and one especially useful when insufficient power is available, consists in measuring the pull exerted with the motor at rest with the full current passing through the armature and series field winding. The locomotive should be fixed down firmly, but with the wheels clear of the rails, etc., and a rope with a spring balance attached should be fastened to the rim or one of the spokes of one of the main wheels.

Let P = pull in pounds read on the spring balance;
R = effective radius at which the ropes acts, in feet;
r = radius of the tread of the locomotive wheels, in feet;
n = number of revolutions per minute of locomotive wheels;
A = current through motor when pull, P, is measured;
V = working voltage of the motor (V_a = internal armature volts);
g = gear ratio (if any) = $\frac{\text{speed of motor spindle}}{\text{speed of locomotive wheels}}$.

Then actual draw-bar pull of locomotive in pounds (per motor if more than one)

$$= \left(P \times \frac{R}{r}\right) - x,$$

where x is a certain small percentage for friction of locomotive bearings, slip between wheels and rail, and loss due to wind pressure on the locomotive. And

Actual horse-power developed at the motor spindle

$$= \frac{P \times R \times n \times 2\pi}{33{,}000} - y,$$

and

$$n = \frac{V_a \times A \times 7{\cdot}05}{P \times R \times g},$$

where y = a small allowance for core losses in the motor armature. These expressions are readily obtainable from first principles. (See S. P. Thompson's "Dynamo-Electric Machinery," fourth edition, p. 110.)

The next method of test is the ordinary brake test with the motor and car wheels running round at full speed, but the power developed being absorbed by some form of brake attached to the car wheel, instead of being allowed to draw the car along.

If P = pull in pounds read on the brake at a radius of R feet, and n = speed of car wheel in revolutions per minute. Then

Actual draw-bar pull of locomotive

$$= \left(P \times \frac{R}{r}\right) - z,$$

where z is a small amount of the pull lost due to slip between wheels and rail to wind pressure. And

Horse-power developed by motor

$$= \frac{P \times R \times n \times 2\pi}{33{,}000} + w,$$

where w is the loss in gearing (if any) and bearing friction between motor and car wheel.

The only method of test, however, which actually takes in all the conditions occurring in practice, consists in running the locomotive on a level line (or a line having a quite uniform grade) dragging a train whose weight can be adjusted as desired.

The drag of the locomotive on the train (draw-bar pull) should be measured by means of a special spring balance (whose motions are strongly damped by means of a dash-pot, or similar arrangement, so as to allow steady readings to be obtained in spite of small inequalities on the line) which forms part of the coupling between locomotive and train.

The speed of the train should be measured by means of an accurately calibrated tachometer carried on the locomotive, and also, if possible, by direct measurement with a stop watch over a measured piece of the line. The difference between these two measurements will be the slip between rails and wheels. At the same time the average input at the motors in volts and amperes should be measured.

If P = true draw-bar pull of locomotive as measured on the balance;
S = actual speed of train along the line in feet per minute;
A and V the amperes and volts respectively. Then

Actual horse-power transmitted by the locomotive to the train

$$= \frac{P \times S}{33{,}000}.$$

And actual electrical horse-power put into the motors

$$= \frac{A \times V}{746}.$$

And the ratio $\frac{\text{Actual H.P.}}{\text{E.H.P.}}$ is the true over-all efficiency of the locomotive.

The commercial efficiency of the motors themselves will be several per cent. higher than this, for to "actual horse-power transmitted to train" must be added the horse-power required to move the locomotive itself + the loss in the gearing and car bearings + loss due to slip + loss due to wind pressure. This "commercial efficiency of motor" is, however, of minor importance compared with the actual over-all efficiency of the locomotive given above.—Q.]

Digitized by Google

Question No. 314.—In working shunt-wound motors from 110-volt circuit nominal, the voltage sometimes drops to 100. If the supply of current is practically unlimited, as from a large generating station, how will the voltage drop affect the working of the motors, electrically and mechanically?

Best Answer to No. 314 *(awarded* 10*s.).*—In considering the behaviour of a motor under variations of the impressed E.M.F., the following equations are of fundamental importance:

$$T \propto C F;$$

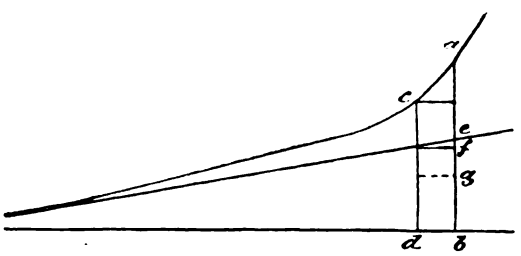
$$C = \frac{E - e}{r} \propto E - e;$$

$$e = \frac{N}{60} F \tau 10^{-8} \propto F N;$$

where T = torque;
C = armature current in absolute units;
E = impressed E.M.F.;
e = back E.M.F.;
F = total magnetic flux;
τ = turns in armature winding;
r = armature resistance;
N = revolutions per minute.

It may be supposed that the load on the motor is constant; hence the product, C F, is also constant—that is, the action of the motor under variations of impressed E.M.F. will be such as to maintain C F at its previous value.

Two cases may be considered: (*a*) when the motor has its magnets fully saturated at the normal E.M.F.; (*b*) when the magnets are excited to a point upon or below the knee in the induction curve. In case (*a*) any small variation of the exciting E.M.F. and current produces so relatively small a change of flux that it may be ignored, and a fall of the magnitude stated in the question may be taken to produce no alteration in F. On the other hand, the quantity $E - e$, and consequently the current, C, is reduced. The motor at once slows down until e is reduced by an amount equal to the fall in E, thus maintaining the value of C F. Thus a fall of $\frac{1}{n}$th in the supply volts produces a fall of $\left(\frac{1}{n} \cdot \frac{E}{e}\right)$th in both back E.M.F. and speed. In case (*b*) a fall in exciting E.M.F. reduces the flux to some value F′; the percentage fall of flux will, however, be somewhat less than the percentage drop of E.M.F. This reduction of flux brings down the back E.M.F. independently of fall in speed. As, however, it does not fall proportionally to E, and as the current must now be greater than before to keep C F constant, some drop in speed will occur. The motor is nevertheless in this case to a large extent self-regulating, and if well designed the speed reduction should be small. The action of the motor under various excitations and E.M.F.'s is clearly seen and found numerically by plotting the diagram shown. The



upper curve is the supply E.M.F. plotted with values of the total flux as abscissæ. The lower straight-line curve has the same abscissæ, and the back E.M.F. at the normal speed as ordinates. Since this E.M.F. is proportional to speed, the ordinates may to a suitable scale represent speed. If the impressed E.M.F. be $a\,b$, the back E.M.F. is $e\,b$. Let, now, the impressed E.M.F. fall to $c\,d$, then the fall in back E.M.F. due to the weaker flux is $e\,f$, and the speed drops by an amount (on the speed scale) equal to $f\,g$, the length, $e\,g$, being equal to the vertical distance between a and c. The influence of armature reaction has not been considered, but the back turns, which in a motor assist the field, tend to diminish the power of self-regulation. As regards e, it will be noted that the nearer e is to E at normal speed, the less will be the speed variation with changes in the latter. ZERO.

Answer to No. 314 *(awarded* 5*s.)*—Taking it for granted that the average load of the motor remains unchanged whatever the pressure of supply, the probable effect of a drop in voltage upon a shunt-wound motor will be as follows: (1) weaker field magnets; (2) increase in the current passing through the armature and a possible heating up of the machine in consequence; (3) probable decrease in the speed of the motor; (4) increased tendency to spark at the brushes.

1. The motor being shunt wound, we may consider its field coils as connected directly across the mains; so that if V = voltage of supply, r = resistance of shunt, S = number of coils in series, then $\frac{V}{r} \times S$ = magnetising ampere-turns on field magnets. Any reduction, therefore, in V reduces the exciting current and consequently the strength of field. Just what reduction takes place in this respect depends upon the magnetisation curve of the material used in the field magnets and upon the degree of saturation normally obtained. With soft iron highly magnetised, the drop may be comparatively small; with steel under the same circumstances, rather more; but a large reduction will probably take place if the field magnets were originally under-magnetised.

Upon the assumption that the nature of the load is the same throughout, the torque required in the armature with the reduced E.M.F. will be the same as before. If i_a = current in armature, N = magnetic flux, C = number of conductors in armature, T = torque, then $T = i_a \frac{CN}{2\pi}$ in certain units; or $i_a = \frac{2\pi T}{CN}$, from which it will be seen that any reduction in N will necessitate a corresponding increase in i_a if we are to maintain the torque constant; but we previously pointed out that N is reduced under the lower voltage, therefore we shall have a greater current flowing through the armature (2).

This current flowing through armature $= \frac{V - v}{R}$, where v = back E.M.F. of motor, and R = resistance of armature; v varies as n C N, where n = speed of motor, other things remaining constant; therefore if V is reduced, v must be reduced in like manner in order that $\frac{V - v}{R}$ may remain unaltered; and if N remains constant, n must be reduced in order to bring v down to this lower value. It was pointed out that a greater current was needed in the armature with the reduced voltage than before—*i.e.*, $\frac{V - v}{R}$ must have a higher value, and in order to obtain this, v, and consequently n, must be still further reduced. In other words, the drop in voltage independently tends to lower the speed of motor, and the consequent increase of current necessary tends still further to lower it—this is upon the assumption that N remains constant. We have shown, however, that N does not remain constant, but suffers a reduction, which reduction tends to oppose the lowering of the speed, consequently you have the two factors before mentioned tending to lower the speed, and one (the weaker field) tending to increase it—the net result will probably be a slight reduction in the number of revolutions per second with the reduced voltage (3).

The fact as to whether a motor will run sparklessly or not, depends upon whether the local field is strong enough to reverse the direction of the current in the coil which is short-circuited under the brushes previously to its becoming one of the series on the other side of the brush through which the current is running in this reverse direction; the stronger the current flowing, the greater the field necessary for conversion. Now we have, as results of the reduced voltage, a weaker field and a larger armature current, both of which tend to oppose sparkless running; and we have still further the field due to the armature stronger relatively to that of the field magnet, and this

Digitized by Google

means an increased distortion of field and a probable weakening of the same just at the point where it is most required to reverse the current in the short-circuited coil. The increased current also has an increased demagnetising effect upon the field magnets, and any movement of the brushes backward in order to obtain a sparkless position tends to increase this demagnetising effect and still further weaken the field; so that the effect of the reduction in voltage may be to make it impossible to get the motor to run sparklessly (4).

In conclusion, if the motor is well designed and has relatively very strong field magnets, normally highly magnetised, the tendency to spark under the reduced voltage will be reduced to a minimum, and it may be quite possible at periods when the pressure is low to insert a resistance in the field circuit, thus counteracting any fall in speed within certain limits. The armature conductors will, however, need to be designed upon a liberal scale in order to carry the increased current without undue heating. The motor will not be so efficient, however, as when running at the voltage for which it was designed, because, among other things, the $C^2 R$ losses will be increased without a corresponding increase in the work performed.—W. G. M.

Answer to No. 314 (*awarded* 5*s.*).—A method of examining the effect of running shunt motors at a lower speed than designed for will be to assume a motor of, say, 6 h.p. built for 110 volts, and which may afterwards be required to work at 100 volts. Supposing efficiency to be 87 per cent., it would require an input of 5,140 watts. At 110 volts this = 46·75 amperes; at 100 volts this = 51·4 amperes.

Let armature resistance be ·06 ohm. The copper loss of armature at 110 volts = 124 watts; the copper loss of armature at 100 volts = 150 watts (probably the latter figure would be increased owing to increase of resistance through higher temperature rise). These figures show an increase of temperature of about 12 per cent. when working at 100 volts. (The slight gain, through the hysteresis loss being a little lower at 100 volts, is practically negligible.)

Beside the heating effect, there is another important point to consider—viz., sparking. In the case under consideration the cross ampere turns are increased by about 10 per cent. at the lower E.M.F., the gap density being also slightly lower. Both these results would, of course, tend to increase the sparking. In a well-designed machine, however, neither the sparking or heating should be very much increased, at any rate to an injurious extent, by a reduction of voltage as required in present instance.

As regards alteration of speed, if the excitation was the same for both voltages it would be lower at the 100 volts in the ratio of

$$\frac{110 - (46\,75 \times \cdot 06) = 107\cdot2}{100 - (51\cdot4 \times 06) = 96\,9} = \text{approx. 11 per cent.}$$

but being excited at 100 volts the percentage of variation of speed would not be so great as this. To obtain difference of speed through variation of shunt voltage, we should find it necessary to refer to a magnetisation curve of each of the motors, as the alteration of speed through weaker field depends a great deal on the portion of curve at which motor is designed for. If we are working off the "flat" of the curve, or, in other words, if the magnets are approaching saturation at 110 volts, we should have but a slight increase of speed when lowered to 100 volts; but, on the other hand, if the line density in magnets is comparatively low at the higher voltage, we should find a much greater variation of speed.—J. W. B

Answer to No. 314 (*awarded* 5*s.*).—Firstly, this drop in voltage would reduce the field exciting ampere-turns by 10 per cent., and this would reduce the flux through the armature by from 4 to 8 per cent., according to the state of saturation of the magnet iron. If the volts across the armature remained unchanged, this would cause a corresponding rise of 4 to 8 per cent. in the speed, but since these volts also drop 10 per cent., the net result on the speed will be a drop of from (10 − 4) = 6 per cent. to (10 − 8) = 2 per cent.

Secondly, there would be a certain change (usually an increase) in current to enable the motor to continue to give out the necessary power at the lower voltage. The actual change in current depends on the nature of the load on the motor. If this load consists of a lathe or similar machine, in which, at least for small changes in speed, the horse-power required is almost exactly proportional to the speed, the current will increase by something less than 10 per cent.—*e.g.*, if the 10 per cent. drop in voltage reduced the speed 6 per cent., the current would increase only 10 − 6 = 4 per cent. If, on the other hand, the load consists of, say, a centrifugal pump or fan, in which the power required falls off much more rapidly than in proportion to the speed, there will probably be no increase in current, and may even be a drop. If desired, the speed could, of course, be kept constant by inserting a small amount of resistance in the shunt at 100 volts, and in this case the current through the armature would always be 10 per cent. higher at 100 than at 110 volts. This small increase in current should not cause any difficulty with a properly designed motor, though the temperature rise of the armature would be slightly increased. If, however, the motor is one designed with very little margin, the weakening of the field, occurring at the same time as an increase in the armature current, might cause sparking at the brushes, though not to any serious extent.—Q.

LEEDS ELECTRICITY ACCOUNTS.

The accounts of the Leeds electricity works for the year ended March 25, 1900, just issued, show a total expenditure on capital account of £307,522. Abstracts of the revenue account and general balance-sheet are appended:

BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Loans	217,420	0	0
Due to treasurer	71,513	13	11
Sundry creditors	18,066	1	7
Surplus	17,603	2	11
	£324,602	18	5

Cr. Assets.	£	s.	d.
Capital expenditure	307,522		3
Cash in hand	10	0	0
Stock in trade	2,212	3	8
Sundry creditors and miscellaneous	14,858	11	6
	£324,602	18	5

REVENUE ACCOUNT.

Expenditure.

Dr. Generation of Electricity.				£	s.	d.
Coal, including delivery and unloading	£2,592	0	3			
Oil, waste, water, and stores	361	2	1			
Wages at generating station	1,874	5	11			
Repairs and maintenance: buildings, £322. 13s.; engines, boilers, etc., £382. 12s. 6d.; dynamos, motors, etc., £85. 12s. 3d.; other machinery, £76. 10s. 10d.	867	8	7			
				5,694	1	10
Distribution of Electricity.						
Stores	10	4	3			
Wages	224	2	6			
Repairs and maintenance: mains, £178. 11s. 10d.; transformers, etc., on consumers' premises, £15. 6s. 11d.; transformer sub-stations, £41. 8s. 4d.	235	7	1			
				469	13	10
Rents, Rates, and Taxes.						
Rents	2	1	0			
Rates and taxes	888	5	10			
				890	6	10
Management Expenses.						
Salaries—Engineer's department	1,509	19	4			
Clerical staff (including outdoor representative)	713	6	8			
Stationery and printing	137	2	3			
General establishment charges	194	8	7			
				2,554	16	10
Law charges				143	17	0
Insurances				175	19	6
				9,929	10	10
Interest				12,473	5	10
				22,402	16	8
Balance, being net profit for the year				13,817	18	9
				£36,220	15	

Digitized by Google

Cr. Income.	£	s.	d.
Sale of current	35,349	9	9
Rental of meters and other apparatus	2,154	16	9
	37,504	6	6
Less estimated discounts, £949. 11s. 9d. ; and leakage, £333. 19s. 4d.	1,283	11	1
	£36,220	15	5

LEGAL INTELLIGENCE.

NATIONAL TELEPHONE COMPANY v. THE EXCHANGE TELEGRAPH COMPANY.

In the Queen's Bench Division on Wednesday, before Justices Lawrance and Kennedy, on the motion of Mr. Roskill, their Lordships directed that this action should not be in the paper before Dec. 1, both sides consenting to the postponement.

CLAIM BY THE LONDON ELECTRIC SUPPLY CORPORATION.

n the Westminster County Court on Tuesday, his Honour Judge Lumley Smith, Q C., heard the case of the London Electric Supply Corporation *v.* Butler, in which the plaintiff company sought to recover payment in respect of electric light supplied to the defendant, a florist carrying on business at Westmoreland-road, Walworth.

Plaintiffs' representatives said the light was supplied to the order of the defendant when he was carrying on business on his own account, but he had since sold the place to his son, and had made no attempt to pay the plaintiffs' claim, although he was in a good position to do so, and judgment had been obtained against him.

His Honour made an order committing the defendant to prison for 12 days in default of the amount due being paid within a month.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY v. FISHER.

This was an application by the plaintiff company to enforce payment of an account in respect of electric light supplied to the defendant, a restaurant keeper carrying on business at Broad-street, Golden-square.

Evidence was given to the effect that the light was supplied to the order of the defendant, and that when application was made for payment he put the matter off with various excuses.

The **Defendant** appeared, and said he was not in a position to pay.

His Honour said it was ridiculous for people to indulge in the luxury of electric light, and then find out that they could not pay for it. There would be an order of committal for 12 days in default of payment by Dec. 1.

DUNDEE TRAMWAY AND CARRIAGE COMPANY.

The First Division of the Court of Session (Glasgow) have granted the petition of the Dundee Tramway and Carriage Company for confirmation of resolutions altering their memorandum of association. The Corporation of Dundee having purchased the tramway plant, the company ceased to operate the tramways in the city. The company had, in connection with their tramway business, conducted and still conduct an omnibus business and hiring business and the carriage of goods, and own large premises in Dundee and Downfield for the carrying on of these businesses. It is in order to carry on these businesses more effectually that the alterations sought to be confirmed were required. The petition was remitted to Mr. J. Smith Clark, S.S C., Edinburgh, for report, and in granting the petition the Court gave effect to certain amendments of the new articles proposed by the reporter.—*Glasgow Herald.*

COMPANIES' MEETINGS AND REPORTS.

CUBA SUBMARINE TELEGRAPH.

The half-yearly meeting was held on Wednesday at the offices, 58, Old Broad-street, Mr. Charles W. Parish presiding. The report showed that the traffic receipts for the first half of this year had fallen to £13 177, from £18,823 in the corresponding period of 1899, due partly to the cessation of the war, and partly to competition and subsequent low rates. In addition to the actual traffic earnings, £2,158 had been received as interest on investments, etc., making the total revenue £15,336. A sum of £2,000 had been carried to the reserve fund, the dividend on the preference shares required £3 000, and from the balance the Board were able to propose a dividend at the rate of 5 per cent. per annum on the ordinary share capital, leaving £5,204 to be carried forward, as compared with £5,165 brought forward from Dec. 31 last. The item of £8,174 for repairs to the cables damaged during the Spanish-American war was still outstanding.

The **Chairman** said that the negotiations which her Majesty's Ambassador was carrying on on the Company's behalf with the United States were still proceeding, but he was afraid that until the American elections were over and the President elected, they could not hope for any definite news The lawsuit between this Company and the West India and Panama Company in regard to the construction of part of their agreement was still before the courts. The result of the trial in the High Court was completely in this Company's favour, but the West India and Panama Company had given notice of appeal, which would probably be heard at the end of this year or early next year.

Mr. George Keith seconded the motion, which was agreed to, and the proposed dividends, at the rates of 10 and 5 per cent. on the preference and ordinary shares respectively, were confirmed.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MANUFACTURING.

At the meeting at Winchester House on the 24th inst. Mr. H. F. Jackson presided.

Mr. Fitzgerald, the late chairman, strongly criticised the balance sheet, and proposed that the report be referred back with the request that the accounts should be made up in the same way as formerly, and submitted to an adjourned meeting to be held one month hence.

Mr. A. H. Baker seconded the amendment.

After a long discussion, the amendment was lost by a very large majority, and the report adopted. A poll was demanded.

We note some correspondence in the financial papers on the subject. Want of space, however, prevents us from going into the matter at present.

WESTERN TELEGRAPH.

The directors' report for the half-year ended June 30 shows revenue of £230,434 and working expenses of £80,579. After providing £11,031 for debenture interest and sinking fund and £3,210 for income tax, a balance remains of £135 613. To this is added the sum of £6,790 brought forward from Dec. 31 last, making a total of £142 404. A quarterly interim dividend, amounting to £31,189, has been paid and £50,000 transferred to the reserve fund. The directors recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share—both free of income tax—leaving a balance of £8,571 to be carried forward. The Company having acquired an interest in the capital of the River Plate Telegraph Company, Limited, the Western directors will join the Board of the River Plate Company. Four per cent. debenture stock has been constituted to the amount of £400,000. Of this amount £348,777 has been allotted to the late holders of the same amount of 4 per cent. debenture stock of the Western and Brazilian Telegraph Company in lieu of their being paid off at par. The balance remains at present unissued. Additional cables have been successfully submerged between Para and Rio de Janeiro, and are being continued from the latter city to Monte Video.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Shoreditch.—The Vestry are inviting tenders for various plant. Tenders by Nov. 20. Details in our advertisement columns.

St. Albans.—The Corporation invite offers for their electric lighting provisional order. Details in our advertisement columns.

Lowestoft.—The Corporation invite tenders for wiring the town hall. Tenders by Nov. 2. Details in our advertisement columns.

Heywood —The Corporation invite tenders for wiring premises in Heywood. Tenders by Oct. 31. Details in our advertisement columns.

Belfast.—The Gas and Electric Committee invite tenders for various plant. Tenders by Nov. 23. Details in our advertisement columns.

London County Council.—The Council invite tenders for the supply, for one year from Jan. 1 next, of engineers' goods and electrical stores. Tenders by Oct. 29.

Palma —The Municipality of this town, in the province of Baleares, Spain, invite tenders for the installation and maintenance of 60 arc lamps. Tenders by Oct. 30.

Swansea.—The Corporation invite tenders for the supply of electricity meters, demand indicators, and main fuses. Tenders by Oct. 29. Details in our advertisement columns.

Breslau.—The Harbour Authorities invite tenders for electric cranes. Specifications are to be obtained from and tenders addressed to Hafenbauamt, Breslau, Germany, by Nov. 2.

Ayr.—The Corporation invite designs, specifications, and tenders for electric tramway cars, with trucks and complete electrical equipments. Tenders by Nov. 1. Details in our advertisement columns.

Pemberton —The Council invite tenders for boilers (preferably Lancashire), engines and dynamos, battery, switchboard, crane, and conductors. Tenders by Nov. 8. Details in our advertisement columns.

Digitized by Google

Dundee.—The Combination Parish Council invite tenders for the wiring for electric lighting of new offices at West Bell-street. Plans, etc., may be obtained from Mr. William Alexander, city architect, Dundee. Tenders by Oct. 27.

Grantown-on-Spey.—The Commissioners of the burgh invite tenders from electric light companies to supply electric light for public and private consumption within the burgh. Tenders by Nov. 6. Details in our advertisement columns.

Stavanger (Norway).—Tenders are invited for an electric installation for the supply of energy from the Alterig Waterfalls, which are about 25 miles from the town. Tenders may be addressed to the Municipal Authorities by Jan. 2, 1901.

Wolverhampton.—The Tramways Committee invite tenders for erection of car depôt, paint and repair shops, etc., at Cleveland-road. Plans, etc., may be seen at the office of Mr. J. W. Bradley, C.E., M.I.M.E., borough engineer, Wolverhampton. Tenders by Nov. 19.

Glasgow.—The Executive Committee invite tenders for the wiring for arc and incandescent lighting and electric motors at the Glasgow International Exhibition, 1901. Full particulars can be had on application to Mr. Thomas Young, the engineer, 4, West Regent-street, Glasgow.

Lowestoft.—The Corporation invite tenders for the supply and erection of two water-tube boilers and fittings, economiser, etc., pipework, etc., in engine and boiler house, and one 250-kw. steam dynamo (vertical enclosed high-speed engine). Tenders by Nov. 2. Details in our advertisement columns.

Leeds.—The Leeds Tradesmen's Benevolent Institute invite tenders for the installation of electric light required in alterations and additions to 41, Park-square, together with three shops and business premises, Park-lane, Leeds. Plans, etc., can be obtained from Messrs. Butler, Wilson, and Oglesby, architects, 12, East-parade, Leeds.

Devonport.—The Corporation invite tenders for the erection of electricity works buildings and works in connection with the new buildings to be erected on Newport Quay, Newport-street, East Stonehouse. Drawings, etc., may be seen on application to the Borough Electrical Engineer, Technical Schools, Devonport. Tenders by Nov. 2.

London (City).—The Streets Committee of the Corporation invite tenders for the hiring of a mechanically-driven dust-cart for collecting and removing the dust, trade refuse, and street sweepings from the City to the Corporation's depôt at Lett's Wharf, Commercial-road, Lambeth, S.E. Tenders by Nov. 10. Details in our advertisement columns.

Kendal.—The Corporation invite tenders for building engine-house, boiler-house, accumulator-house, chimney shaft, offices, etc., in connection with the electric lighting station to be erected at the gasworks, Kendal. Specification, etc., may be seen at the office of the engineer, Mr. T. N. Ritson, A.M.I.C.E., Gas Offices, Parkside-road, Kendal. Tenders by Oct. 29.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Alterig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

RESULTS OF TENDERS.

Killarney.—The Council have accepted the tender of Mr. Santry for the installation of 10 lamps at £52. 12s. 5d., and for lighting, etc., £2. 17s. 6d. per lamp per year.

Aberdeen.—The Tramways Committee have accepted tenders for 12 double-deck cars for the Beach and Woodside electric routes at a total cost of about £9,000, or £625 per car.

Barnsley.—The Corporation have placed with D. Bruce Peebles and Co. an order for a 600 h.p. generating set of their P.P.P. combined lighting and traction type. This will consist of one of that firm's machines direct coupled to a Willans engine.

Aberdeen.—The Town Council have accepted the tender of J. Leith, jun., 3, Cattofield-place, at £9,904. 15s., for the supply of materials and the construction of works in connection with the laying down of the permanent way of new electric tramways.

Middleton (Lancs.).—The Corporation have received the following tenders for the buildings required for electricity station: R. Partington and Son, The Lodge, Middleton (accepted); F. Cable, Durnford-street, Middleton; W. Pollitt, Burton street, Middleton; T. Jackson and Sons, Manchester Old-road, Middleton; J. Parker, Peter-street Sawmills, Blackburn; J. Tinline, Parker-street Sawmills, Bury; A. Coward, Tonge Moor-road, Bolton; J. and D. Blunn, Limited, Villa-road, Bury.

Southampton.—The Harbour Board have received the following tenders for a 30cwt. portable electric crane:

J. Booth and Bros., Limited, Leeds	£1,325
Chatteris Engineering Works Company, Chatteris	1,150
Bow, McLachlan, and Co., Paisley	1,100
Fullerton, Hodgart, and Barclay, Limited, Paisley	970
Stothert and Pitt, Limited, Bath	950
Southgate Engineering Company, Limited, New Southgate	798
Clayton Engineering and Electrical, etc., Company, Limited, Newton, Hyde (accepted)	735

Brighton.—The Corporation have received the following tenders for the supply and delivery of the following—viz.: (1) 2 000 tons steel girder tramrails (including curve rails), 78 tons of steel fish-plates, and 90 tons of steel joists; (2) 25 electric motorcars (in three sections):

1.—Steel rails, &c.

E. Le Bas and Co., 18, Billiter-street, London	£15,718 0 0
Westfalisch Stahlwerkes, Bochum, Westphalia	16 975 18 0
Witting Bros., 49, Cannon-street, London, E.C.	16,941 13 0
Bolckow, Vaughan, and Co., 16, Philpot-lane, London, E.C. (accepted)	18,397 0 0
Barrow Hematite Company, Barrow-in-Furness	18,564 0 0
R. White and Sons, Widnes, Lancashire	18,564 10 0
Leeds Steelworks, Hunslet, Leeds	18,970 0 0
W. David, Swansea	19,700 0 0

Note.—Of above tenders, only those of Bolckow, Vaughan, and Co. and W. David comply strictly with the specification.

2.—Motorcars—57-passenger car.

British Westinghouse Company, 5, Norfolk-street, Strand, W.C. (each)	630 0 0
British Thomson-Houston Company, 83, Cannon-street, E.C.	647 17 0
British Schuckert Company, Clun House, Surrey-street, Strand, W.C.	685 0 0
Witting Bros., Limited, 49, Cannon-street, E.C.	765 0 0
Dick, Kerr, and Co., 110, Cannon-street, E.C.	724 0 0
Brush Electrical Engineering Company, 49, Queen Victoria-street, E.C.	728 0 0

50-passenger car.

British Westinghouse Company (each) (accepted)	619 10 0
British Thomson-Houston Company	637 7 0
British Schuckert Company	675 0 0
Witting Bros., Limited	689 0 0
Dick, Kerr, and Co.	696 0 0

London, N.E.—The Electric Lighting Commitee of the Hackney Vestry have recommended the following tenders for acceptance:

Cole, Marchant, and Morley, Limited, condensing plant	£4,749 0 0
Klein Engineering Company, Limited, cooling apparatus	1,960 0 0
Alton and Co., pipework and valves	5 065 0 0
Worthington Pumping Engine Company, feed pumps	753 0 0
S. Z. de Ferranti, Limited, switchboard and instruments, boosters and motors, etc. (Part 1)	2 976 10 0
Johnson and Phillips, ditto (Parts 2 to 5)	2,160 0 0
Johnson and Phillips, public arc lamps and switchboard	5,248 18 6
Chamberlain and Hookham, Limited, house meters	3,632 10 0
Higginbottom and Mannock, overhead travelling crane	638 0 0
Easterbrook, Allcard, and Co., workshop equipment	772 2 4
W. T. Allen and Co., 132, Queen Victoria-street, E.C., arc lamp pillars (per pillar)	13 5 0

London, N.E.—The Hackney Vestry have received the following tenders for electricity mains:

Trenching.

Siemens Bros. and Co., Limited	£12,899 6 8
British Insulated Wire Company, Limited*	14,339 0 0
Western Electric Company	14,982 0 0
Callender's Cable and Construction Company	15 202 0 0
Henley's Telegraph Works	18,536 16 8
W. T. Glover and Co.	11,073 6 8
Callender's Cable and Construction Company (alternative without lead)	15,202 0 0

Troughing.

Siemens Bros. and Co., Limited	7,047 6 8
British Insulated Wire Company, Limited*	5,236 0 0
Western Electric Company	7,722 0 0
Callender's Cable and Construction Company	7 624 18 9
Henley's Telegraph Works	7,940 5 4
W. T. Glover and Co.	12,519 16 8
Callender's Cable and Construction Company (alternative without lead)	7,624 18 9

Cables.

Siemens Bros. and Co., Limited	17,697 16 8
British Insulated Wire Company, Limited*	18,973 10 10
Western Electric Company	19 506 6 3
Callender's Cable and Construction Company	18,966 12 6
Henley's Telegraph Works	20 416 2 6
W. T. Glover and Co.	24,182 6 8
Callender's Cable and Construction Company (alternative without lead)	16,817 19 2

Boxes.

Siemens Bros. and Co., Limited	5 859 14 0
British Insulated Wire Company, Limited*	5 867 14 0
Western Electric Company	4,645 10 0
Callender's Cable and Construction Company	4,030 18 0
Henley's Telegraph Works	4 394 19 2
W. T. Glover and Co.	6,438 5
Callender's Cable and Construction Company (alternative without lead)	4 030 18

House services.

Siemens Bros. and Co., Limited	1 600 0 0
British Insulated Wire Company, Limited*	2 000 0 0
Western Electric Company	1 000 0 0
Callender's Cable and Construction Company	2 100 0 0
Henley's Telegraph Works	1 625 0 0
W. T. Glover and Co.	1,750 0 0
Callender's Cable and Construction Company (alternative without lead)	2,100 0 0

* Recommended for acceptance.

Digitized by Google

Melton (Suffolk).—The Visiting Committee of the Suffolk County Asylum have received the following tenders in connection with the wiring and fittings for the electric lighting of the asylum at Melton:

Baily, Grundy, and Barrett, Limited, Cambridge	£5,900	5	5
J. E. Lester, Leicester	5 834	0	0
A. Emanuel and Sons, Limited, Manchester-square, W.	4 860	0	0
T. H. Wathes, Leicester	4 285	2	6
Lighting Corporation, Limited, Bloomsbury	4,252	18	0
F. Suter and Co., Limited, Berners-street, W.	3 853	6	0
F. Troy and Co., Finchley	3 648	6	6
Hall and Hackblock, Ipswich	3,633	15	4
Dawson, Roberts, and Co., Stalybridge	3,609	9	5
Maple and Co., Tottenham Court road	3,432	17	6
Anglian Engineering Company, Limited, Stowmarket	3 417	7	6
J. Finlay and Co., Limited, Glasgow	3,375	16	7
Walsall Electric Company, Limited, Walsall	3,337	14	2
T. Scott Anderson, Sheffield	3,300	0	0
Shalders and Davis, Southampton	3,255	13	2
National Electric Wiring Company, Limited, Newington-butts	2 867	0	0
W. J. Fryer and Co., Limited, Sloane square, S.W.	2,824	14	8
G. N. C. Mann and Co., Norwich (accepted)	2,740	18	9

BUSINESS NOTES.

LIGHTING AND GENERAL.

Ilford.—The Urban District Council will shortly invite tenders for free wiring.

Leominster.—Telegraphic communication is being made between Leominster and Hatfield.

Worcester.—The Town Council have adopted a proposal to build an additional electricity generating station.

Removal.—The Sturtevant Engineering Company, Limited, have removed their offices to 147, Queen Victoria-street, E.C.

Wisbech.—The Town Council intend to apply for a provisional order under the Electric Lighting Acts. Advertisements are being prepared.

Sevenoaks.—The Urban District Council have approved a draft supplemental agreement with the Electrical Power Distribution Company, Limited.

Beckenham.—The Urban District Council have passed a resolution authorising the clerk to sign agreements with householders in respect of electric wiring.

Lichfield.—The Council will at a meeting on the 9th prox. discuss the advisability of applying for a provisional order under the Electric Lighting Acts.

Northfleet.—The District Council have decided to take the necessary steps to obtain a provisional order for the electric lighting of the district in the ensuing session of Parliament.

Sleaford.—Mr. M. K. North has held a public enquiry at Sleaford with reference to the borrowing of £7,000 by the Sleaford Urban District Council for an installation of the electric light.

Calcutta Electric Supply Co.—The directors have declared an interim dividend on the share capital of the Company at the rate of 3 per cent. per annum for the half-year ending June 30 last.

Eccles.—Colonel J. T. Marsh, R.E., has held an enquiry into an application for power to borrow £5,308 for purposes of electric lighting, being money expended in excess of the original estimate.

Earsdon.—The Seaton Delaval Co-operative Society have offered to supply electric light and lay the plant from the Seaton Delaval boundary to Holywell Bank Top. They would lay down the plant for £180.

H. A. C. Barracks.—The headquarters of the Honourable Artillery Company have been wired for the electric light by Messrs. Donnison, Berlyn, Sillem, and Co., of London and Liverpool.

Huddersfield.—The last report to the Electricity Committee shows an increase of 25,998 in the units metered in August and September, or 27½ per cent. more than in the corresponding months of last year.

Ashton-in-Makerfield.—Application is to be made for an electric lighting provisional order to authorise the Urban District Council to supply electrical energy for public and private purposes within their district.

Kingsburgh Motor Construction Co.—This Company has been registered at Edinburgh with a capital of £50,000 in £5 shares, the object being to acquire and carry on the Madelvic Motor-Carriage Works at Granton, etc.

Boston.—At the meeting of the Paving and Lighting Committee on Monday the question of the lighting of the town by electricity was discussed, and it was decided that an expert should be invited to visit the town and make a report.

Frome.—The Urban District Council have adopted a report of Mr. F. H. Medhurst as to the establishment of electric lighting works in the town, and have decided to proceed with the matter and obtain the necessary provisional order.

Melksham.—A number of workmen are now at work laying the electric cable through the principal streets under the supervision of an electrical expert, Mr. Poolley, of the firm of Messrs. Glover and Co., cable manufacturers, Manchester.

Bournemouth.—With regard to the proposed purchase of the electric light undertaking, a conference has been arranged between representatives of the Town Council and of the Bournemouth and Poole Electricity Supply Company, Limited.

Alnwick.—Arrangements have been completed between the Postmaster-General and the Urban District Council for the making of the telephone trunk line to Alnwick. The refuse destructor and electric lighting questions are still undecided.

Castner-Kellner Alkali Co.—The directors announce an interim dividend on the original capital, as well as on the new capital allotted to the shareholders of the Aluminium Company, at the rate of 8 per cent. per annum for the six months ended 30th ult.

Chester.—The distributing main for supplying energy for public and private lighting in Gladstone avenue, Whipcord lane, Charlotte-street, Catherine street, and Cambrian-view is to be extended, and the existing gas lamps converted, etc., at an estimated cost of £280.

Stratford-on-Avon.—Alderman Hawkes, Messrs. Holtom, Park, Flower, and North have been appointed an Electric Lighting Committee, the Council having decided to apply for a provisional order to supply electricity for lighting and traction purposes within the borough.

Normanton (Yorks).—A special meeting of the Council has been convened for an early date in November to finally decide whether to seek an electric lighting order provisional. Some of the other West Riding councils are awaiting the result of this meeting before taking action.

Edinburgh.—At the last meeting of the Electric Lighting Committee of the Town Council, it was reported that there had been applied for from Oct. 4 to 18 2,337 8 c.p. lamps for lighting purposes and 112 h.p. motors, equal to 2,928 8 c.p. lamps, making a total of 5,625 8-c.p. lamps.

Aylesbury.—At the last quarterly meeting of the Bucks Standing Joint Committee letters from the General Post Office and the National Telephone Company, Limited, as to the terms of connecting police stations were submitted, but the terms offered were not entertained by the committee.

Eastbourne.—Application is to be made to the Local Government Board for power to borrow the sum of £31,912 for the erection of a new electric light station at Roselands, new transformers, mains, etc., as set forth in Scheme 2 of Mr. Hawtayne's report, dated April 9, 1900, and adopted by the Council on May 3, 1900.

Brighton.—In order that the Corporation may be in a position to place their exchange wires underground, it will be necessary, in accordance with the Telegraph Act, 1892, for the Postmaster-General to delegate to them his statutory powers of constructing telegraphic works. The Council are asking the Postmaster-General to do so.

Colwyn Bay Electric Light and Power Co.—This Company has been registered with a capital of £3,000 in £1 shares (1,000 preference), the object being to adopt an agreement with T. S. Jones and R. H. Jones, and to carry on at Colwyn Bay the business of electric light and power producers, manufacturers, and fitters of electrical appliances, etc.

Royton.—At a special meeting of the District Council held on Monday it was decided to apply in the next session of Parliament for provisional orders enabling the Council to supply electricity for all public and private purposes within and throughout the whole or any part of the district, and also empowering the Council to take over and work tramways.

Barry.—The District Council intend to proceed with their application for an electric lighting provisional order. The application received from the Penarth Electric Lighting Company to provide the Barry district with electric power has been rejected, the Council being of opinion that such power, for the purposes of the town, should be provided by the local authority itself.

Mansfield.—The Town Council on Friday passed a resolution to the effect that it was desirable to promote a Bill in Parliament excluding the loans for the purposes of the water and electric light undertakings from the sanitary loans, and containing provisions as to moneys to be raised for water and electric light purposes, and also modern and financial provisions with reference to loans.

Woking.—The price of the current has now been reduced as follows: for any number of units up to 20, 8d. per unit; and for each unit over 20, 7d. In addition to the above reduction, the Woking Electric Supply Company offers a discount to consumers whose consumption exceeds 150 units per quarter of ¼d. per unit; 250 units per quarter of ½d. per unit; 375 units per quarter of 1d. per unit.

Appointments Vacant.—The Corporation of Darlington are prepared to appoint an assistant engineer and a junior assistant engineer.—The Electric Lighting Committee of Bury invite applications for an assistant engineer at their generating works. Particulars of these and other vacancies relating to switchboard attendants, wiremen, and electricians will be found in our advertisement columns.

Castleford.—At a special meeting of the Council on Tuesday it was decided to support the scheme of the United Kingdom Tramway Light Railway, and Electric Lighting Syndicate. This is a scheme for electric lighting, with power for industrial purposes and for tramways, applicable to Castleford and the districts around, including Pontefract, Normanton, Whitwood, Featherstone, and Knottingley.

Digitized by Google

Evolution of Switch Gears.—Messrs. Johnson and Phillips have written to us referring to Mr. E. Warrilow's interesting articles, stating that they are the sole makers of the Proctor-Blaikie patent plug, which is mentioned as having been fixed on the Bristol Corporation switchboard. They add that they find no difficulty in keeping the size of the plug within quite moderate dimensions for very large currents.

Wormit.—Last week a meeting of householders was called by the directors of the Tayside Electric and Gaslight Company, Limited. Extracts were read from Mr. Tittensor's report upon the electric lighting plant at Wormit, presently the property of Mr. Alex. Stewart, builder, which it was proposed the company should acquire. A former proposal was referred to, and a committee was appointed to confer with the directors and report to a later meeting.

Pateley Bridge.—At a meeting held in the District Council-room, Pately Bridge, on Friday evening, for the purpose of discussing the advisability of introducing electricity for lighting purposes into the town, Mr. Boord occupying the chair, it was stated that there was sufficient surplus power at Mr. Wood's corn mill to supply the motive power, and to supply 750 8 c.p. incandescent lights. Mr. Harrison, of Ripon, estimated the cost at £2 000. Discussion followed, and a resolution favourable to the introduction of the electric light was passed.

West Bromwich.—On Thursday night a meeting of the West Bromwich Tradesmen's Association was held to consider the best and cheapest method of applying the electric light to the shops and offices of the borough. The Mayor (Alderman S. Pitt) explained the scheme, and said it was the intention of the Council to light the principal streets with electricity, and probably the electric tramcars would be running in about 12 months' time. A resolution approving of the scheme, and recommending the tradesmen to adopt electric lighting, was carried.

New Issue.—An issue of 19,900 6 per cent. cumulative preference shares of £5 each is being made by the Electric and General Investment Company, Limited, which has an authorised share capital of £200,000, divided in 20 000 ordinary, 19,900 preference, and 100 founders' shares, all of £5 each. The net profits of the company, which was formed in May, 1890, to promote and develop undertakings, are certified in the prospectus to have averaged £14 713 per annum for the last 10 years The net profits for 1897-98, 1898 99, and 1899 1900 were respectively £27,719, £27,450, and £16,711.

Society of Arts.—We have received the syllabus of the course of four Cantor lectures to be delivered by Prof. J. A. Fleming on "Electric Oscillations and Electric Waves," at the Society of Arts on Monday evenings, Nov. 26, Dec. 3 10 and 17. The first lecture will deal with "Electric Oscillations," their production, the factors determining their frequency and energy, secondary oscillations, and magnetic and other effects produced by electric oscillations. Lecture II will deal with "Electric Resonance," the third lecture with "The Electromagnetic Medium," and the fourth with "Electric Waves."

Bermondsey.—Mr. William H. Vincent, M.I E E., borough electrical engineer at Ashton-under-Lyne, and formerly assistant engineer to the Metropolitan Electric Supply Corporation, has been appointed resident electrical engineer. There were 46 applications for the appointment. Tenders will be shortly invited for the supply of columns and arc lamps for the lighting of the public streets. The Vestry have decided to apply to the London County Council for a loan of £12,723 for the purpose of erecting the electric lighting buildings and the dust destructor, the tender for which was accepted by the Vestry at a recent meeting.

"General Electrical Progress."—The General Electric Company, Limited, have just issued No. 29 of this catalogue. It contains a new "loop-in" ceiling rose specially designed for the looping-in system of wiring, suitable for 220-volt circuits; a new B.C. adaptor with fuse terminals; a portable medical battery, comprising six No. 3 sack cells in varnished pine box and cell-selecting switch, enabling the current to be increased by the addition of one cell at a time, or correspondingly decreased; and a slide rheostat suitable for use with accumulators or primary batteries, any kind of which may also be used for small medical lamps on 100 volt circuits.

Pontefract.—A scheme by the United Kingdom Tramway, Light Railways, and Electric Syndicate, Limited, to supply electrical energy, through one power station, for lighting, tramways, and power purposes for the districts of Glasshoughton, Brotherton, Ferrybridge, and Fryston, will come before the District Council at their next meeting. The District Council have invited the engineers, Messrs. Richardson and Lemaitre, of Leeds, to meet the Council and explain the details of the scheme. The syndicate propose to erect the works, giving the Council the option of purchase at the end of each recurring seven years. They would supply light at 5d. per unit for private purposes, and 4d. per unit for public; and power at 4d. per unit for the first hour and 1d. per unit for each succeeding hour.

Worthing.—The Council have authorised the Electric Lighting Committee to proceed with the erection of a generating station and alterations to existing buildings in connection with the electric lighting station, and have engaged Mr. Davison, of Worthing, as general foreman on the works. Tenders will be invited for cartage work and for the supply of 160,000 bricks, etc. With reference to the communication received from Mr. W. A. Taylor on the subject of the provision of effective smoke-consuming apparatus in connection with the generating station, after consulting the engineers thereon, the Electric Lighting Committee report that they are satisfied that adequate provision will be made for the due and proper consumption of smoke at the works when the same are in operation.

London Gazette.—The estate of E. L Joseph, 109, Brondesbury-villas, Brondesbury, has been released from trusteeship. Notices of intention to apply for provisional orders under the Electric Lighting Acts, 1882 and 1890, have appeared from the Wisbech Corporation and the Gainsborough Urban District Council. The East Stonehouse Urban District Council have notified their intention to transfer their order to the Devonport Corporation The North Metropolitan Electricity Supply Company have notified that the necessary arrangements are being made for the supply of electricity (*a*) to the authority for lighting streets and bridges or public places, (*b*) to all local authorities, persons, or companies being authorised undertakers under the statutory powers within the districts of the poor-law unions of Hendon, Barnet, Edmonton, Ware, Hertford, Welwyn, St. Albans, and Chingford.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 13 as a special settling day for Telegraph Manufacturing Company, Limited, further issue of 5 000 shares of £5 each, fully paid, Nos. 20,001 to 25,000. The committee have also ordered the undermentioned securities to be quoted in the official list: Folkestone Electricity Supply Company, Limited, 10,000 ordinary shares of £5 each, fully paid, Nos 1 to 10,000; National Telephone Company, Limited, £500,000 4 per cent. debenture stock; and Telegraph Manufacturing Company, Limited, further issue of 5,000 shares of £5 each, fully paid, Nos. 20,001 to 25,000. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to British Electric Traction Company, Limited, further issue of 10,000 6 per cent. cumulative preference shares of £10 each, fully paid; and 15,000 ordinary shares of £10 each, fully paid.

Institution of Engineers and Shipbuilders in Scotland.—From the report of the council on the session 1899 1900, submitted at Tuesday's meeting, we note that the membership of the institution continues to increase. Eight meetings were held during the session, at which the following papers, among others, were read and discussed: "Lighthouse Engineering at Home and Abroad," by Mr. John A. Purves, D.Sc., F.R.S.E; "The Electric Wiring of Buildings," by Mr. W. A. Chamen; and "The Action of Electric Tramway Currents on Submarine Telegraph Cables and other Electric Circuits," by Prof Andrew Jamieson, F.R.S.E. The council is arranging an international engineering congress, under the presidency of Lord Kelvin, in connection with the Glasgow International Exhibition of 1901. The leading engineering and kindred societies have already accorded their hearty support to the congress. An influential London committee has been formed, and the congress gives every promise of being a perfect success.

"Manual of Electrical Undertakings."—The fifth edition of Garcke's "Manual of Electrical Undertakings" will be published about Nov. 1 next. It will contain general information and particulars relating to over 1,250 electrical undertakings, including, where possible, copy of latest accounts and comparative tables showing progress. The manual is divided into six sections—viz, (1) telegraph, (2) telephone, (3) supply. (4) traction, (5) manufacturing, and (6) miscellaneous. In addition there is a directory of over 4,000 names and addresses of chairmen, directors, managers, secretaries, engineers, solicitors, bankers, and auditors of the undertakings given in the manual. The following are issued as supplements to the manual: (1) coloured diagram showing comparative results of 118 electricity supply undertakings; (2) analysis of the revenue accounts of electricity supply undertakings, showing the details of working expenses, revenue, profit or loss before providing for depreciation, reserve, debenture and other interest, which are stated separately, year of working, and number of units sold; (3) map of the electrical railways in London authorised and constructed. The price is 12s. 6d. net, and the work can be obtained from the publishing offices, Donington House, Norfolk-street, Strand, W.C., or from the offices of the *Electrical Engineer*, 139 140, Salisbury-court, Fleet-street, E.C.

Catalogues.—We have received from the Morley Engineering Company, Limited, of Leeds, a copy of their price-list of dynamos and motors. The list is very neatly and concisely drawn up, and contains information respecting 14 different dynamos and motors of the Morley D.B. type.—We have also received from the Campbell Gas Engine Company, Limited, of Halifax, a copy of their new catalogue and price-list of gas-engines. In this list considerable alterations have been made, both in the powers of the engines and in the prices, and the company state that they have entirely revised the whole of their gas-engine designs and patterns. The list is well illustrated and contains information concerning a large number of the gas-engines manufactured by the Campbell Gas Engine Company. A supplementary list is also given of horizontal engines, and horizontal engines specially adapted for electric lighting work.—We have received from the British Thomson-Houston Company, Limited, pamphlets Nos. 75 and 76. The former deals with electrically-operated cranes, and illustrates these cranes at use in various towns and for various purposes. At the end of the pamphlet the data required when ordering an electric crane is given. Pamphlet No. 76 deals with rheostats manufactured by the above company for generators and motors. The rheostats described are of three types—packed card, spiral wire, and iron grid—and they are made with a wide range of capacities. A number of drawings and illustrations of the rheostats are given in the pamphlet.—The British Westinghouse Company have just published their circular No. 1,032, which deals with their No. 56 tramway motor. A good description of this motor is given, sectional illustrations and diagrams being shown.

Digitized by Google

Blairgowrie.—On Monday a special meeting of the Blairgowrie Police Commission was held in the clerk's office to confer with Mr. Hawtayne, M.I.E.E., regarding the proposal to apply for a provisional order to give powers to light the burgh with electricity. Mr. Hawtayne was strongly of opinion that electricity could be supplied at half the price of gas. He was not impressed with the water power of the Ericht, and if the electricity were generated at Craigmill the size and length of cable necessary to carry it to the town would be so great that it would more than meet any gain to be derived from water power. He rather favoured the use of coal for generation by steam power at a centre in the burgh, and estimated that the cost of coal for lighting the burgh with electricity would be ½d. per unit. The Commissioners thought their best plan was to get the order in their own name, and afterwards transfer their powers to a company, as had been done in several places. If an order were granted to a company, the town could not take over the works for 42 years.

Paisley.—The burgh auditor, Mr. J. Balderston Whyte, has issued a report pointing out that while the electric works and installation were originally estimated to cost £33,750, they have cost £95,000, being £14,000 over the Council's powers. The buildings, originally estimated at £5,500, have cost £20,562. The machinery and plant, originally estimated at £18,200, have cost till date £33,277. As in the case of the buildings, when the estimates and contracts were accepted for the machinery and plant the amount was increased from the original sum to £28,573 and the excess expenditure in machinery and plant over the accepted estimates is thus only £4,704. For the high and low tension mains and distributors, also mains for arc lamps, the estimated original cost was £5,050, but this amount was increased when the estimates were accepted to £9,860, but the total cost now up till date is £20,725. A sum of £1 100 was estimated as the cost of transformers and sub-stations, which sum was subsequently increased to £2,548, whereas up till date the amount expended is £9,416, an increase of £6 868 over the accepted estimates. There was also an excess over the amounts estimated for arc lamps, pillars, etc. The report also shows that in 1896 the cost of the works and installation was originally estimated at £33,750 for 10,000 lights, or £65. 10s. per kilowatt. Taking the capital expended at £95,000, and the kilowatt capacity at 1,100, the cost of the installation was about £86 per kilowatt. With the extensions to mains, etc., required to take up the current still in reserve, the ultimate cost will probably be from £90 to £95 per kilowatt.

Taunton.—The following report of the Electric Lighting Committee was adopted on the 22nd inst.: "The British Electric Traction Company having applied to the Council to supply electric power for the company's proposed trams in the borough, your committee have ascertained that the company would be prepared to agree to the following terms: Terms of supply of electrical energy—for any quantity up to 60,000 units per annum, 2d. per unit; for any excess quantity up to 120,000 units per annum, 1½d. per unit; for any excess quantity from this figure up to 180,000 units per annum, 1½d. per unit. Guarantee by the company to take or pay for 60,000 units per annum, also that if the company cease to work within seven years they will pay one-half of the cost of laying down plant. Your committee present the following estimate of the cost of the plant which the Council would have to lay down for the purpose of supplying current to the company: 75-kw. direct-current generator, £600; 75 kw. direct current engine and generator, £1,200; alterations and additions to Willans engine, £200; 33-kw. motor-alternator, £370; switchboard and cables, £300; foundations and trenchings, £75; steam and exhaust piping, £175; contingencies, £150; engineers' fees, etc., £150—total, £3,220. Your committee recommend the Council to enter into the before-mentioned arrangement with the British Traction Company, and to authorise your committee—on the due execution of an agreement embodying the said terms—to obtain tenders for and proceed with the laying down of the said plant. Your committee recommend the Council to apply to the Local Government Board to sanction the raising by the Corporation of a loan of £3,220 to be expended on plant according to the above estimate."

Oban.—The following is the report by a committee appointed to consider and report on the question of introducing electric lighting within the borough, for which we are indebted to the *Oban Times*: "The committee, in accordance with the remit to them, visited Rothesay, Edinburgh, Leith, and Stirling, in which towns there are electric lighting installations in operation. At these places the committee had the privilege of meeting with the conveners or other representatives and the officials of the electric light departments of the corporations, and of being shown over the stations. The committee derived considerable profit and satisfaction from their visits, every opportunity being given them of making themselves generally acquainted with the working of the installations, and a great deal of valuable information being afforded them. The committee desire to put on record an acknowledgment of the great kindness shown to them by the representatives of the several burghs visited, and their thanks for the information so willingly given. The committee having given their best consideration to the matter remitted to them beg to report as follows—viz: (1) Public lighting.—At present Oban is poorly lighted, the illuminant being gas, and the cost thereof being 7s. 6d. per 1,000 cubic feet. The public lamps are 220 in number, and the total cost for lighting the burgh, including gas and wages for lighting and cleaning the lamps, amounts to £540 per annum. The committee believe that there is a general desire on the part of the community that Oban, as a tourist resort, should be much better lighted than it is at present, and the only satisfactory way to do so, in keeping with modern ideas, is by means of electric lighting. They desire to point out that in any such new scheme of lighting it is absolutely necessary to increase the amount of light in the principal thoroughfares, and that to do this, quite irrespective of the comparative cost of gas and electric light, would mean a somewhat increased charge for this purpose. The committee are of opinion that it would require at least 30 arc lamps, being about the number erected on Rothesay esplanade, to do this satisfactorily and with credit to the burgh. They found that the cost of lighting, etc., the arc lamps in the places visited was as follows: Edinburgh (where the installation has been a great success and the price is very low), £13 per lamp; Stirling, £17; Leith, £20; and Rothesay, £24; and they consider that a charge of not less than £20 per each arc lamp per annum, which would mean £600 per annum, would be necessary. From this, however, there would fall to be deducted the cost of the gas lamps rendered unnecessary, say 67 at an average cost of £2. 10s. 6d. each, being £170 per annum. (2) Private lighting.—If the foregoing suggestions were approved of, the committee are of opinion that electric lighting could be supplied to private consumers at the rate of 6d. per unit, which is reckoned to be equal to gas at 3s. 6d. per 1,000 cubic feet. The committee are also of opinion that a considerable supply of electrical energy could be sold for power, which would materially help to reduce the cost of private lighting. The committee accordingly recommend that application be made by the Commissioners of the burgh for power to introduce an electric lighting scheme within the burgh on the lines above set forth. The committee have further carefully considered the question of professional advice, and they have come to the conclusion that, to ensure success, it is necessary that an engineer of great experience should be consulted, and accordingly they recommend that application be made to Dr. A. B. Kennedy, London, who was engineer, amongst other schemes, for that of the Edinburgh installation, which has been from the start a very great success."

TRACTION.

Netherton.—The cars on the Dudley, Netherton, and Cradley Tramways have resumed running.

Berlin.—The electric railway from Saalburg to Homburg is to be continued as far as Frankfort-on-the-Maine.

Derby.—The last horse car route has now disappeared, and the first electric cars to West Derby were run on Sunday. They met with considerable patronage.

Smethwick.—The Town Council are about to promote a Bill with regard to the purchase of the tramways and for effecting public improvements in the borough.

Automobile Race.—The Automobile Club de France have agreed to a proposal to organise a Paris to Berlin race next year. The Kaiser intends to give £2 000 in prizes.

Llandudno.—The Urban District Council have appointed a committee to consider the advisability of constructing an electric tramway around the Great Orme's Head.

Littleborough.—The District Council have decided to apply in the next session of Parliament for a provisional order authorising them to take over and work the tramways at the expiration of the tramway company's lease.

Overcrowding.—The Imperial Tramway Company were recently fined 20s. and costs for overcrowding their tramcars during the Stockton race days. The defence was that the officials were unable to prevent the crowds overloading the cars.

Lowestoft.—The National Electric Traction Company have agreed to the proposals of the Council. A letter referring to the suggested leasing to them of the tramway and the suggested new agreement with the company has been referred to the Joint General Purposes Committee and the Legal and Parliamentary Committee.

City and South London Railway Co.—We learn that in consequence of the illness of one of the leading counsel in the case, the arbitration between the Ecclesiastical Commissioners, the rector and churchwardens of St. Mary Woolnoth Church, and the City and South London Railway, which was to have commenced to day, has been postponed for the present.

Ipswich.—The Joint Committee of the Corporation and the Dock Commission have recommended the latter to proceed with the works for which it has power for improving the tramway accommodation around the dock. The Joint Committee propose to continue its deliberations, and to formulate at no distant time a scheme for the further development of the port.

Kingswinford.—Colonel Von Donop and Mr. Trotter are about to inspect the electric tramway, which diverges from the Dudley and Stourbridge tramway at Holly Hall, runs to Kingswinford, and then, turning south, runs through Wordsley to Brettell-lane, where it connects again with the Dudley and Stourbridge line. Trial trips of the cars took place a few weeks ago.

Bradford.—A trial trip was made on the 23rd inst. on the new electric tramway between Thornbury and Stanningley, which has been constructed by the Bradford Corporation. The committee hope to have a regular service of cars running in two or three weeks. The cause of the delay is the want of a depôt at Thornbury, where a huge shed is to be erected capable of holding 100 cars.

Manchester.—At the meeting of the Tramways Committee on the 23rd inst. it was reported that the Board of Trade have intimated their approval of the proposal to lay a double line of tramways in Corporation-street. It was also stated that there are now nearly 500 men engaged on the work of relaying the permanent way. Progress is being made at the rate of about a mile a week.

Digitized by Google

Protection Guards.—A protection guard for tramway cars is just being tested in connection with the new electric tramways at Dundee. The guard, which was invented by Mr. J. Dewar, Dundee, differs from the guard commonly in use in respect that it is movable. A wooden bar stretches along the front of the car, and on its being struck the guard falls down close to the ground and the body rolls on to it. The tests are, according to the *Scotsman*, considered very successful.

Maidstone.—The Corporation have decided to promote a Bill for the following purposes: to authorise the Corporation (1) to construct and work tramways along certain streets and roads; (2) to widen certain streets and roads along which the tramways will pass; (3) to supply electrical fittings, to alter the date for making up the electrical accounts, and to make further provision in regard to the electric lighting undertaking, etc.

London County Council.—At Tuesday's meeting the Parliamentary Committee recommended that they should be instructed to renew in the next session of Parliament applications for powers (1) to reconstruct as a double line for electrical traction the existing single tramway line from Camberwell green to Vauxhall as mentioned in the Council's resolutions of July 25 and Oct. 17 1899. The proposed route along the Embankment has been abandoned.

Dundee.—The electric cars have been started on the Lochee-road. Eight cars are available, by which a 7½ minutes' service, beginning at 7 30 a.m., will be maintained, while the steam cars will be employed before that hour for the workmen's service. The Town Council have decided upon the promotion of a Parliamentary Bill for two tramway extensions—one a new line from the centre of the city to the north end *v d* a steep incline on the west of the Royal Infirmary buildings, and the other a new line at the east end. The estimated cost is considerably over £30,000.

Rowley Regis.—At the last meeting of the District Council it was stated that the Midland Electric Corporation for Power Distribution had given notice of works to be undertaken in Tipton-road, Tividale, thence past the Hange Colliery through city, Turner's-hill, Gadd's-green, Tippity-green Dudley-road, Dog-lane, Cox's-lane, Reddall Hill road, Spinner's End, High-street, Crad'ey Heath, Lomey Town, to the Quarry Bank boundary, Hales-owen-road. The committee have requested the clerk to examine the company's provisional order and inform them what (if any) powers the Council had for buying the works and supplying electricity themselves.

Kingston.—At the meeting of the Town Council on Tuesday, the Tramways Special Committee presented a report embodying some correspondence with the London United Tramways, Limited, a report from the tramways expert, Mr. J. Edward Waller, and a letter from the parliamentary agents, Messrs. Rees and Frere. The committee recommended that the Bill to be promoted in the next session should include, besides certain specified routes, all in the borough, one from the borough boundary in Maple-road to the Surbiton Station, in the Surbiton Council's district; another extending a short distance from the boundary on Kingston-hill into Coombe; and a third across Kingston Bridge to High-street, Hampton Wick.

Electric Street Car Manufacturing Syndicate.—At an extraordinary general meeting on Thursday a resolution was adopted ratifying an agreement made between the Company of the one part and the Electric Tramway Maintenance and Construction Company, Limited, of the other part, for the sale of the Company's business. This business was established about three years ago for the manufacture of motorcars, electric tramcars, and tramway appliances. It is reported that the Tramway Maintenance Company, who are a London syndicate, will buy 20 acres of land at Wednesfield for the purpose of extending the works. Mr. Thomas Parker, who was chairman of the Electric Street Car Syndicate, will join the Electric Tramway Maintenance Company.

Burnley.—Notices have been served upon the tramway company requiring them to sell their undertaking to the adjacent local authorities, and also upon the Corporation of Nelson, the Urban District Councils of Brierfield and Padiham, and the Reedley Hallows Parish Council, requiring them to state within three months whether they intended to construct the new lines within their own district or allow the Corporation to do the work. A very satisfactory report has been received from Major Cardew upon the plans and specifications for the reconstruction of the tramways prepared by the borough surveyor and the borough electrical engineer, and arrangements will be made for Major Cardew to inspect the line and meet the Tramways Committee at an early date.

Taunton.—At a special meeting of the Town Council on the 22nd inst. the Streets and Highways and Electric Lighting Joint Committees reported that they had received a communication from the British Electric Traction Company intimating that that company had arranged to take over from the local company the Taunton Tramways Order, 1900, and to at once start the work of laying the tramways if the Council would consent to the company (1) abandoning the proposed tramway in St. James's-street and substituting a line up Grays road and along Blake-street, as an approach to the company's proposed depôt; (2) substituting tar macadam for wood block between the rails. The committees duly considered the proposed variations in consultation with the company's engineer, and with a view to the Council adopting other proposals they recommended the Council to rescind the resolution passed at a meeting of the Council held Feb. 13, 1900, so far as it required wood blocks or paving to be laid by the tramways company between and on either side of their tramrails in the streets of the borough authorised by the tramways provisional order. The committee also recommended the Council to consent to the company's first request for the abandonment of the tramway in St. James's street and the substitution of a line up Grays road and Blake street. As to the second request of the company, they recommended the Council to require a single line of setts (dog-toothed) to be laid on either side of the metals or rails of the tramways, and to require the space between the metals to be made up with macadam, except opposite and for a sufficient distance on either side of the hospital, where wood blocks should be used. A long and animated discussion took place, and the committee's recommendations were eventually agreed to by a majority of 17 to 3.

Maryport.—The representatives of the Council appointed to attend conferences at Carlisle and Workington respecting the proposal to construct an electric tramway starting at Cleator Moor and passing through Whitehaven and Workington to Maryport, have made a report on the suggestions as to alterations of the route which were made and which are still being considered. The probable cost is put at £2,000 to £2,500 per mile where waste or spare land is available on the roadside, up to £6,000 per mile in other place, and in towns, including equipment, £10,000 to £12,000. The conditions named by the promoters are as follows: (*a*) The scheme to be carried out by a company, the company to have the tramways for 50 years, then the authorities to be compelled to buy on the following terms: the original cost to the company of the undertaking and all additions, with interest at the rate of 5 per cent. per annum on the share capital of the company to be guaranteed by the authorities. All the profits above and over the profit of 5 per cent. during the 50 years to belong to the company. Or, in the alternative (*b*) the option at the end of 21 years of purchase on the basis of a going concern price—*i.e.*, taking into consideration the past and prospective earnings of the company, with other details, and in addition 10 per cent. on the price so arrived at for compulsory sale. The promoters will not undertake to go on unless they are able to guarantee those who find money the full amount invested, with 5 per cent. interest for 50 years. Further consideration led the promoters to say that possibly the compulsory purchase at the end of 50 years might be changed to an optional purchase then or subsequently at agreed periods. At the second conference, when representatives of Workington, Whitehaven, and Maryport authorities were present, it was unanimously agreed that the terms proposed were not such as could be recommended for acceptance.

Bournemouth.—The County Borough Council have adopted the following report of the Tramways Committee: "Tramways extension.—The borough engineer reported that it would be advisable to construct a tramway from the proposed depôt in Southcote-road along Church-road and Palmerston-road, for the better working of the traffic, and that it would be necessary for this purpose to take powers to widen Church-road. Generating station and tramways extension.—The town clerk reported (verbally) that he was advised that it would be necessary to promote a Bill to obtain compulsory powers to purchase the freehold reversion of the Cumberland Estate in Southcote-road, also to obtain powers to construct tramways outside the borough. Recommended that the Council promote a Bill in the next session of Parliament for, amongst other things (*a*) obtaining compulsory powers for the purchase of the Cumberland Estate; (*b*) the purchase of the lands necessary for street widening; (*c*) the construction of the tramways extensions already resolved upon by the Council, including the extension and widening mentioned in Clause 1 of the report; and (*d*) for power to use the Southcote-road depôt as a generating station. Winton.—A letter (dated Sept. 21) from Mr. T. E. Gosling, clerk to the Urban District Council of Winton, was read, stating that his Council would consent to the proposals of the Corporation, provided the line of tramways were extended to the old boys' school at Moordown Scheme (General).—Loan (342-2): A letter (dated Oct. 1) from the secretary of the Board of Trade was read, stating that the Board would hold a local enquiry on the subject of the Council's application, and asking for particulars as to the debt, etc. The town clerk reported (verbally) that these had been forwarded. Alteration of Tramways.—A letter (dated Oct. 4) from the secretary of the Board of Trade was read, stating that the Board saw no objection to the proposed doubling of certain tramways authorised as single lines by the order, providing that no rail should be laid in connection with these alterations within 9ft. 6in. of the edge of the footpath, except in accordance with Section 13 of the order."

Sheffield.—The tramways department of the Corporation continues to push on its work effectively. The next district to be provided with cars will be Heeley, which is practically ready. We quote the following interesting particulars from the *Sheffield Daily Telegraph*: "The old difficulty of want of power still faces the department, but not nearly so acutely as in the past. The energies of the 500-kw. engine started this year are now almost absorbed by the demands of the various sections, and there is very little spare power available in the case of a breakdown. However, the second 500-kw. engine, which is capable of driving 50 cars, is rapidly nearing completion, and there is every hope that it will be ready for work by Nov. 10, the date given to the contractor. The first section to feel the benefit of its running will be Brightside. The equipment of this route is practically completed. Only a few odds and ends of things require finishing off, and the section will be ready for the cars as soon as power can be obtained, or very soon after. Walkley also requires attention. An early step will be the placing of three double-deck cars on this route to run as far as Harcourt-road. The cables are being laid now. The deliveries of cars have

Digitized by Google

been very good lately, and, in addition to the 65 now running, there are upwards of 30 in reserve at Tinsley and Queen's-road. Besides which, the Corporation carmaker's hammer rings merrily at the Nether Edge workshop, where the framework of the first of six cars has been laid down. There need be no fear of deficiency in this respect for some time to come. The laying of the lines on the Darnall and Crookes sections has made capital progress, and the fixing of the poles, which has now been started, will go on as rapidly as possible. On the Owlerton route, too, work is being pressed forward very rapidly. Another six months, and great things will have been accomplished. Kelham Island must always be remembered. Engines and boilers must be provided, or the extension of lines will be of little use. And so the committee is not stopping short at the new 500 kw. set. The present building is still large enough to accommodate two sets each of 1,000 kw. power, and the specifications for one of these have already gone out."

Hull.—At the last meeting of the Corporation Works Committee Mr. Barnard (electrical engineer) reported on the breakdowns in the electric tram service, and advised the committee to appoint a linesman, with a labourer, to examine the whole of the overhead wires every fortnight. The recommendation was adopted. At a meeting of the Corporation Works Committee held on the 19th inst. a recommendation of the Tramways Sub-Committee was adopted to request the town clerk to insert in the proposed Bill powers for extending the present tramways in Prince's-avenue along Queen's-road and Newland-avenue to Cottingham road. It was also resolved to insert powers to run the tramways from Whitefriarsgate Bridge, down the new street, and along Lowgate to the pier. The electrical engineer submitted a report as to what steps he would recommend should be taken to remedy any existing defects in the tramways equipment. With regard to the wear and tear on the car equipments (all types) he considered that it was necessary to provide for the complete overhauling of the cars one by one, and for that it would be necessary to set on an additional fitter and two labourers who would work on that alone. With regard to the breakages of the overhead lines, which he admitted had become much more frequent of late, he said that many of the breakages had been due to faulty workmanship, and had been repaired by the contractors at their own expense. Other cases were due to carelessness on the part of the Corporation employés, and still more were due to fair wear and tear. The two first causes were now giving rise to fewer breakages, and would probably soon cease, but the wear and tear of the line was, of course, steadily increasing. It should be remembered, in comparing the Hull system with other towns, that, owing to the quick service over short lines, the car miles run on any one piece of line were very heavy indeed, and the wear and tear was correspondingly great. During last year, with seven miles of track in use, the car miles run were approximately 15,100 per week, or each fixture on the overhead line had 2,157 trolleys running over it every week. The only way to avoid accidents from wear and tear, therefore, was to adopt a rigid system of inspection of the lines, every hanger and fitting being gone over at least once a fortnight. Messrs. Siemens Bros. and Co. had been doing that on their own behalf to a certain extent, but the electrical engineer considered it was now time that the Corporation undertook the work, and he suggested the employment of a competent linesman and labourer to maintain the trolley wires and mains, and that arrangements should be made to hire a horse and driver to take the tower wagon over the lines every Sunday morning. He did not consider that the Hull system could be called seriously defective, and the number of accidents from defects on the electrical equipment were certainly not more in proportion to the car miles run in Hull than in other towns. He had, therefore, rather suggested the means of avoiding accidents in the future than the remedying of defects. With regard to Messrs. Siemens's controllers and trolley heads, the firm had submitted new designs, which they undertook to fit on all their 15 cars. The report and the recommendations contained therein were adopted.

PROVISIONAL PATENTS, 1900.

OCTOBER 15.

18298. Improvements in electric couplings. Charles Bell Walker, 2, Ormonde-terrace, Regent's Park, London.

18337. Improvements in electrical fuses or cut-outs, and indicating carriers for same. William Henry Wood, 32, Warwick-road, Birmingham.

18345. Improvement in telegraphic codes. Adolphus Washington Greely, 19, Holborn-viaduct, London.

18347. Switch apparatus for electrically-propelled vehicles. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) Complete specification.)

18357. Improvements in and in apparatus for taping insulated conductors. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

18372. An operating device for the regulating mechanism of the electric ignition of explosion motors. Louis Schreiner and Gratien Elie Nicolas Michaux, 18, Buckingham-street, Strand, London.

18376. Improvements in or relating to trolley poles for electric traction and power purposes. Robert Price Strachan, 70, Chancery-lane, London.

OCTOBER 16.

18397. Improvements in the electrolytic decomposition of metallic salts and in the apparatus employed therefor. James Dick Gilmour, 115, St. Vincent-street, Glasgow.

18434. Improvements in or relating to the feeding mechanism of arc lamps. Charles Oliver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

18451. Circuit controller for electric street railway cars and other uses. William Andrew McCallum, 322, High Holborn, London. (Complete specification.)

18471. Improvements in electric arc lamps. William Edward Pugsley, Henry Mitchell Descher, Violette Lucilda Douglas, and William John Robinson, 18, Buckingham-street, Strand, London. (Complete specification.)

OCTOBER 17.

18497 Improvements in coin-freed apparatus chiefly for telephone instruments. John Davis Miller, 62, St. Vincent-street, Glasgow.

18498. Improvements in automatic guards or protecters for electric or other tramway cars William Dewar, 41, Reform-street, Dundee.

18529. Improved electric heat generator. Louis Schramm, Heim-Ruh, Anerly-road, Westcliffe-on-Sea.

18534 Improvements relating to electrically-operated clocks. Hjalmar Emanuel Andersson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

OCTOBER 18.

18557. Improvements in and connected with lightning arresters and high-voltage guards or heating coils for telephonic purposes. Hermann Oppenheimer, 55, Redcross-street, Barbican, London.

18613. Improvements in rectifiers for periodic electric currents The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Alexander D. Lunt, United States.) (Complete specification.)

18614. Improvements in end play devices for rotary electrical machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry Geisenhoner, United States.) (Complete specification.)

18615. Improvements in electromagnetic blow-outs or fuse boxes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

18616. Improvements in electric controllers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

18617. Improvements in high-potential electric circuit breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

18618. Improvements in electrical indicating and measuring instruments. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Lewis T. Robinson, United States.) (Complete specification)

18642. Improvements in low-pressure incandescence lighting. Paul Greyson de Schodt, 322, High Holborn, London.

18645. Improvements in electric furnaces. Arthur Parker, 6, Bank-street, Manchester.

18649. Improvements in or connected with apparatus for making tubes of lead or the like, and for sheathing electric cables with lead or the like. Henry Edmunds, 47, Lincoln's-inn-fields, London.

18656. Improvements in commutator brush-holders. Harry Bishop, 53, Chancery-lane, London.

18658. A new or improved system of and apparatus for secret electric transmission. Pierre de Chimkévitch, 18, Buckingham-street, Strand, London.

OCTOBER 19.

18661. Improvements in wireless telegraphy. Sidney George Brown, 9, Putney hill, Putney, London.

18681 Improvements in electric fire-alarms. Henry Simpson and Robert Tomlinson, 34, Castle street, Liverpool.

18706. Improvements relating to electrically heated laundry irons and like appliances. Julius Hayem, 45, Southampton-buildings, Chancery-lane, London.

18707. Improvements relating to micro-telephonic apparatus. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (The Telephon-Fabrik Actiengellschafs, vorm. J. Berliner, Germany.)

18718. Improvements in magneto-electric ignition devices. Willy Seck, 111, Hatton-garden, London. (Complete specification.)

18729. Improvements in or connected with the generation of electricity. John George Lemon and George Pirie, 53, Chancery-lane, London.

OCTOBER 20.

18741. Improvements in those systems of electric tramways and railways in which current is collected from two insulated conductors (positive and negative), such improvements being in connection with crossings and turn-outs. John Johnston, 53, Bothwell-street, Glasgow.

Digitized by Google

18742. Improvements in electric lampholders. Christopher Thomas Briscoe, Penny Bank-chambers, Halifax.

18757. Improvements in safety devices for the trolley poles of electric cars. Charles Revill Bellamy, William John Turner, and Daniel Richard Wallwork Hardman, 34, Castle-street, Liverpool.

18762. Improvements in wireless telegraphy. Sidney George Brown, 9, Putney-hill, Putney, London.

18779. Improvements in electrical circuit-closers, particularly adapted for use with the indicators of railway signals. Charles Cheal and Henry John Millner, 55, Chancery-lane, London.

18789. Improvements in and relating to electricity meters. Friederich Ludwig Catenhusen, 27, Chancery-lane, London.

18793. Improvements in or relating to electric railways operated on the conduit system. William Chapman, Westinghouse-building, Norfolk-street, Strand, London.

18794. Improvements in insulators. William Chapman, Westinghouse-building, Norfolk-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Nov. 10.

1899.

20493. Electrical signalling systems for railroads. Berry.

21650. Systems of control for electrically-propelled vehicles and trains. British Thomson-Houston Company, Limited. (Potter and Case.)

21655. Systems of controlling electric motors. British Thomson-Houston Company, Limited. (Garfield.)

21660. Electric circuit breakers. British Thomson-Houston Company, Limited. (Buck.)

21662. Electric arc lamps and magnets therefor. British Thomson-Houston Company, Limited. (Stevens.)

24594. Automatic electrical cut-outs. Greenstreet and Selby.

25746. Alternating-current electric meters. British Thomson-Houston Company, Limited. (Steinmetz.)

1900.

10273. Controller regulators for electric motors. Haddan. (Garton Daniels Company.)

10312. Wireless telegraphy. Wilson.

10312a. Electric wireless signalling. Wilson. (Date claimed under Patents Rule 19, June 5, 1900.)

10751. Electrical generators and electrical motors. Willatt.

12249. Thermo-electric cells. Lake. (Langville.)

12950. Apparatus for the electrolysis of water. Garuti and Pompili.

13415. Manufacture of electric insulators. Y. López.

14525. Electric controller brushes. Johnson. (Riker Motor Vehicle Company.)

15710. Electric storage batteries. Lake. (Bowker.)

16050. Controlling high potential electric circuits. British Thomson-Houston Company, Limited. (Rice.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Oct. 20	598	527	+ 71	15,109	13 146
Birmingham Trams.	,, 20	4,430	4,247	+ 183c	183,689	174,696
Blackburn Corp'rat'n	,, 20	414	437	+ 23	18,955	16,767
Blackpool Corporatn.	,, 18	333	234	+ 94	25,947	19,187
Blackpool-Fleetwood	,, 22	258	325	- 67	18,663	18,633
Bradford City Trams	,, 21	515	349	+ 166	15,093	17,217
Bristol Tramways Co.	,, 20	2,993	3,060	- 67	—	—
Carlisle Tr'mw'ys Co	,, 20	153	—	—	3 199f	—
Central London Ry.	,, 20	5,465	—	—	58,396e	—
City & South London	,, 21	1,708	1 119	+ 689	24,592	15 254
Cork E. T. and L. Co.	,, 18	410	377	+ 33	17,463c	16,009
Dover Tramways ...	,, 18	198	187	+ 11	8 875	8,463
Dublin & Lucan E.R	,, 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	,, 19	3 468	2,302	+1,166	—	—
Dublin S.D. Electric	,, 19	749	726	+ 23	—	—
Glasgow Corporation	,, 20	9,251	9,377	- 125	—	—
Halifax Corporation	,, 22	708	609	+ 99	23,305	18,248
Hull Corporat'n E.S.	,, 20	1,575	—	—	39,583a	— c
Liverpool Corporat'n	,, 13b	8,628	7,161	+1,467	322 322	281,675
Liverpool Overhead	,, 21	1,594	1,571	+ 23	27,376	26,174
St. Helens Tramwys.	,, 17	—	—	+ 198	—	—
Sheffield Corporation	,, 21	2,479	—	—	—	—
Southampton Trams	,, 18	687	376	+ 311	—	—
Southport Corporat'n	,, 13	199	—	—	2 399a	—
Swansea Tramways..	,, 5	447	263	+ 184	7,093	4,462

a Since April 1. b Partly electrical. c Since Jan. 1. e From July 30. f From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p c. Cum. Pref. Shares, 1-125,000	1	—	⅜-½
British Insulated Wire, Ord., 1-40,000	5	—	10-11
—— 40,001-70,000	5	—	10-10½
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	⅜-½
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅜-½
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	102-104
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-13½
—— 5 per cent. Pref.	5	—	5-5½
Crompton and Co.	3	—	3¾-4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	1¾-2¼
—— 5 per cent. Debentures	5	—	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	..	96-100
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-13½
—— 4½ per cent. Preference	5	—	5-5½
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20-21
—— 4 per cent. Debentures	100	—	99-102
Telegraph Construction and Maintenance	12	—	35-39
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	..	5-5½
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11½ x
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¾-7½ xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6½-6¾
Charing Cross and Strand	5	—	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-6
Chelsea Electricity Supply	5	—	6½-7½
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	—	12½-13½
—— 5 per cent. Debenture Stock	100	—	125-130
County of London and Brush Provincial, Ordinary	10	—	8¾-9½
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	—	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	—	1½-2¼
—— 6 per cent. Pref.	5	—	4½-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-103
Metropolitan, Ordinary	10	—	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	112-115
—— 3½ per cent. Mortgage Debenture, Red	100	—	97-99
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1½-1¾
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	..	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	3-4
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	97-100
Westminster, Ordinary	5	—	12-13
—— 80,001-109,437	5	—	11-12
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	5-5½
—— ,, ,, deferred	5	..	5-5½
City and South London, Consolidated Ordinary	100	..	58-61
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	120 125
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	..	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	14-16
Brisbane Tramway	100	—	101-103
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary	10	..	13-14
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	12-13
—— 5 per cent. Perpetual Debenture Stock	100	..	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	..	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	3½-4½
—— 5 per cent. Deb. Stock, Red.	100	..	104-107
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10½
New General Traction, Ordinary	5	..	3½-3¾
—— 6 per cent. Cum. Pref.	5	..	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	18-19
—— 5 per cent. Cum. Pref.	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
—— 4½ per cent. Debenture Stock	100	—	104-107
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	96 99
Oriental Telephone and Electric Company	1	—	¾-1¼

Digitized by Google

NOTES.

Camera Club.—At an ordinary meeting of the Camera Club to be held this evening, Mr. Jas. Cadett will read a paper on "The Latest in X-Rays."

Smoking Concert.—A smoking concert in connection with the Faradian Club is, we learn, to take place on Friday evening, Nov. 9, at St. James's Restaurant. The Regent Saloon is to be used on the occasion, the concert commencing at 8 p.m.

Institution of Electrical Engineers.—We are informed that the twelfth annual dinner of the Institution of Electrical Engineers will be held in the grand hall of the Hotel Cecil on Monday, Dec. 2. The Commander-in-Chief, Lord Wolseley, is, we understand, among the guests who have already accepted.

Russian Telegraphs.—The postal telegraph system between Russia in Europe and Siberia have proved so deficient and unsatisfactory that steps have had to be taken with a view to the improvement of it. Thus the first telegraph wires were laid in July last, and skilled linesmen and telegraphists hurried to the spot. Great progress has, we learn, been made since July, and the way in which the operations are being conducted are being favourably commented upon in the quarters interested.

Extra Current. — The following abstract, which appears in the *Electrical World*, is of a paper contributed by Mr. Johnson to *L'Eclairage Electrique* on the subject of the extra current due to breaking a circuit which contains an induction coil, a cell, an interrupter, and a condenser in shunt with the interrupter. He supposes that the discharge of the condenser is oscillating, and calculates the maximum potential difference between the plates of the condenser. The formula found shows that this maximum potential difference is the smaller, the greater the capacity of the condenser. The greater the capacity, the smaller is the liability to sparking when the circuit is broken; this is in agreement with experiments. When a spark occurs, the phenomenon becomes very complicated.

"The Street Railway Review."—The *Street Railway Review* for Oct. 15 is a special number, which commemorates the holding of the nineteenth annual meeting of the American Street Railway Association and the fourth convention of the Street Railway Accountants' Association of America. In this number a history of the rise of Kansas City, in which the convention was held, is given, after which comes a history of the street railway system of Kansas City. With respect to this latter article, a large number of illustrations are given showing the track in course of construction, views in the power stations, cars car-sheds, etc. Information is also given in this number concerning the Kansas electric light undertaking, and also of the various local men connected with the convention.

Electricity on the Congo.—What promises to be the first electricity station in the Congo district is, we learn, soon to be started at the Roman Catholic Mission of Luluabourg, which is situated on the River Lubia, a tributary of the Kaosas River, which is itself a tributary of the Congo. The head of the mission, Father Gambier, who has for several years been in Luluabourg, is now proceeding there again, taking with him a dynamo, turbine, lamps, cables, wires, etc. He proposes to obtain the necessary power from a waterfall, the fall being some 28ft. high. The dynamo will light 150 lamps, and it is proposed to instal 100 incandescent lamps and three arc lamps. The dynamo was manufactured by a firm in Charleroi, and the turbine is of French construction. We hope, however, to hear further of this pioneering effort in the Belgian Congo district, and trust that when fitted the installation will work successfully.

Institution of Electrical Engineers (Glasgow Section).—The opening meeting of the Glasgow section of the Institution of Electrical Engineers is, as we announced in our last issue, to take place on Nov. 14. On that occasion a paper on "Electrical Supply" is to be read by Mr. W. A. Chamen, the Corporation electrical engineer of Glasgow, and a paper written by such an authority should be well worth hearing and considering. We are glad to learn that sufficient papers have been promised already for this section to provide important and interesting discussions for the whole of the session. Mr. E. G. Tidd, the hon. secretary, also announces that any member wishing to take part in any discussion can, a short time previously, obtain advance copies of the papers by applying to him at 25, Gordon-street, Glasgow.

American Electrical Exports.—The Treasury Department, in recently issued returns, gives some figures relating to the exports of electrical machinery and apparatus from the United States during the first eight months of the present year. For this period the exports of electrical machinery reached the sum of about £718,000, as against a value of £305,600 for the corresponding period of last year. The value of the exports of instruments and apparatus for scientific purposes, including telegraph, telephone, and other electrical apparatus, increased from £722,000 during the eight months of 1899 to £834,000 for the corresponding period of 1900. In speaking of these figures, the *Western Electrician* warns electrical manufacturers against over-production, and thinks that foreign markets should be assiduously cultivated in order to provide an outlet for the large amount of electrical machinery, etc, manufactured in America.

Liverpool Tramways. — A serious breakdown occurred on Monday last on the Liverpool electric tramway system, when the cars running in some of the most important streets in Liverpool had to stop running. The accident which caused the suspension of service was the breaking of a span wire on the Pierhead route. The span which collapsed was fixed to the Pierhead buildings, and the result of it breaking was that two trolley lines fell, thus completely blocking the whole system, but fortunately no injury was occasioned either to individuals or to the cars. One explanation which is given as to the cause of the occurrence was that a trolley on one of the cars came off the wire and struck the span, but this the conductor concerned denies, he stating that the breaking of the span threw his trolley off the wire. Mr. Bellamy's staff were kept hard at work trying to replace the wires, and about an hour after the accident, which happened at a quarter past three, managed to restart the service.

Electrical Treatment of Rheumatism (?)—Sir Jas. Grant, M.D., of Ottawa, has, says the *Electrical World*, for some time been making experiments as to the treatment of human ailments by means of electricity. Thus for many years he has been in the habit of treating cases of supposed muscular rheumatism by the insertion of small steel needles, the number varying according to the area affected. The needles remain stuck in the muscles for one or two minutes, and the previous hard, tense condition, approximating one of tetany, relaxes, and the patient is able at once to use the muscles. Experiments point to an abnormal storage of electricity in the tissues. It may be stored as a result of sudden draughts and cold. When the inserted steel needles are touched, the electrical

Digitized by Google

accumulation is discharged, passing through the body of the operator without any serious result. There is almost immediate relief in lumbago from this acu-puncture. While the treatment may give relief, we are not believers in Sir J. Grant's explanation that it is due to electrical phenomena.

Novel Drying Lines.—Mr. G. A. Wiese, who has recently returned from China, to which country he went to instal the electric light in the city of Canton, gives in *Electricity* of New York some of his experiences with the inhabitants of the Flowery Land. Thus he states that in many places the streets of Canton were too narrow for poles. For this reason he had to get permission of the authorities to cut holes in the walls of the buildings, and into these holes modern cross-arms were inserted. After the cross-arms had been placed and the wires strung a tour of inspection was made, and the inspectors were astonished to find that the wires were loaded with laundry work that had been hung out to dry. A current of 1,000 volts was running through the wires at the time, but luckily no one had been killed. When the Chinese were warned of their danger they only laughed, and said that the electricity dried their clothes much quicker than the sun, so they refused to move their wash. Mr. Wiese finally had to report the matter to the authorities, who detailed a guard of 40 soldiers to go with him and put an end to the clothes-drying.

Platinum-Silicium Resistances.—A short article in the *Elektrotechnische Zeitschrift* by Mr. Victor Rodt describes some experiments conducted with a view to ascertaining the chemical resisting qualities of platinum-silicium resistances. Resistances consisting of a thin film of the alloy fused on to porcelain rods have been recently introduced by a German firm, we are told. The rods have a length of 2·83in. to 4·75in., and a diameter of about 0·2in. Although originally intended for use in connection with electrical heating apparatus, it is concluded by the writer that these resistances are also eminently adapted for work where chemical action has to be guarded against. However, the suitability of the resistances for making accurate measurements has not yet been determined, nor do the methods hitherto employed of connecting the platinum-silicium with the conductor exclude the possibility of slight fluctuations of the current density. On the other hand, the resistance offered against overloading, not to mention chemical and thermal influences, confers upon this form of resistance such advantages for certain classes of work that its use deserves consideration.

The Cable-Ship "Orizaba."—We noted recently that the Pacific Coast Steamship Company's vessel "Orizaba" was wrecked on Rock Point Reef, St. Michael's Island, on Sept. 20, while engaged in laying a cable across the Behring Sea. At the time it was thought that the vessel could be saved, but it is now reported that she is a total loss. The captain lays all the blame upon the United States Hydrographic Bureau, stating that the wreck was due to three large uncharted rocks in a place in which the charts showed 36ft. of water. On finding it impossible to get the ship off the rocks, efforts were directed to getting out the cable, and this was accomplished on Sept. 23, the cable being quite uninjured. Mr. G. F. Porter, who was with the expedition and in charge of the kerite cable, hoped to have laid the entire cable by the middle of October and before the Sound freezes. The undertaking is attended with great danger on account of the swiftness with which the ice moves, great bergs appearing without warning in such numbers as to make it impossible for a ship so trapped to escape, and once caught in the floes or heavy drift ice the unfortunate vessel, if not crushed like an eggshell, would be compelled to remain a prisoner all winter. It may be possible to run only the shorter cable, but it was thought at the cable office that Mr. Porter would probably succeed in laying both lines.

A Distortionless Commutator.—The General Electric Company of America has taken out a patent for a commutator which will be free from distortion under centrifugal and other strains, thus tending to keep the bars of the commutator in perfect alignment during the entire service of the machine. The device consists in locking the several bars of the commutator together, so that no one of them can slip with relation to the others, by means of a key passing through the several bars, but insulated therefrom. The key is formed sectional, each segment supporting and locking a number of contiguous commutator segments. A keyway is preferably provided at or near the middle of the length of the bar, so as to bind the latter down against the supporting drum for the commutator bars. In assembling the commutator, the keys, with their segments, are set successively in place and fastened by bolts on the inside of the cylindrical support. The keys are carefully insulated from the commutator segments by a lining of mica on the inner walls of the keyway. The last segment inserted after the balance of the commutator has been assembled, may be insulated by strips of mica or similar material fastened over the end walls of the key segment, and its commutator segments and the combined parts slipped into place and bolted fast, after the fashion of the balance of the segments.

Connecting Alternators in Parallel.—Mr. Perot recently read before the French Academie des Sciences a paper concerning the connecting of alternators in parallel. The paper is abstracted in the *Electrical World* digest as follows: "The author first considers two alternators connected in parallel, which have E.M.F.'s with identical fundamental waves and identical higher harmonics, the only difference being that the wave of one alternator has a special higher harmonic which is missed in the wave of the other alternator; he calculates the current which is due to this special higher harmonic, and the E.M.F. at the terminals of the two alternators. This is proportional to the ratio of self-induction of the alternator, which has not that special higher harmonics and the sum of the self-inductions of both alternators. He then deduces the results for more than two alternators in parallel. He considers an alternator, the wave of which has higher harmonics, and supplies current to a synchronous motor of small power and of small self-induction compared with that of the alternator; the motor may be supposed to be normally excited and unloaded; it behaves like a machine with a sine wave coupled to the alternator, so that the formula mentioned above can be applied; it follows that the E.M.F. at the terminals of the alternator, due to the higher harmonics of the alternator, is decreased in the ratio of the self-induction of the motor to the sum of the self-inductions of motor and alternator, which ratio was supposed to be very small, in other words, the E.M.F. at the terminals of the alternator becomes nearly a pure sine wave.

St. Pancras Vestry.—We have received from Mr. C. H. T. Barrett, the clerk to the St. Pancras Vestry, an interesting retrospect of the work done by the Vestry of St. Pancras by its predecessors for the period extending from 1718 to the present year. The retrospect in question was prepared by Mr. E. A. Brown, of the Burials Department of the Vestry, from the information in the books and records in the Vestry's strong-room. To any one interested in the various methods of local government

Digitized by Google

which have been tried during the past two centuries in London areas, this retrospect will be most valuable. We gather that the open vestries, which were established in the early part of the eighteenth century, used to hold their meetings in alehouses, and conducted their business more in the interests of the large landowners than of the ordinary inhabitants. The open vestry was followed by what was known as the select vestry, which was a self-electing body, and hence could in no way claim to represent the various people whose interest it ought to have served. The Select Vestry of St. Pancras held its first meeting in June, 1819, and it was not until 1832 that the ratepayers had any part in electing their representatives. It was in 1853 that the present Vestry commenced to meet, and it has a long list of improvements to its credit. The author, however, expresses the opinion that the Vestry meets too often and talks too much, and that personalities are introduced more than need be. With this conclusion most people will agree, and we trust that the reduction of the number of representatives on the new borough councils will tend towards more businesslike procedure.

Institution of Junior Engineers.—The annual general meeting of this institution was held on Saturday last at the Westminster Palace Hotel, the retiring chairman (Mr. Basil H. Joy) presiding. There was a large attendance of the members. After the usual business, the council's report on the work of the past year was presented and adopted. It stated the net increase in membership had been 30, the membership roll now numbering nearly 600. M. Gustave Canet, of Paris, and Prof. W. E. Dalby, of London, had been elected honorary members. The institution premium for the best paper read by members during the session had been awarded to Mr. E. W. Porter, A.M.I.C.E., for his paper on "A Comparison of Railway Bridge Structures of Moderate Dimensions, and of Methods of Determining their Working Loads." Seven meetings had been held and eleven visits paid to works, apart from the visits arranged in connection with the summer meeting at Newcastle-upon-Tyne and Sunderland. Reference was also made to the fifteenth anniversary dinner and to the conversazione. The institution had been represented at the receptions given last June by the Socié é des Ingenieurs Civils de France in connection with the Paris Exhibition. The scrutineers reported the election of the following officers and members of council: chairman, Mr. Percival Marshall; vice-chairman, Mr. Ernest King; hon. librarian, Mr. Lewis Rugg; hon. auditors, Messrs. Adam Hunter and A. W. Marshall; and secretary, Mr. W. T. Dunn. The members of council were Messrs. Louis F. Awde, W. Rushworth Beckton, H. Norman Gray, and W. G. Wernham. A vote of thanks was accorded the retiring officers and council, and was acknowledged by Mr. Joy, who inducted his successor into the chair.

A New Battery Switch.—Some of our German contemporaries describe a new type of accumulator switch which is designed to avoid the necessity of employing a booster to furnish the extra voltage for charging when the charging dynamo is required to provide current at the normal voltage for other purposes at the same time. The new switch effects this end by enabling two-thirds of the total number of cells contained in the battery to be always charged together. It is pointed out that for a battery having a capacity of 100 amperes at 110 volts terminal pressure, 60 elements are necessary. The mean charging pressure required per element is 2·4 volts. When charging the battery in parallel halves, there are 30 elements in each half, for the charging of which $2{\cdot}4 \times 30 = 72$ volts mean charging pressure is necessary. But since the line pressure is 110 volts, $110 - 72 = 38$ volts, with a current of 100 amperes per half—that is to say, a total of $2 \times 100 \times 38 = 7{,}600$ watts, or about 11·7 h.p. must be choked back by means of resistances. The driving engine is called upon to furnish about 34 h.p. for the charging process alone. If, on the other hand, we charge two-thirds of the total number of cells—that is to say, 40 elements, which require $40 \times 2{\cdot}4 = 96$ volts—there will be only $110 - 96 = 14$ volts to choke by means of resistances, which with 100 amperes represents about 22 h.p., while the driving engine is called upon for only 17 h.p. Extensive application of this method of charging has been prevented hitherto by the absence of a switch which would enable the individual thirds of the battery to be switched together as desired without the possibility of error. But this difficulty is claimed to have been satisfactorily overcome by the new switch introduced by the well-known Berlin company associated with Dr. Paul Meyer.

Wind Power.—The utilisation of wind power for the generation of electricity continues to receive attention in Germany, and we learn from the *Elektrotechnische Zeitschrift* that Mr. Gustave Couz, of the Gustave Couz Elektricitäts Gesellschaft, in Hamburg, has been experimenting in this direction with promising results. A wind motor has been erected at the works of the company in question, which has a diameter of 40ft. and an effective sail surface of 1,070 square feet. The motor works at the rate of about 11 revolutions per minute, which speed is regulated by the automatic modification of the direction of the sails to the wind. With this motor an output of 1 h p. to 30 h.p. and more may be obtained, according to the force of the wind, which power is transmitted to a 30-h.p. shunt-wound iron-clad dynamo, designed to give 120 amperes at 160 volts terminal pressure when running at 700 revolutions per minute. The current generated by this machine is conducted to a switchboard and thence to a battery of accumulators having a capacity of 66,000 watt-hours, or may be delivered to electromotors. So soon as the wind has attained a velocity of 8ft. per second, the dynamo may be brought up to its full terminal pressure. With an increasing wind force the charging of the battery may be commenced. Automatic cut-outs for the dynamo were proved unnecessary with the arrangement adopted. The electromagnets of the dynamo are permanently excited by the battery, the + pole being connected with the battery, while the − pole is connected to the charging switch. By this arrangement automatic regulation of the dynamo voltage is secured. An automatic battery-discharging switch serves to maintain the line tension of 110 volts constant, both during the charging process and when discharging. Small motors are connected up to the lighting circuits, but larger ones are supplied by separate circuits branched off from the terminals of the generator.

Electricity on the Metropolitan and District Railways.—The announcement that the two companies controlling the most of the underground lines in London have invited tenders for the complete conversion of these lines to electric working is good, and also the statement that the offers from the selected firms must be in by Dec. 1. As is known, there are absolutely no engineering difficulties of any moment to be overcome in the conversion of these lines, and we do not doubt that any one of those firms selected will be able to carry out the change in such a way as to give an enormous saving of the running expenses. There would also be an increase in the traffic returns owing to the higher speed and greater convenience and comfort, which would be most acceptable to the companies. Behind all this, however, there is the unpleasant

Digitized by Google

fact that the board of directors must have additional capital, and that this new capital can hardly be provided unless reasonable returns on it can be guaranteed. For instance, one company has not paid any dividends on its ordinary stock for years, and the stock in question stands at a very low figure in consequence. It is not, therefore, to be expected that the new capital to be found will rank with this old stock. We have heard rumours that the difficulty is to be got over by leasing the undertaking to a new company, which would provide the cost of conversion. According to the *Daily Mail*, Mr. Alexander Siemens offered the companies terms somwhat similar to these 10 years ago. In his offer, however, the company would not have gained much beyond the increase in the traffic returns, as the running charges calculated out per train mile were to have been paid to the electrical contractors providing the electrical equipment. In other words, the cost per train mile would have been the same, but the revenue would have increased. More definite news as to the proposals of the contractors will be awaited with interest, and we trust that there will not be any great delay in deciding on the acceptance of the tenders to be submitted in December. We note by the way that Mr. T. Parker, of Wolverhampton, has been added to the list of consulting engineers advising on the question of the conversion.

German Enterprise.—Through their London house—*i.e.*, the Electrical Company, Limited—we have received from the Allgemeine Elektricitäts-Gesellschaft, of Berlin, two interesting pamphlets. One of these describes in German the firm's exhibits at the Paris Exhibition, and, besides some instructive matter relating to the Nernst lamp and other special attractions to be found in the A. E. G. pavilion, contains some beautifully-executed illustrations. We have already on previous occasions remarked upon the high artistic merit characterising the catalogues issued by this enterprising firm; the samples now under notice certainly betray no retrogression in this respect. In fact, we again have to acknowledge super-excellence of design and execution. But as the exhibits of the company at Paris have been fully dealt with in our columns, we will pass on to the second catalogue, which contains many excellent illustrations of the firm's works and productions, not to mention some interesting data relative to the continued growth of their immense business. Incidentally we learn that the capital invested in the parent and affiliated companies amounts to the enormous sum of £15,000,000. The share capital fully paid up in the parent company is now £3,000,000. From 1890 to 1894 the share capital stood at a round million, but has since undergone a rapid increase, notwithstanding which the dividend-earning capacity of the concern has been more than maintained, a steady 15 per cent. per annum having been paid since 1896. Upwards of 14,000 workpeople are employed at the company's Berlin works, which cover an area of 57 acres. For the year 1898 9 the output in dynamos and motors from these works totalled 12,000, representing an aggregate capacity of 163,000,000 watts. The separate system of driving by means of three-phase motors is in vogue at the works. The various departments, each huge in itself, are illustrated in the catalogue. In the incandescent lamp department a yearly output of 10,000,000 lamps has been reached, which is equal, we are told, to one-half the annual consumption in all Europe. The productions of the works may be said to include practically every article required in the electrical industry, but it is quite beyond the scope of a note to give data relative to all, so we must refer the reader to the pamphlet itself for further information.

The Hunting in Rotary Converters.—Mr. C. P. Steinmetz continues his interesting articles in the *Electrical Review* of New York on "The Systems and Apparatus for Light and Power Distribution." Amongst the points taken up in the last article which we have read in the series is that of the hunting which occurs in the rotary converters for changing alternating current into direct current. Mr. Steinmetz points out that to understand the phenomenon of hunting it is well to take the simplest case, of a generator of absolutely steady and constant E.M F. feeding a converter or synchronous motor over a circuit of certain resistance and self-induction or reactance, with a constant load on the converter. The usual theory of the text-books then shows that the counter E.M.F. of the converter adjusts itself to a definite phase relation with regard to the generator E M.F., depending upon the load and the excitation. Closer investigation shows, however, that the phase of the counter E M.F. of the converter, and thus its speed, and in consequence thereof the current, can pulsate around a mean position, and the power supplied by the generator pulsates correspondingly with a period depending upon the E.M.F.'s, the impedance, the momentum of the moving masses, and several other constants, but usually of a magnitude of somewhere near one cycle per second. During the time of acceleration the generator supplies an excess of power, which is stored by the moving masses and returned during retardation, where the generator supplies less power than the load on the converter represents. This period is entirely definite and independent of wave shape or engine pulsation, although the latter may start the oscillation. He continues by stating that several of the constants upon which hunting depends are beyond the control of the designer of electrical machinery, and consequently it is well to prevent hunting by using damping devices to prevent the surgings which occur. The oscillation of the armature reactions which cause a considerable amount of the hunting can best be prevented by using low-resistance closed circuits of copper in and around the field poles. Another point taken up in this article is the fact that in the design of engines for driving alternate-current machinery for the transmission of energy, the uniformity of speed is not so important as even turning moment. In fact, in order to get the load properly distributed between a number of steam-driven sets, an appreciable fall of speed between no load and full load is advantageous. It is most essential, however, that there should be no hunting from the governors, and Mr. Steinmetz points out that a heavy flywheel does not prevent hunting, but rather takes the opposite direction, and tends to increase it.

The Commercial Value of Electromobiles.—In articles contributed by Mr. R. A Fliess to the *Electrical World*, the author deals with the electric automobile when used for commercial purposes, and gives a number of tests which he has carried out both in good and bad weather. From the fair-weather tests on level asphalte, he concludes that an ordinary light delivery wagon fitted with friction-reducing devices requires about 90 watt-hours per ton-mile. Without such friction-reducing mechanism 95 watt-hours per ton-mile were needed. The vehicles required about the same watt-hours per ton-mile whether loaded or empty. Tests made with pneumatic tyres and solid tyres showed that vehicles fitted with pneumatic tyres indicated a slightly increased rate of power consumption over those fitted with solid tyres. When travelling over a macadam road surface, the rate of power consumption was nearly 116 watt-hours per ton-mile. Tests were also made with a light electrical postal wagon under very adverse weather conditions. In this case tests were made just after a very severe snowstorm, the snow in some places being 4in. or

Digitized by Google

5in. deep, and the roads rather badly paved with macadam. Under circumstances described as the worst such a vehicle would be likely to encounter, the vehicle required only an average rate of consumption per ton-mile of 114 watt-hours, the average watt-hours per car mile being 193. The total distance covered was 13·4 miles, this taking 1 hour 37 minutes, the average speed being 8¼ miles per hour. The open-circuit voltage at the end of the journey had dropped from 96 to 89 volts, and the running voltage from 91 to 86½ volts. In conclusion, the author gives a table which is a *résumé* of 12 separate tests with four different vehicles. In this case the watt-hours per ton-mile vary from 68·79 to 89·42, the average being about 80. The average speeds of the vehicles varied from 9·68 to 11·31 miles per hour. He concludes that from these tests it would seem as though electric vehicles designed for use in light delivery service can be expected to cover at least 22 miles on one charge of battery at an average speed while in motion of at least 8·5 miles per hour under ordinary service conditions when carrying the average load required of vehicles in this class of service. This they can be expected to do with an average rate of power consumption seldom exceeding 115 watt-hours per ton-mile, and with an average battery efficiency not often less than 70 per cent. if the running voltage is not often allowed to drop below 1·75 volts per cell on a trip—this when the vehicle is equipped with solid rubber tyres. Under adverse conditions, however, the range of such electric vehicles would seem to be not more than about 11 miles for one charge.

High-Voltage Cables.—An article in *Cassier's Magazine* for November, by Mr. Wm. Mavor, jun., on "High Tension Electric Cables as used in the United States," is somewhat disappointing from a technical point of view to the reader who knows anything of cable manufacture. This is so because the author, instead of assuming a certain amount of knowledge on the part of his readers, gives a vast amount of well-known information which crowds out the expert description of the high-tension cables which we should like to have seen. We gather, however, from the article that both indiarubber and paper are used by cable manufacturers in the States. The use of indiarubber has practically ceased in this country for cables under our streets, and it is doubtful if ever any large contracts will again be given in England for rubber-covered cables. The next point we notice is that for distribution work the Americans favour three-core cables. Each of the three cores is independently insulated with either paper or indiarubber, and when laid up together the space between the three insulated cores is filled up with jute to form a circular section. In a number of cases an insulating jacket of indiarubber or paper is then put round the cable, after which comes the lead covering. As an example, the author gives the following particulars of a cable which is to be used in New York with 6,600 volts. The cross-section of each of the three conductors was half a square inch. The conductors are formed of 37 wires stranded together, and the thickness of the indiarubber insulation round each of the coils is $\frac{5}{32}$in. The insulation put round the cable outside of the three cores is also of the same thickness and material, so that there is always $\frac{5}{16}$in. of indiarubber between any pair of the cores or between any core and the lead. We are surprised to find, however, that the lead covering of the cable is only ⅛in. thick, which, with a total diameter of 2·56in., seems to us to be too thin. A glance at a section of the cable also shows what an advantage would be gained by using segment-shaped cores, as is done by one of our prominent English manufacturers for such work. The author also gives some particulars of a cable to be used for 25,000 volts. Here again indiarubber is used, but the thickness is increased from $\frac{5}{32}$in. to $\frac{7}{32}$in. Although the author states in the heading of his article that he will deal with the testing of these high-voltage cables, there is very little information given as to the way in which this testing is carried out. It is, of course, simple to say that on a 10,000-volt cable an alternating pressure of 15,000 volts is applied for one hour, but, as is well known, the details of how the voltage is turned on have a very great deal to do with the actual stresses set up in insulation. For instance, when 15,000 volts is switched on to a cable, it frequently occurs that an arc will start on a spark-gap which will not discharge under 30,000 volts.

The Manchester Electricity Supply.—We have had brought to our notice some criticisms by Mr. S. Norbury Williams, one of the elected auditors of the city of Manchester, on the working of the Manchester Electricity Committee. These criticisms were published in last week's issue of the *Manchester City News*, and we regret to find that they are largely aimed against the chairman of the committee, Mr. Lloyd Higginbottom. We do not propose here to deal with Mr. Norbury Williams's personal remarks, but there is one point which makes one gravely doubt his capabilities to hold the office of auditor in such an important city as Manchester. This is contained in the twenty-first clause of the so-called remarkable disclosures, and reads as follows: "'Electricity sold under cost price.' You will perhaps be surprised to hear that the Electricity Committee is at present selling electricity to users of motors at less than half the price which you have paid to make it. This may seem astounding. It is time you looked into it carefully. Examine the figures. The cost of production and management, including interest and sinking fund, is 2·87d. per unit. We sell it to the motor people at 1·25d.—that is, 1¼d. In other words, we sell £100 worth of electricity for £43. This works unjustly in many ways. Take one. I know a man who is giving up his gas-engine. Why? He says they make him pay full price for the gas he uses, a price which the Corporation make a profit out of. But he finds he can get electricity for his motor at less than half its cost price, and he takes out of the citizens' pockets the other half. He says the gas-engine makers must look after themselves; he prefers a motor which will run largely at your expense. The figures are striking. In the last financial year, we supplied to consumers, at the 5d. rate, 1,993,000 units, which brought us an income of £41,500; whereas, to the motor users at the 1¼d. rate, we supplied 479,000 units and received only £2,500. One result of this low price is that the demand for motors is constantly increasing. Another singular feature of the matter is this, that when I refer to the book in which are entered the applications for electric power for these motors I find, under the heading 'Fitter's Name,' that the name of the firm of Higginbottom and Mannock stands opposite 23 motors. This does not include the cases in which this firm is the sub-contractor." This criticism shows that Mr. Williams has no idea that the cost of electricity supplied to motors may be less than that supplied to electric lamps. That this is so is well known to all electrical engineers, as the cost of supply to any particular class of consumer is largely influenced by the number of hours during which that consumer takes his electrical energy. So much has been written on this subject that we need hardly go into figures again, but we must strongly dissent from Mr. Wilson's criticisms of the action of the Manchester Electricity Committee on this head. It would be well if he had taken the trouble to enquire from Mr. Wordingham as to this point before making such unwarrantable charges as he has done.

Digitized by Google

BURY ST. EDMUNDS ELECTRICITY WORKS.

The history of the town of Bury St. Edmunds goes back as far as that of any place in England. Thus, according to Camden, in the time of the Romans the name of this place was Villa Faustini, which in Saxon times was changed to Bederick-gueord, or Bederick's Court. In the early days of the introduction of Christianity, King Sigebert built a religious house here; but when King Edmund was killed by the Danes and translated here, and a large church built in honour of him, it began to be called St. Edmundsbury—and, for

THE MAYOR OF BURY ST. EDMUNDS
MR. T. SHILLITOE.

shortness, Bury. Canute built the church anew, enriched it, brought in the monks and their abbot, whence it became an established monastery. The history of the monastery till the dissolution is the history of the town. As one would

MR. CHARLES OLIVER, CHAIRMAN OF ELECTRIC LIGHTING COMMITTEE.

accordingly expect, there are numberless relics of this old monastery, illustrations of some of which we give herewith. The history and legends connected with the founding of this monastery, and with St. Edmund himself, are numerous and of great interest to the antiquarian. The story goes that when he was killed by the invaders of England, his head was cut off by them, and that his people only succeeded in finding the head again through the assistance of a wolf.

The position of Bury St. Edmunds leaves nothing to be desired. As Leland says: "A city more neatly seated, the sun never saw, it hangs so curiously upon a gentle descent, with a little river upon the east side; nor a monastery more great and stately, whether one consider the endowments, largeness, or unparalleled magnificence. One might even think the monastery itself were a city, so many gates has it (some whereof are of brass), so many towers, and a church than which nothing can be more magnificent; as appendages to which there are three more, of admirable beauty and workmanship, in the same churchyard."

At the present time the population of Bury St. Edmunds is about 18,000. The business of the town is almost entirely connected with the agricultural interests of the district in which it stands, together with certain brewing establish-

MR. FRANCIS HASTINGS MEDHURST, THE CONSULTING ELECTRICAL ENGINEER.

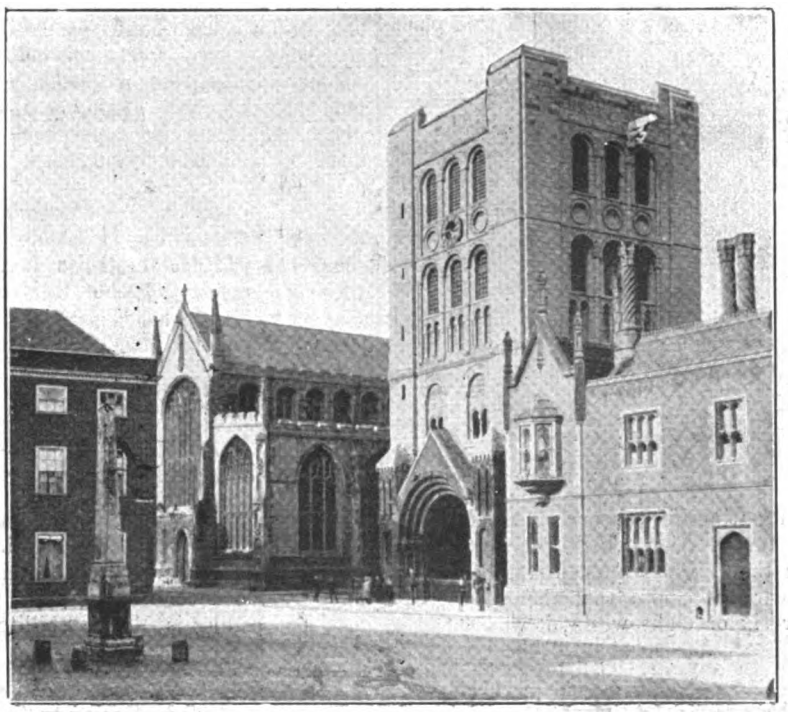
ments and one large agricultural engineering works in the town, where about 400 hands are employed. In consequence of the great age of the various buildings, the jerry wireman will not find things so easy as he would like in the town; thus, we are informed that it is no unusual thing to find that the floor of the room has been raised by additional oak floors, and the unhappy contractor often finds that three thicknesses of solid oak floorboards, not to mention joists, intervene between the floor of one room and the ceiling of

MR. A. H. ROE, BOROUGH ELECTRICAL ENGINEER.

Digitized by Google

the other. Although the population has not been greatly on the increase during recent years, the town is a prosperous one, and is, we believe, noted for the healthiness of the inhabitants. This healthiness also, as is not unusual in small towns, is evidenced by a combative nature, in consequence of which the electric lighting has been seriously delayed. The

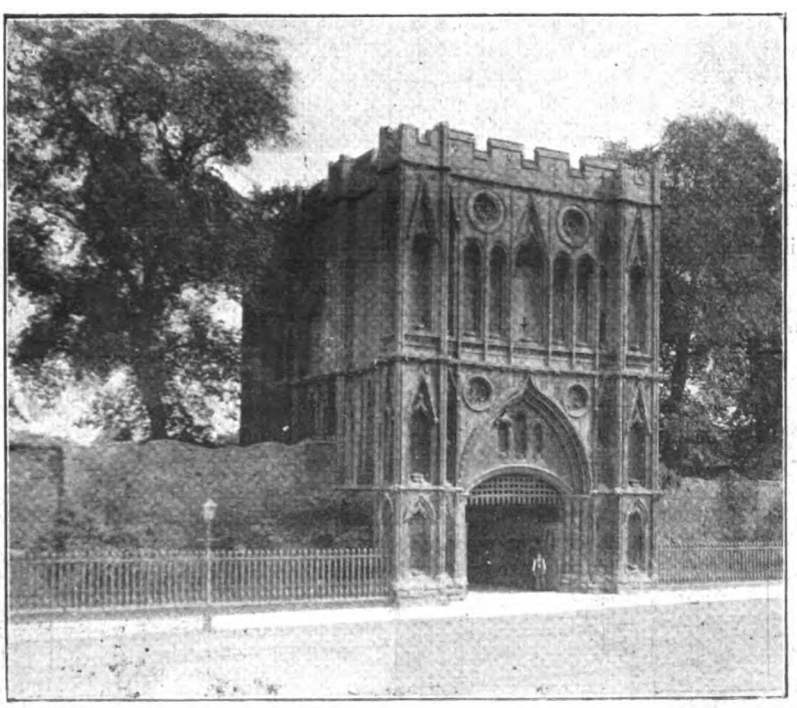
but a brief reference to one of the most curious reasons for the delay will be of interest. In years past the gas company at Bury St. Edmunds were not in the prosperous condition which they enjoy at the present time, and the question even arose as to whether they might not suspend operations, and by so doing put the public streets in darkness. In order



THE NORMAN TOWER.

Council, however, are to be congratulated on the sound policy adopted, by which they are now in possession of an electric lighting undertaking which bids fair to be not only a boon to the town, but also a good financial success. It it noteworthy that the surrounding towns of Cambridge, Newmarket, and Norwich have allowed their electric lighting arrangements to get into the hands of companies.

that this should not be the case, the Corporation were advised to advance to the gas company £2,000 free of interest on the consideration that the then existing gas lamps were always lighted by the gas company at cost price. The other curious provision in connection with this loan was that it could only be returned on the joint consent of both the gas company and the Corporation. We believe that the wording



THE ABBEY GATE.

The supporters of the municipal electric lighting, amongst whom the present chairman of the Electric Lighting Committee, Councillor C. Oliver, is one of the foremost, have had a very hard fight in order to carry their views as to the best course to be adopted in the town. Now that they have been successful it is not well to rake up old sores,

of the agreement also was rather vague and indeterminate, so that the exact meaning of the term "existing gas lamps" even could not be absolutely fixed. It seems, however, to have been assumed that if the Corporation put down an electric lighting plant and lit the streets themselves, the gas company would have to return the loan, as the gas lamps in

Digitized by Google

question would not be used. Apart from this, there were many townsmen who used the whole weight of their influence against the municipal electric lighting scheme. The outcome of the whole matter was that Mr. F. Hastings Medhurst had his report adopted, and on the enquiry by the Local Government Board succeeded in getting his scheme carried through with the exception of that portion which dealt with the street lighting. Seeing that Mr. Medhurst first reported in the beginning of the year 1896, and that the station has only been supplying for six or eight weeks, it will be seen that the obstructionists have been successful in retarding very considerably the introduction of the electric light to Bury St. Edmunds. Still, all is well that ends well, and we are sure that the townspeople will find that even if they are gas shareholders, their interests have been well served in the success of the efforts of the Electric Lighting Committee and their consulting electrical engineer.

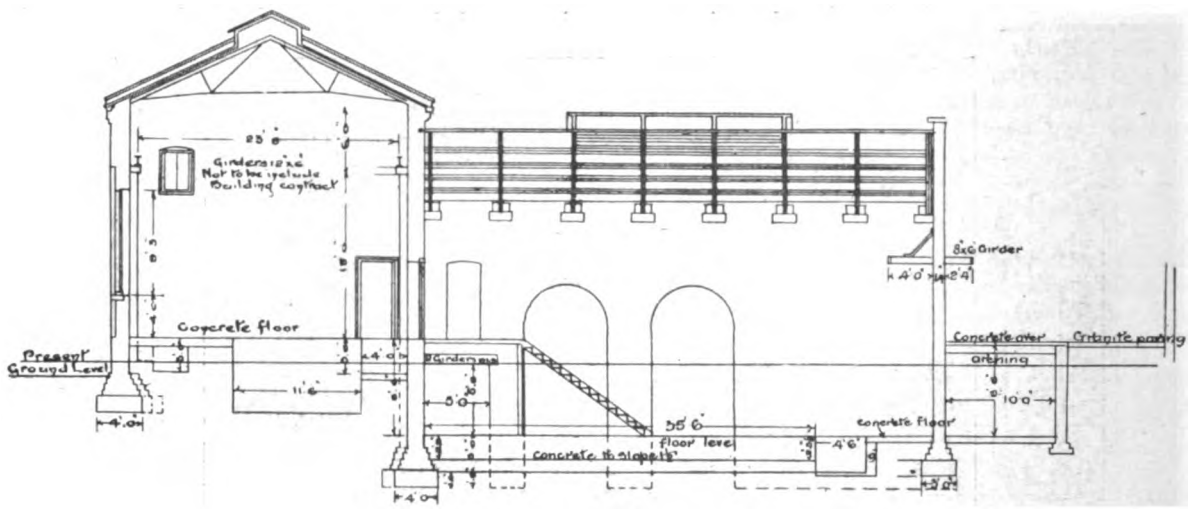


FIG. 1.—Section of the Electricity Works Buildings.

The present composition of the Electric Lighting Committee is as follows: Councillor C. Oliver (chairman), Alderman E. W. Lake, Councillor John G. Oliver, Councillor J. Gough, Councillor W. Jaggard, Councillor T. Shillitoe (mayor), Councillor E. E. Hunter, Councillor W. D. Paine. Of these gentlemen, Mr. Charles Oliver, the chairman, has occupied that position for two years, and much of the success of the undertaking is due to his exertions. He was the first to introduce electricity into the town, having put down a gas-driven plant in 1895 at his business premises. The Corporation is fortunate in obtaining the services of a chairman for the Electric Light Committee who has made a special study of electrical matters. The Mayor, who for the year just ending is Mr. T. Shillitoe, was elected a member of the Council in 1892, taking the seat rendered vacant by the death of his father, who represented the same ward for several years. The Mayor by business, trading under the title of Messrs. Shillitoe and Son, is a contractor, and has carried out many very important public and other works,

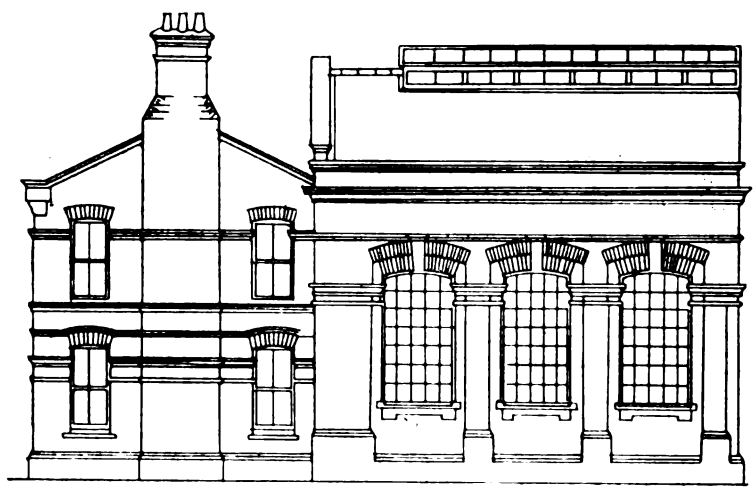


FIG. 2.—Front Elevation.

FIG. 3.—Side Elevation.

amongst which are the first block of the new Admiralty Offices, the National Portrait Gallery, the new head offices of the Metropolitan Asylums Board, the Grand Hotel at Clacton, and is still engaged on the Westminster Cathedral and the West Ham Infirmary. With all this work he has not missed a meeting of the Council, and has attended most of

Digitized by Google

the various committee meetings, and his practical common sense has been of great value to the Electric Lighting Committee in carrying out their work.

When it was decided to erect the works, the question of the most suitable site was naturally one of the first consi-

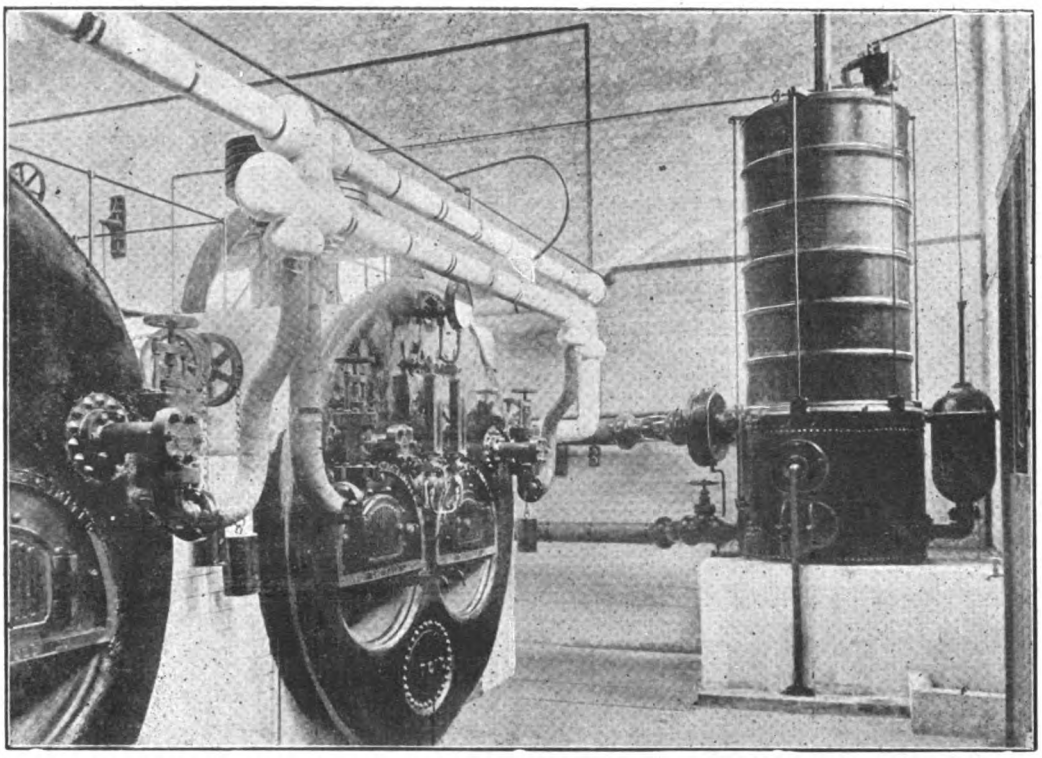


FIG. 4.—View of the Boiler Fronts and Feed Heater.

derations to which Mr. Medhurst had to give his attention. After considering the relative advantages of land to be had in various parts of the town, it was decided that it would be best to establish the works on a large piece of Corporation land at the back of the markets. A portion of this land was already occupied by the buildings of the Corporation waterworks department, and the electricity station has been erected next to these. The site is very central, and consequently the length of feeders is very small, the only drawback to the site being that all coal has to be carted from the railway station, a distance of three-quarters of a mile. Ample room is available for extensions, and temporary ends have been left on both the boiler-house and engine-room for this purpose.

The close proximity of the waterworks to the electricity works is of advantage, and it goes without saying that the Corporation are using the electric light at the present time in their other departments on the same site. It is also likely that in the near future the pumps in connection with the waterworks will be partly driven by electric motors, so that it will not be necessary to keep two sets of boilers under steam in the daytime. The buildings which are now erected on this site were designed by Mr. Medhurst, and are shown in section in Fig. 1, while Figs. 2 and 3 give elevations and sections of the same, from which some idea of the type of building can be obtained. The engineer's office, test room, and accumulator room are placed on the first floor, and in

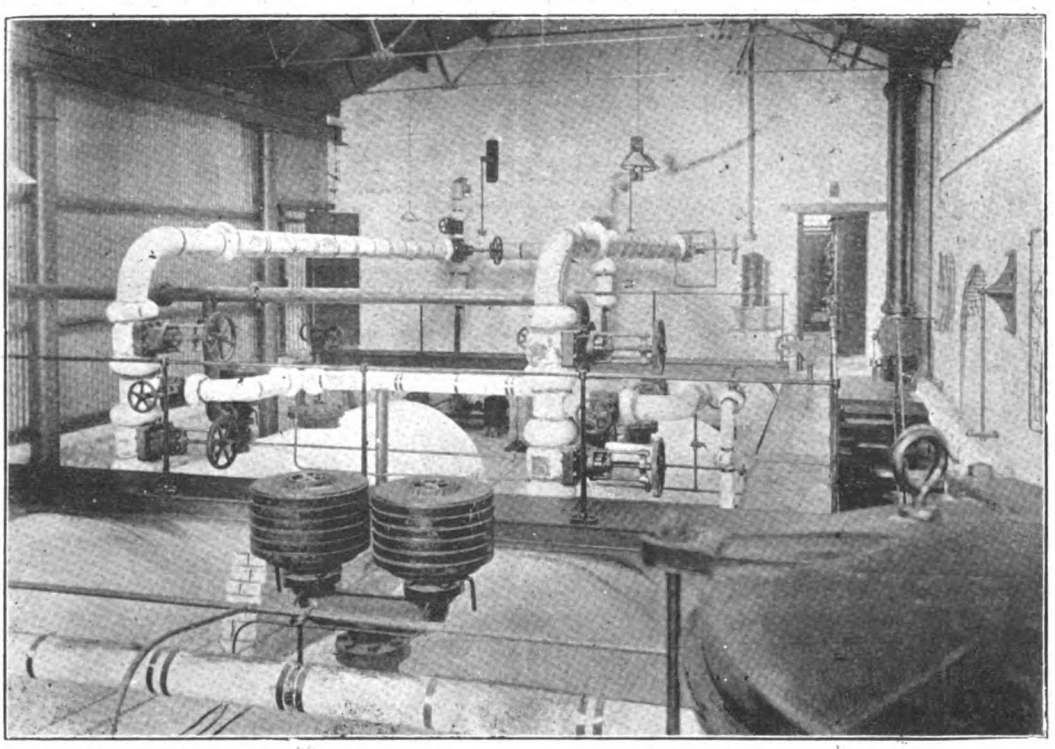


FIG. 5.—The Boiler Tops, showing arrangement of Steam Pipes and Platforms.

Digitized by Google

this way the ground space covered has been saved. The engine and boiler house are provided with temporary ends for ease in extension, and we think from the load already obtained in Bury St. Edmunds that it will be necessary in the near future, probably next year, to extend the building in order to provide room for more machinery.

The Steam-Raising Plant.

The most striking feature about the arrangement of these buildings, and one which cannot be too highly recommended, is the arrangement of the boilers. It will be seen from the drawing that a large excavation was made to receive these boilers, so that they are at a much lower level than the engine-house. The advantages are twofold. Perhaps the greatest is that the coal which is brought in carts to the station can be thrown directly down into the bunkers situated at the back of the firing floor. These bunkers hold a very considerable quantity of coal, which is readily accessible to the firemen, and there is no question of raising coal until it is actually to be thrown into the furnace by the firemen. In Fig. 4 a view is given of the firing floor, the bunker doors being at the extreme right hand of the picture, while the feed-water heater is seen directly in front. The actual cross-section of the coal bunker is 8ft. 6in. high by 10ft. wide. Another advantage of sinking the boilers is that the platform over the same is at exactly the same level as the floor of the engine-room. This platform can be seen in Fig. 5, which was taken from a doorway just above the feed heater. The open door seen at the end of the platform leads direct into the engine-room. It will be seen from these illustrations that all the valves in the steam-pipe range are accessible from this platform, and that they can be quickly got at by the engine attendant in case of need. The iron stairs seen just over the feed heater lead down to the firing floor.

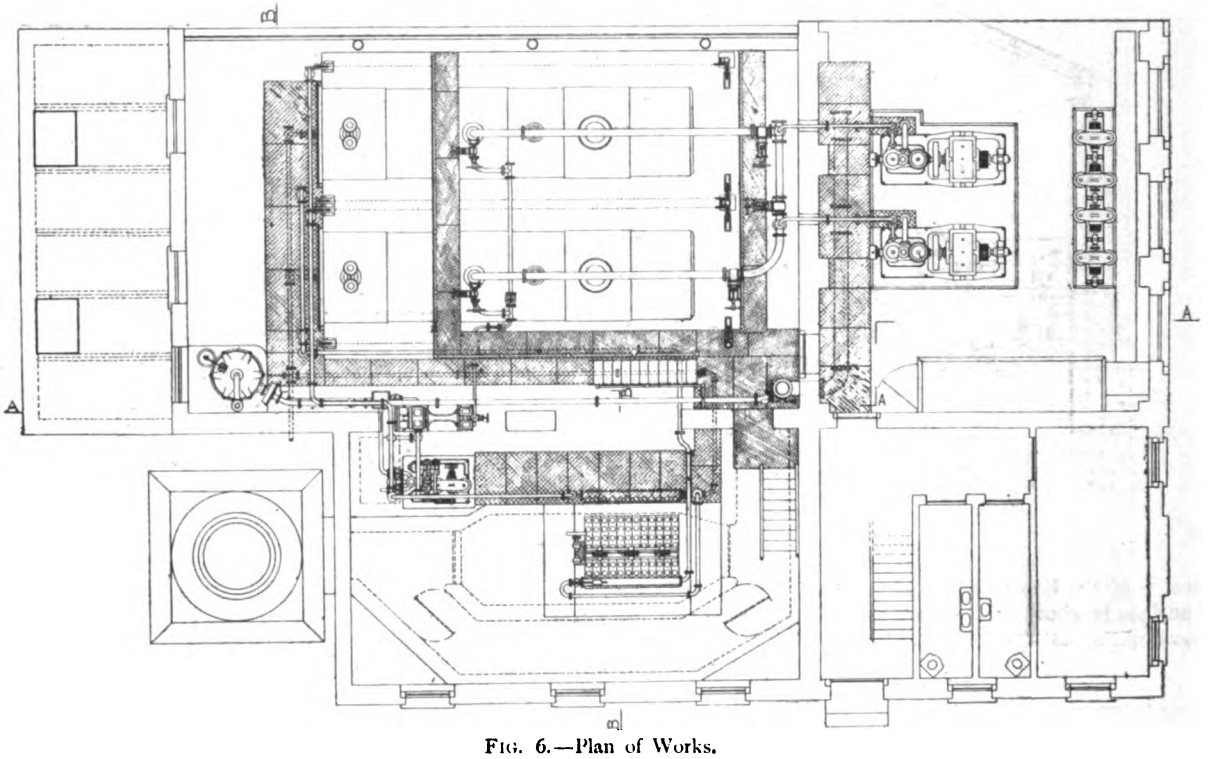


Fig. 6.—Plan of Works.

There are at present two boilers fixed, each 28ft. long by 7ft. in diameter. These are supplied by Messrs. Davy Bros., of Sheffield, and are designed to work at a boiler pressure of 150lb. per square inch. They have each two flues 2ft. 9in. in diameter. The whole of the material used in the construction of these boilers is Siemens-Martin's steel. The boiler mountings supplied can be seen in Fig. 5, from which it will be gathered that there are the usual number. They are practically all of Hopkinson's make. The position of these boilers in the main building can be seen from Figs. 6, 7, and 8. Fig. 6 gives a plan of the whole

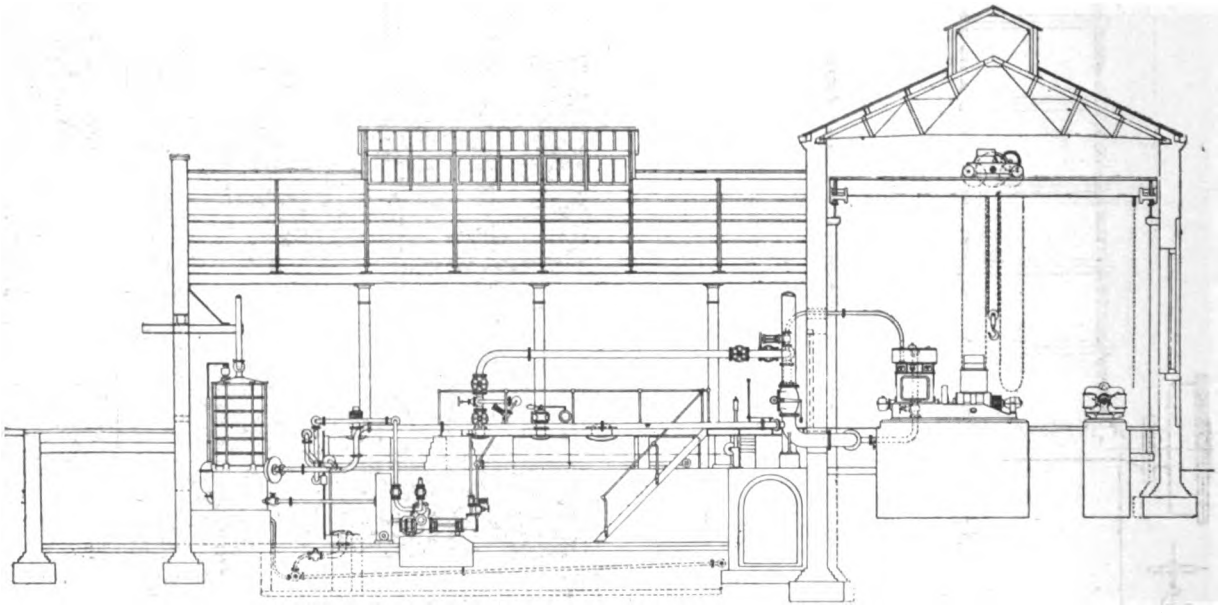


Fig. 7.—Sectional Elevation through the Works.

Digitized by Google

works, Fig. 7 is an elevation which shows a section through the station, and Fig. 8 is a front elevation and section in order to show the boiler fronts and the economiser. This

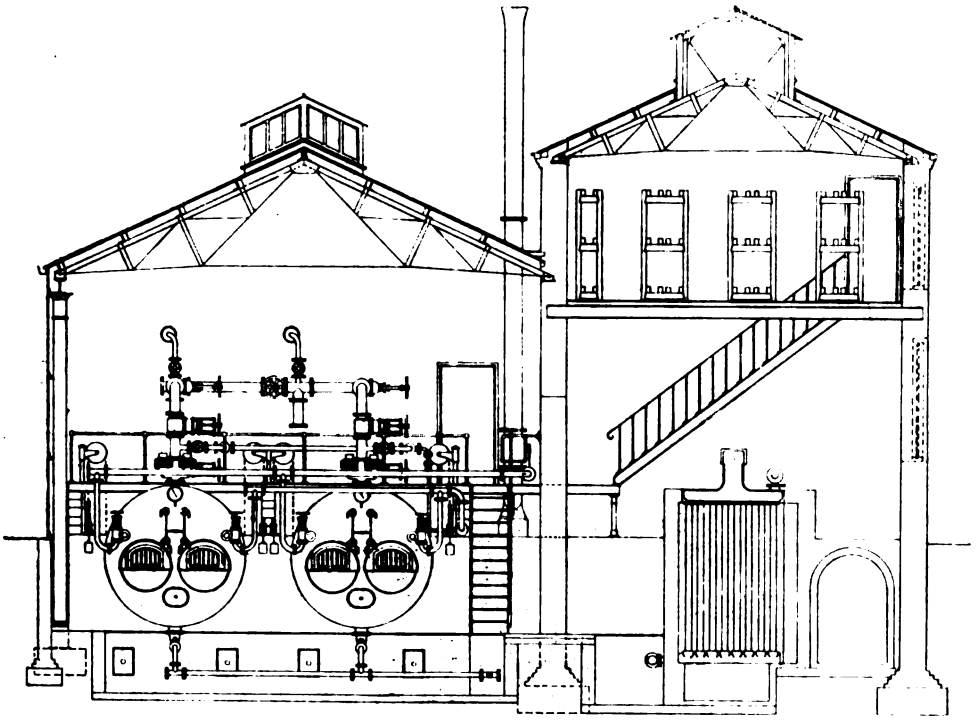


FIG. 8.—Boilers and Economiser.

economiser is of the Green type, and contains 96 tubes. The heating surface is about 720 square feet. The construction of the economiser is specially adapted for working at high

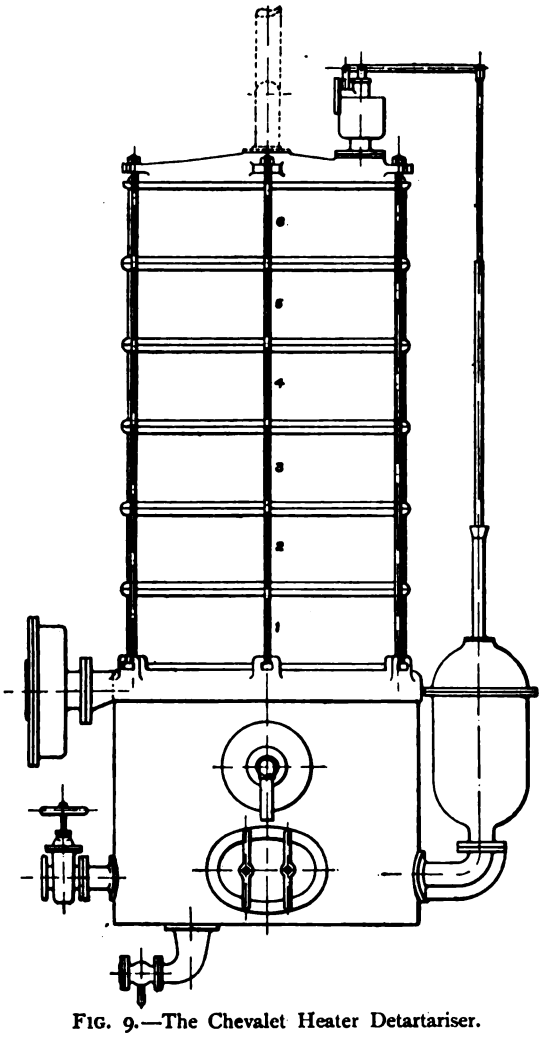


FIG. 9.—The Chevalet Heater Detartariser.

pressures. The economiser is fitted with internal lids on the top boxes, and also with patent access pipes at the bottom to facilitate the cleaning out.

The steam and exhaust pipes were all supplied by Messrs. J. Fowler and Co., of Leeds, who are to be congratulated on the high character of the work carried out. The branches to each boiler from each steam-pipe, as well as the steam-pipes themselves, are 6in. diameter. The connections from the engines to the main steam-pipe are 3in. diameter. The exhaust is of cast iron, 12in. in diameter, having an automatic relief valve to atmosphere, with a branch to the

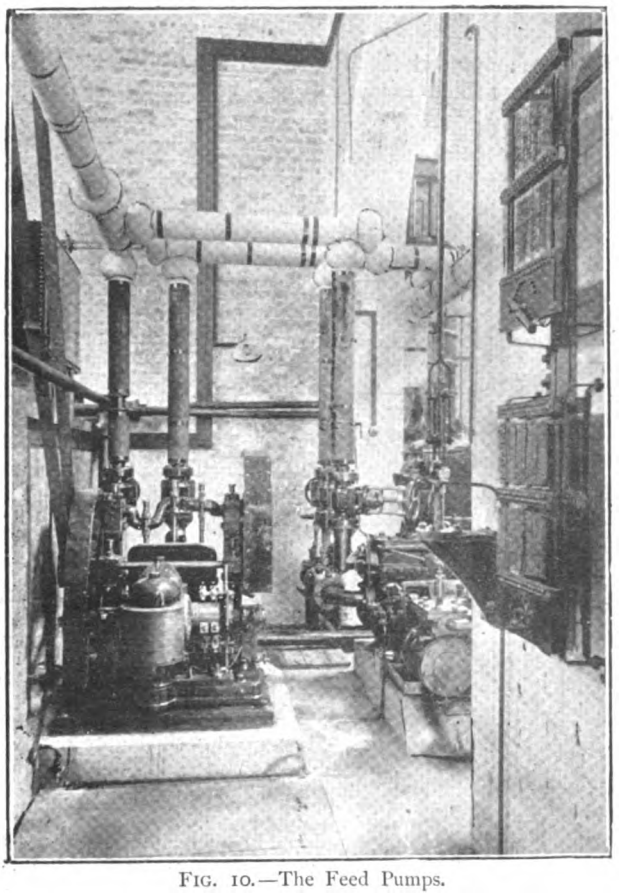


FIG. 10.—The Feed Pumps.

heater. This heater, which is of the Boby type, is well seen in Fig. 4, but is shown more in detail in Fig. 9. The name of the apparatus is the Chevalet heater detartariser. This consists of a series of trays placed one above the other, through which the water trickles. The outlet from one tray to another is by means of a tube covered over by a

Digitized by Google

movable cap of larger diameter. The water-level thus gives a slight seal. The exhaust steam from the engines is admitted into the lower tray and mixes with the water as it ascends through these various tubes and under the edges of the inverted caps. In this way the water is heated up to the boiling point, and the hard matter which would have been deposited in the boilers is thrown down in the trays. Owing to it not being subjected to any high temperature, as is the case when the heat passes through it in a boiler to get to the water, this deposit is not difficult to remove from the heater, as it is quite soft. The heater in question is capable of delivering 540 gallons of water per hour heated up to boiling point. The feed pumps are in duplicate, as can be seen in Fig. 10. The one consists of an electrically-driven feed pump, the motor of which also drives the scrapers of the economiser. This electrical feed pump is able to deliver 1,000 gallons of water per hour against the boiler pressure. The duplex steam-pump, also seen in the illustration, is able to deliver 2,500 gallons per hour. The whole of the steam-pipes, the exhaust pipe in the engine-room, feed pipes, the boilers and boiler fronts, have been most carefully covered with non-conducting material to prevent loss of heat, the covering used being of the magnesia type. It was found that until the boiler fronts were covered the temperature of the stokehole was excessive, owing to there being no through draught.

The Engine-Room.

The engine-room is 25ft. broad by 35ft. long, and, as we mentioned above, we think that the length will have to be extended in the near future. The whole of the plant contained in this engine-room was supplied and erected by Messrs. J. Fowler and Co., of Leeds. As will be seen from the plan, and also from the photograph, Fig. 11, the switch-boards occupy one end of this engine-room. The balancing and boosting dynamos are placed near the window at the left hand in the illustration, while the two steam dynamos are on the right-hand side. These machines are each of 60 kw. capacity. The engines were made by Messrs. Belliss and Morcom, and are of the usual high-speed type manufactured by that firm. One of these engines is shown in end and side elevation in Figs. 12 and 13. The dynamos coupled to these engines were made by Messrs. J. Fowler and Co., and are each capable of giving 130 amperes at 460 volts. The normal speed of the sets is 500 revolutions per minute. They can provide an emergency load of 66 kw. for two con-

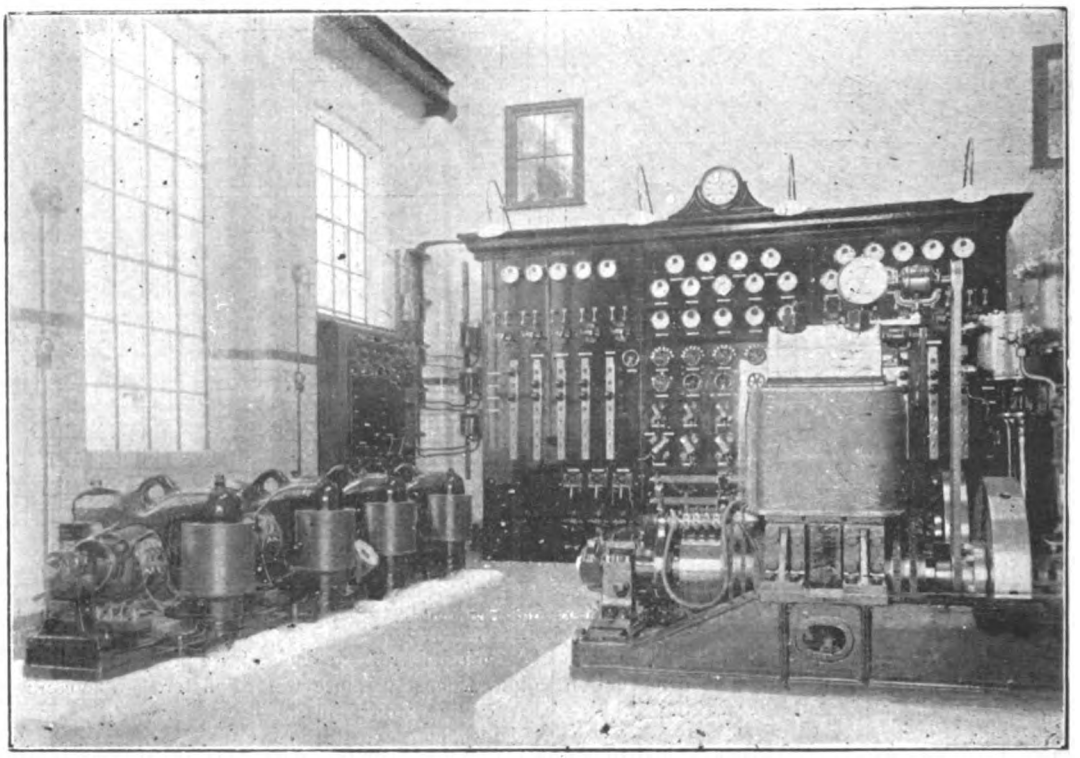


Fig. 11.—View in the Engine-Room at Bury St. Edmunds.

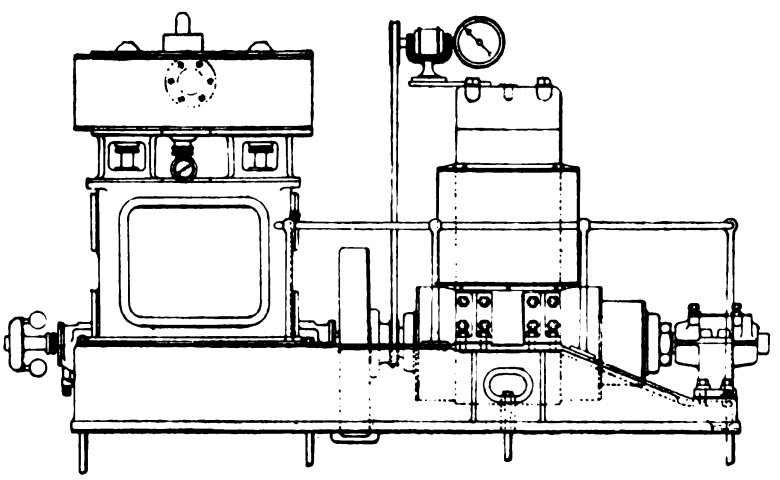


Fig. 12.—The Belliss-Fowler Steam Dynamo.

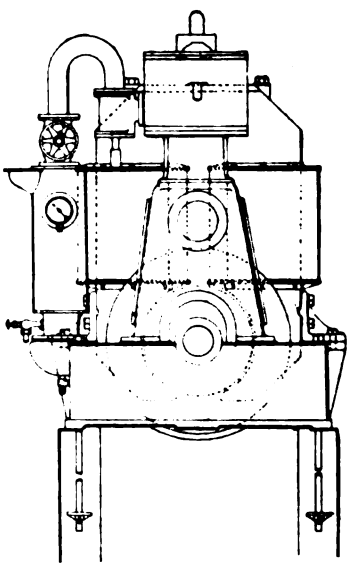


Fig. 13.

Digitized by Google

secutive hours with 10 per cent. extra steam pressure. The balancing and boosting dynamos are, as is usually the case, connected on a continuous shaft, the two balancing machines for the three-wire network being in the middle and one booster at each end. Each of these boosters is capable of giving 100 volts when taking the charging current of the battery. A good view of the two steam dynamos is shown in Fig 14.

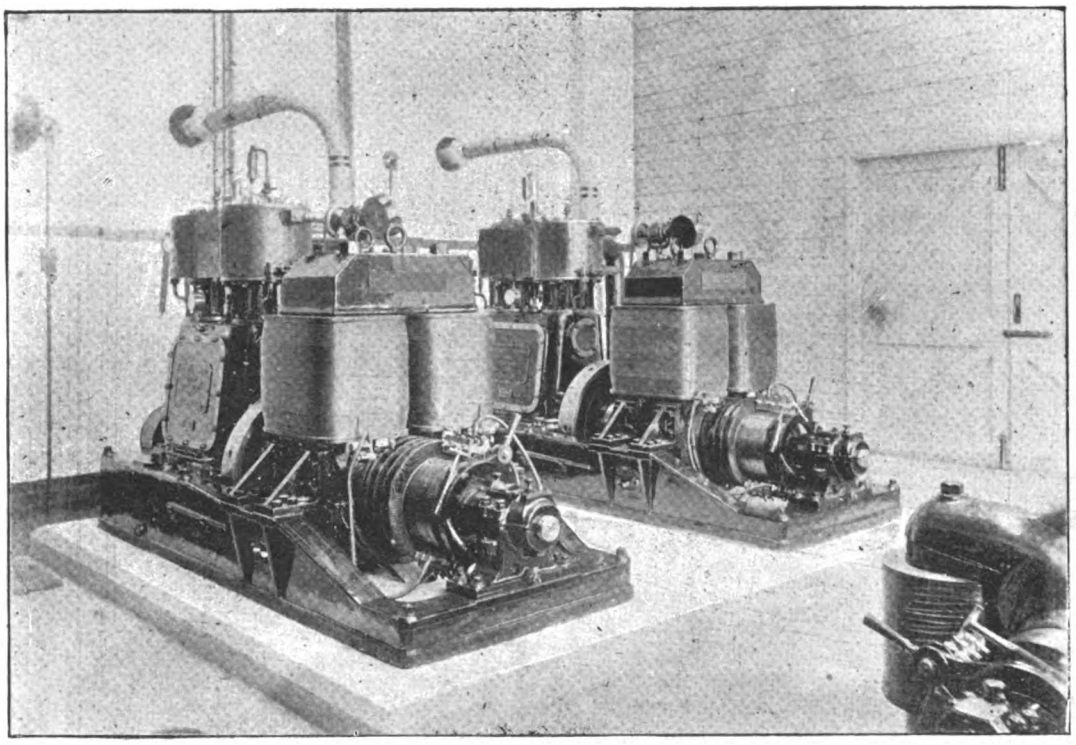


FIG. 14.—View of the Two Steam Dynamos.

THE SWITCHBOARD.

The switchboard is of the plug type, and is of larger and handsomer design than is usual for a station of this size. It consists of three panels, the centre one containing the regulators, instruments, and switches for the balancers, boosters, and battery, the other two arranged as positive and negative, containing the feeder and dynamo bars, instruments, and switches. There is also a switchboard on the left-hand side of the main board, which deals with the station circuits and with the supply of other departments on the same site. The diagram of connections used with the switchboard is shown in Fig. 15, while Fig. 16 is from a photograph taken behind the switchboard. Mr. A. H. Roe, the resident engineer, has arranged his mains at the back of the switchboard in a very neat way in order that there may be a free floor space. With this end the floor is made hollow and bridged over with York stones, which can be easily lifted by means of handles. These handles are of the usual T section, and are arranged to slip back into a recess in the stone when they are not being used. It will be seen from the last illustration that certain of the regulating switches are not mounted on the board itself, but on the wall at the back. In this case the spindle of the switch handle is carried right to this back wall, as can be seen in the photograph.

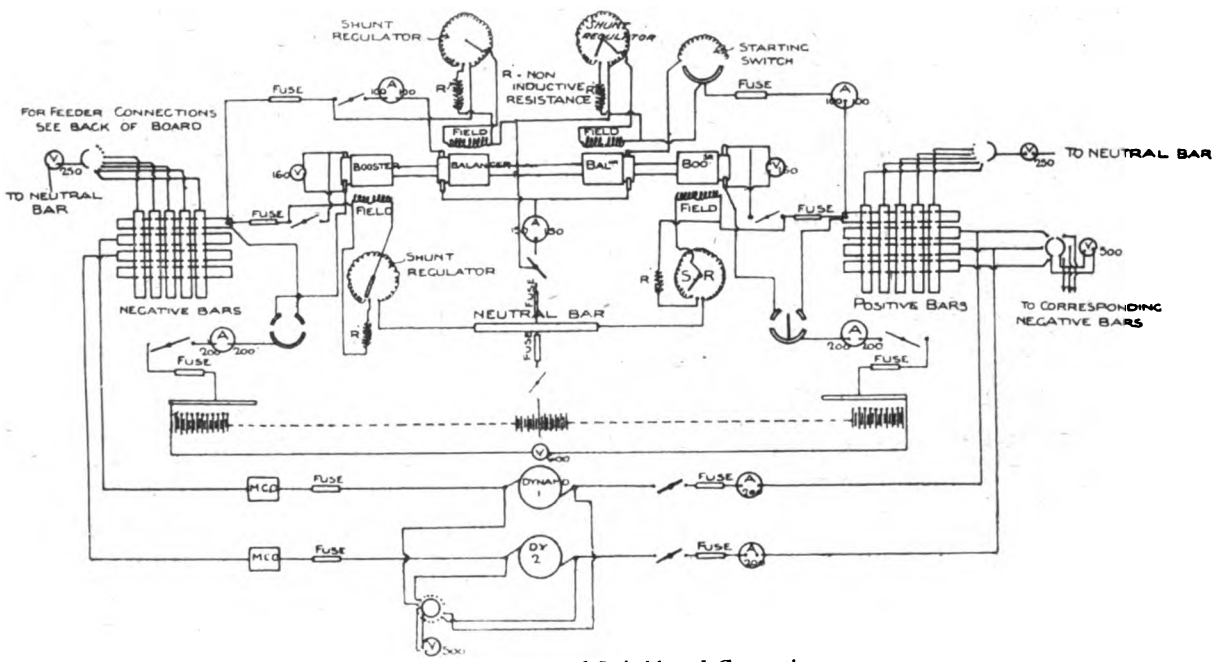


FIG. 15.—Diagram of Switchboard Connections.

ACCUMULATORS.

The accumulators are placed, as mentioned above, on the first floor, in a room 32ft. long by 92ft. broad. The cells were supplied by the Electrical Power Storage Company, and 252 have been fixed. They are placed in double three-tier stands, the stands being of cast iron, with wooden bearers

Digitized by Google

for the cells. The guaranteed discharge rate of the battery is 500 ampere-hours when discharging over 10 hours.

MAINS.

The contract for the mains was placed with Messrs. Callender and Co., who have laid everywhere triple concentric armoured cable, placed direct in the ground. Fig. 17 shows a plan of these mains; the circles in this illustration denoting feeder boxes, while the stars are the arc lamps which are about to be erected as the first instalment. These will be run eight in series off the two outside wires. Up to the present three feeders have been laid, with a collective length of about 3,000 yards. These feed into the network at Brentgovel-street, Angel-hill, and Westgate-street, the two latter having a sectional area of ·2 for the outers and ·1 for the middle, and the former a sectional area of ·1 for the outers and ·05 for the middle. From the feeding points three-core $^{7}/_{20}$ pilot cables are led back to the station. The distributors laid up to the present time have a total length of about 5,000 yards, and the sectional area of these cables is ·125 for the outers and ·06 for the middle conductor.

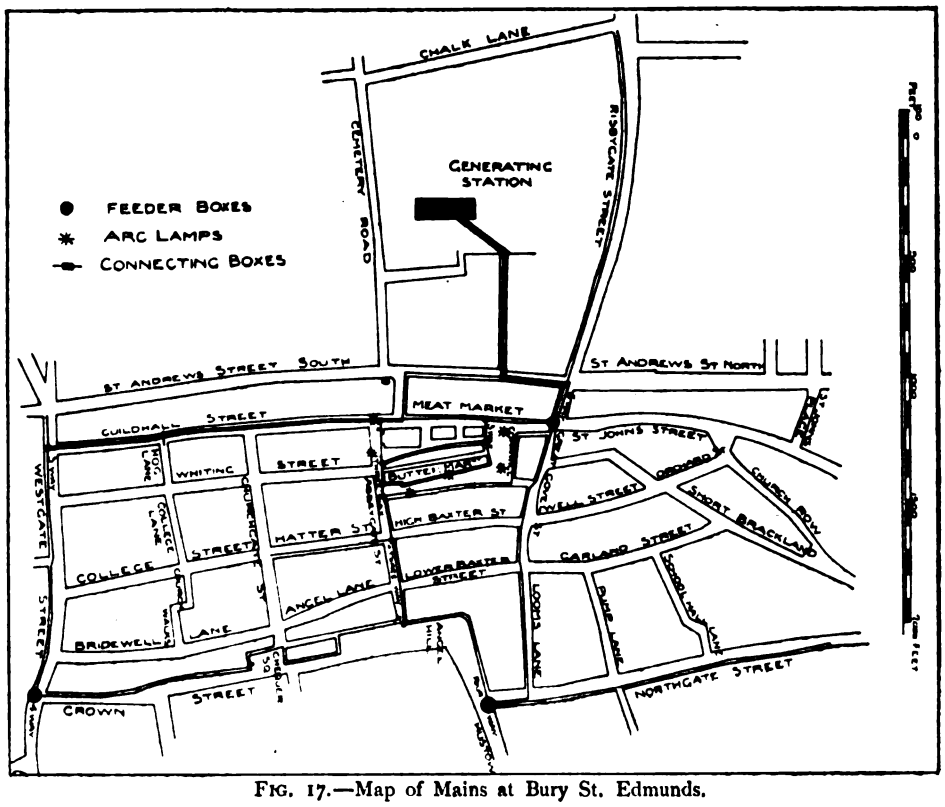


FIG. 17.—Map of Mains at Bury St. Edmunds.

Fourteen feeder and disconnecting boxes are placed in convenient positions, and three fuse boxes have also been put in with a view that in the event of a breakdown on the mains only one-third of the town would be affected. As before mentioned, a very comprehensive scheme was prepared for removing the whole of the gas lamps used for lighting the streets and substituting arc lighting, but this was cut out of the scheme by the Local Government Board owing

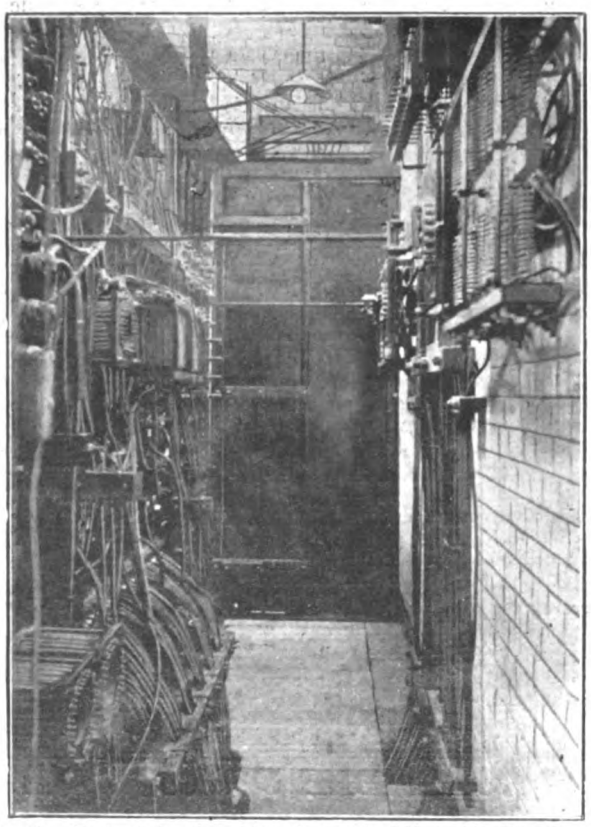


FIG. 16.—Back of the Switchboard, showing Moveable Flagstones.

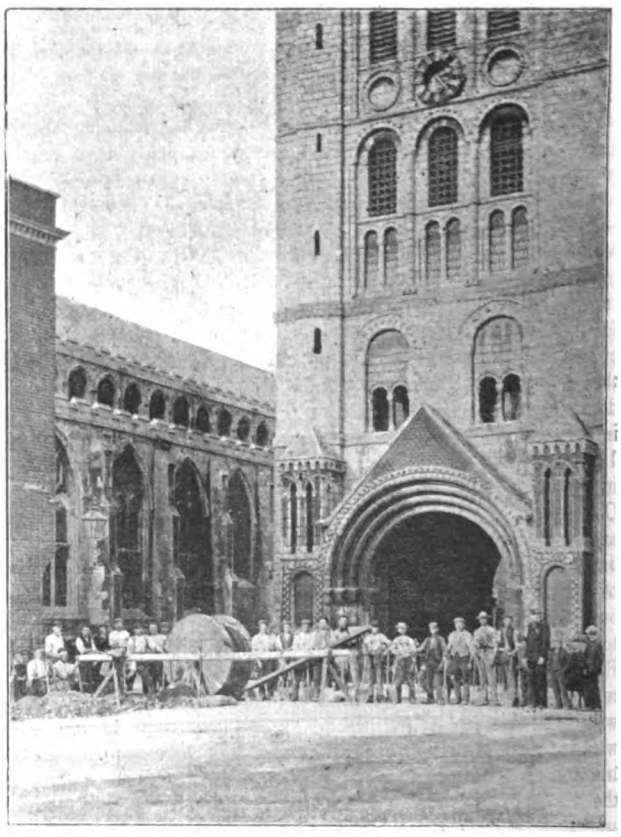


FIG. 18.—Main-Laying near the Old Tower.

Digitized by Google

to the very strong opposition offered to the whole scheme at the enquiry, the Local Government Board deciding that the private lighting should be undertaken first. Fig. 18 shows a view of these mains being laid.

Supply.

Owing to the delay on the part of the contractors supplying the battery, the Corporation have been enabled to give only a temporary supply (commenced on the 28th of August) up to the present time. This has so far given excellent results. Now that the battery is completed, a continuous supply will soon be available. The total number of lights connected up to the present are equivalent to 1,950 8-c.p. lamps, and upwards to the equivalent of another 1,000 8-c.p. lamps will soon be added. The applications for a supply still come in very steadily, and there is little doubt that the financial position of the undertaking will soon reach a satisfactory state. The gas supply is in the hands of a local company, and as the price charged is 4s. per 1,000 cubic feet, the new illuminant at a charge of 6d. per unit competes on most favourable terms. Owing to the opposition when the scheme was mooted, none of the streets are lighted electrically. The Local Government Board, have, however, recently sanctioned the use of £800 for this purpose. Eight 10-ampere arcs are to be placed in the centre of the town, and 20 incandescent pillars in Risbygate and St. Andrew's streets. The total capital outlay up to the present is £15,000, and comes within the original estimate.

Workmen's Cottages.

At the present time workmen's cottages are almost unobtainable in the town, and with a view to overcome this difficulty, Mr. Roe advised the Council to build two cottages next to the works. This idea is now being carried out, and the cottages will be occupied by two of the staff at the works. This arrangement offers many advantages, as not only do the occupants of the cottages obtain comfortable quarters in the most healthy part of the town, but the electricity department have the advantage of having some of the staff always on the spot—a great consideration where the staff is necessarily small and the buildings have to be left unattended for a considerable length of time.

The Engineers.

As mentioned above, Mr. F. Hastings Medhurst has designed and superintended the carrying out of the whole of the work from the buildings to the mains, and the town is to be congratulated on the result. The contractors have also done their best, and have loyally stood by their contract pledges. Mr. Bennett has acted as clerk of works for Mr. Medhurst. The principal contractors, Messrs. Fowler and Co., of Leeds, have been represented on the spot by Messrs. Anson and Moore, while Mr. S. B. Collard superintended the main laying for Messrs. Callender and Co. When the work was nearing completion, applications were invited for the post of assistant engineer. Out of a large number of applicants the committee selected Mr. Arthur H. Roe, and they are to be commended for their choice, as he has already done much to increase the popularity of the electric light in Bury St Edmunds. His past experience, extending over 11 years, is as follows: After serving an apprenticeship in London, Mr. Roe entered the service of the P. and O. Steam Navigation Company as a sea-going electrical engineer, and in this way visited India, China, and Japan. He finally had charge of the electrical equipment of the hospital ship "Coromandel," when that vessel took out Prince Henry of Battenberg on his ill fated expedition to Ashanti. Mr. Roe then transferred his services to the Bradford Corporation, and during the three years he remained the electric lighting undertaking made great headway, the system of supply being changed over to the three-wire, a new generating station erected and equipped, electric traction introduced, and many improvements effected. At the time of his resignation he occupied the post of chief assistant electrical engineer. He was appointed to his present post in January of this year.

In conclusion, we have to thank Mr. Medhurst for the drawings from which our illustrations are prepared, and both him and Mr. Roe for their kindness in placing all available information at our disposal. The portraits reproduced were taken by Mr. J. Palmer Clarke, of Bury St. Edmunds.

THE ELECTRICAL ENGINEERS (R.E.) VOLUNTEERS.

We have received from the officer commanding the Electrical Engineers (R E.) Volunteers extracts from a letter sent by Captain Lloyd, R E, who commands the section of the corps which is now in South Africa, to Major Crompton. From this we gather that Captain Lloyd himself has been appointed deputy-assistant adjutant-general for transport, in addition to his duties with the Electrical Engineers. There is also good evidence in the letter that the corps has not been kept idle, but is being used in many ways in which the ordinary soldier could not be. Thus Sergeant Phillips, Corporal Hossack, Quartermaster-Sergeant Wordmore, R G.A., and three civilian engine-drivers have lately been employed in bringing up from Koomati Poort some of the rolling-stock, of which a large quantity was taken at that place. The lighting apparatus which was taken out has also been well used. Captain Leaf with a detachment, including Sergeant Graham, Corporal Sellon, and Lance-Corporals Peart and Levin, has also gone to Koomati Poort with No. 2 engine and search-light apparatus in order to enable nightwork to be carried on and to bring up captured rolling-stock. Other members of the corps have been employed bringing captured dynamos, engines, and boilers from Waterval. Apart from these special duties, Sergeant Phillips, Corporals Hossack and Hodgson, and Sapper Young have been regularly employed on traction work in connection with eight civilian drivers belonging to the Steam Transport. Corporal Sellon, who has been ill in hospital, has, we are glad to state, regained his health, and is now at work in Pretoria. Mr. D. F. Colson, who was amongst the prisoners captured and liberated some time since, and who was connected with the gas and electric lighting undertaking at Leicester, had blood-poisoning and was invalided home. He is now coming home on the "Nubia," which will probably reach England early this month. We are sorry that such an unfortunate incident should have stopped the good work which Mr. Colson appears to have done in South Africa, and we trust that it will not be long before he throws off all traces of his recent illness. It is interesting to note that Captain Lloyd states that the probable date of the departure of the E E R.E V. from South Africa is Nov. 4. Although, of course, no such reception as was given to the C.I.V. could be given to their electrical comrades, we are quite sure that on their arrival in England the members of the electrical profession will extend to them the heartiest welcome in their power.

MANCHESTER ELECTRICITY COMMITTEE.

The Manchester Corporation is now considering a series of allegations brought against the Electricity Committee, and especially against its chairman, by Mr. S. Norbury Williams, one of the elective auditors of the city. These charges appeared in the last week's issue of the *Manchester City News* for last Saturday. They were replied to by Alderman Lloyd Higginbottom at the Council meeting on Wednesday, and a small committee has been appointed to consider the charges as far as they affected Alderman Higginbottom. This committee is to report to a special meeting on Monday next. This promptness is due to the fact that Alderman Higginbottom is the Lord Mayor-Elect of the city of Manchester.

Mr. Norbury Williams's address is somewhat condensed by us owing to its great length, and to the fact that certain clauses affecting the committee as a whole will come up for discussion by the Council at a later date than others. The address is addressed to the ratepayers, and the paragraphs are numbered consecutively. Mr. Williams begins thus:

1. For the eighth time you have elected me to the office of elective auditor for this city, and I beg sincerely to thank you for the confidence you have uninterruptedly reposed in me in these past years. The office is perhaps one of the most responsible, as it is one of the most trying, which devolves upon any man whom you send to represent you in the town hall. This city, which we all love, and for whose good name and pure government we are all so solicitous, now embraces a population of about 550,000 persons, and the turnover in the city treasurer's office during the past year amounted to nearly £8,000,000 sterling. The city is a little kingdom in itself, and one feels it a great honour to represent, in any capacity, so great and so progressive a community.

Digitized by Google

2. When I took office I signed, in the presence of the Lord Mayor, the following declaration: "I, having been elected elective auditor for the city of Manchester, hereby declare that I take the said office upon myself, and will duly and faithfully fulfil the duties thereof, *according to the best of my judgment and ability*." These words have had a great meaning for me, for it is often a most unpleasant and disagreeable task to have to speak out plainly on matters which affect the city's interests, and which sometimes affect also individual members of the City Council. I feel it my bounden duty to report to you now—to you who find all the money which keeps the municipal machine going—upon a matter which concerns one of the committees of the Council, and particularly one of the members of that committee. The news that I had this intention got wind in the town hall, and you would be surprised, if I felt in a position to give the details, at the number and the influence of the members of your Council who have approached me or sent messages to me, with a view to induce me to keep silence, and to abandon my intention of informing you of the facts which I am about to lay before you for your information and for your immediate consideration and prompt action.

3. It is astonishing how the members of your Council cling together for mutual defence, and what great efforts they make to keep from the ratepayers anything which tends to show any weakness or wastefulness in their administration. I have been asked "to consider our good name," "don't make us a laughing stock again," "don't help outsiders to charge us with corruption," and so on, *ad nauseam*. But the words I have quoted in paragraph 2, that I will fulfil my duties "according to the best of my judgment and ability," are ever ringing in my ears, and I must and will be mindful of them, be the consequences what they may. The citizens have an absolute right to know all that goes on in the town hall; they have a right to follow the expenditure of the vast sums received and expended by the Council, even to the last single shilling. And I will never be a party to hushing-up or concealment, whatever may be the influences brought into play with a view to secure secrecy. No member of the Council should assent to any act of administration or to one penny of expenditure upon which the full light of day could not be at once admitted.

4. The section of the Council to which I desire to draw your attention at this moment is the Electricity Committee. This body consists at present of 17 members. Alderman Lloyd Higginbottom is its chairman, and Councillor Bowes its deputy-chairman. Its other members are the Lord Mayor (ex-officio), Messrs. Bax, Gibson, Griffin, Mainwaring, Arrandale, Batty, Bishop, Boyle, Heaketh, Jennison, Lambert, Phythian, John R. Smith, and Matthew Wells. This body was constituted in November, 1897, and then became a separate committee. Previously to that date all operations concerning the supply of electricity to the citizens were carried out through the Gas Committee. Alderman Higginbottom became a member of the Council in 1890, and was at once elected a member of the Gas Committee. In November, 1894, he became its vice-chairman, and retained that office until 1897, when, as before stated, the Electricity Committee became a separate committee. Mr. Higginbottom still remains also a member of the Gas Committee.

5. This clause deals with the great expenditure of money which the Electricity Committee have been responsible for, and which amounts to more than £756,000. It is alleged in this clause that great lengths of unremunerative cable have been laid.

6. This clause deals with the alleged bad management of the committee, which it admits is being looked into by a sub-committee, which the full committee has appointed recently. The report of this sub-committee is still to be considered by the Council.

7. In this clause Mr. Williams alleges that a considerable amount of money, in amounts ranging from £124 up to £1,106, have been spent by the committee or by the engineer without asking for any competitive tenders.

8. Then this sub-committee enquired what increases of wages or salaries had been made in the staff under the control of the electric lighting stations during the 12 months ended June 30, 1900, showing the cases where these increases had been submitted to the committee; and this wonderful discovery is now made that out of 37 men employed in various capacities at this station there have been 29 advances of salary or wages which have never been so much as mentioned to the committee, and of which the greater part of the members are in blank ignorance. Comment, again, is needless.

9. We then come to the appointments and promotions made in the electricity department during the 12 months named in previous paragraph, without the knowledge or consent of the committee. This remarkable list contains 19 names. These 19 gentlemen have all been added to the staff in a quiet unobtrusive way. Nobody knew anything about them, apparently. Not only have they been "taken on," but in 12 cases increases have been made in their salaries, and still the committee have not known a word about it all. These gentlemen include a draughtsman at £195 a year, and nearly all receive £100 a year or more. The thing reads almost like a novel. One could not have thought such a state of things possible. One of the gentlemen in this list, a Mr. John Walton, appears later on in this address, and his name should be noted.

10. In this clause it is stated that discounts have been lost by not promptly paying accounts, and one admitted instance is cited.

11. In the section certain extras to contracts are detailed, and the engineer has quoted to the effect that "a little more consideration might have prevented one or other of the extras."

12. This clause deals with the ordering of goods without tenders being invited, and contains an extract from a report to the sub-committee from Mr. Alderman Higgenbottom, in which it is stated that Mr. Wordingham had been carrying out all that was done under the old *régime* when the electrical undertaking was managed by a sub-committee of the Gas Committee. This Mr. Williams stigmatises as showing that the electricity business has been carried on in an abominably loose way from its birth.

13. In this clause reference is made to members of the Corporation being also shareholders in limited liability companies which have dealings with or supply goods to the Corporation. It seems that Mr. Norbury Williams made certain similar remarks to these concerning one of the aldermen of the Council in 1894, and that the alderman in question left the Council in consequence.

14. (*a*) S. Z. de Ferranti, Limited.—This is a company which manufactures meters and generators. Your Corporation have done a large business with them and given them continuous orders. Since May, 1893, we have paid them £27,225. Mr. S. Z. de Ferranti is also a director of the company marked (*b*).

15. (*b*) The British Insulated Wire Company, Limited.—This company was registered in April, 1897. Its works are at Prescot, and it manufactures electric cables. Large quantities of its wires are being laid under our streets at this moment. Since January, 1896, the Electricity Committee, of which Mr. Higginbottom is chairman, has bought from this company, and paid for, cable to the extent of £44,957. I ask you now to note who are its directors. The chairman is Mr. W. Marriner Brigg, who is also a director of the company marked (*c*). Another director is Mr. James B. Atherton, a brother of Mr. Jacob Atherton, who is named twice below, and is director also of company (*c*). Another director is Mr. S. Z. de Ferranti, who is also on the Board of company (*a*). The solicitors to this company are Messrs. F. J. Leslie and Co. Mr. F. J. Leslie himself is also a director of company (*c*). The London representative of this company is Mr. Jacob Atherton (brother of the director above named). Mr. Jacob is also a director of company (*c*).

16. (*c*) The British Electric Works Company, Limited.—Now we come to the third of this singular chain of companies. You will be much interested in this company, because its chairman is Alderman Lloyd Higginbottom, who is also chairman of our Electricity Committee. It was registered in April, 1899, its capital being £135,000 in £1 shares. Of these £50,000 are preference. The "Directory of Directors" for 1900 says: "Mr. L. Higginbottom, Hill Top, Cheadle Hulme, is a representative of the Manchester Corporation on the Board of the British Electric Works Company." But this is evidently a mistake, as your Corporation cannot be represented on the Board of a private company. And who are its directors? Mr. Lloyd Higginbottom (chairman Manchester Electricity Committee), chairman; Mr. Jacob Atherton, the London representative of company (*b*); Mr. W. M. Brigg, chairman of company (*b*); Mr. T. Goffey; Mr. R. F. Hall; Mr. F. J. Leslie, whose firm are the solicitors to the company (*b*). The company's works are at Aston, Birmingham, but about four months ago it opened a branch in Manchester. And this is how the advent of the new company to Manchester was announced. The *Electrical Review*, in its issue of June 22, 1900, says: "The British Electric Works Company, Limited, have opened a branch in Manchester for the supply of their electrical fittings. They have secured a very central position at 37, Piccadilly, and have engaged the services of Mr. John Walton, who was for several years with the Manchester Corporation electricity supply as inspector of installations. Mr. Walton also had charge of all the testing of accessories submitted to the Manchester Corporation." Now it is necessary to enquire who is this Mr. Walton who has thus joined the Manchester branch of Alderman Higginbottom's company. If you will kindly refer to paragraph No. 9, you will find the appointments and promotions made without the knowledge or consent of the Electricity Committee. One of the gentlemen in that list is the Mr. John Walton named above. Two advances in his salary were made "without anybody knowing," and then we find he has left us and gone to Mr. H.'s company. This transfer would not have been mentioned by me, nor would it have concerned you, except for the unfortunate fact that Alderman Higginbottom is chairman of both concerns. The representatives of three large electrical firms have seen me, and this is what they say: "There is a general

Digitized by Google

feeling amongst all who are engaged in the electrical supply business that the advent of this new company will seriously affect the business of the other existing firms. This feeling is based on two facts: (1) the chairman of the company is Mr. Higginbottom; (2) the new manager is the late assistant to the city electrical engineer here. We consider that free competition is not now possible."

17. The allegation is that Mr. Walton, after his years of Corporation experience, and consequent knowledge of Corporation requirements, will be able to sell to citizens the fittings made by Mr. Higginbottom's company, and that it is but natural that Corporation officials should be ready to pass the fittings of a company of which their own master is chairman! One gentleman who is in the business writes me thus: "In view of the fact that the chairman of the Electricity Committee is the chairman also of this company, is it compatible with municipal probity that he should be interested in a commercial undertaking to which in his official capacity he is able to show favour, to the disadvantage of other business undertakings and of fair trading generally?" I think the citizens will have no difficulty in answering this gentleman's very proper question.

18. Among the shareholders in this company I find:

	Ordinary.	Preference.
Lloyd Higginbottom	500	500
W. M. Brigg	500	500
George Makin (see below)	50	50
Jacob Atherton	—	1,100
Nine members of Atherton family.	2,500	4,900
F. J. Leslie	—	250

19. I would not have entered at such length into the details of this company were it not that it has positively sent in a tender to the Electricity Committee, with a view to supply its fittings to the Corporation. This took place on Sept. 10 last. I have seen the tender. It is simply intolerable that Mr. Higginbottom (as the British Electric Works Company) should be applying to the same Mr. Higginbottom (as chairman of the Electricity Committee) for orders for his wares. Luckily for all concerned, the tender was refused. But it had no business to be sent. This sort of thing must be stamped out. I may say that one thing which greatly enrages competing electrical firms is that "Mr. Higginbottom's fittings," as they are called, are publicly exhibited at our Dickinson-street station.

20. West Gorton Foundry Company, Limited.—Now we come to the fourth and last "link" in the chain. This foundry company is, if I may so call it, a thoroughly "family affair." It is like the Alderman Hugo Shaw company already referred to. It was registered on Jan. 4 last, with a capital of £5,000; £1,800 are taken up. There are 14 shareholders, who include the following persons:

Lloyd Higginbottom	118 shares.
Thomas Mannock (his partner)	118 "
Edward Broome (secretary of company)	14 "
James B. Atherton (see company *b*)	250 "
Harriet C. Higginbottom (Mr. H.'s wife)	40 "
George Makin (her father)	250 "
Thirza Hilditch (her sister)	25 "
Richard Hilditch (Mrs. Hilditch's husband)	75 "
Wm. L. Chew (his partner)	110 "

This company of Mr. Higginbottom's has also, I greatly regret to say, been striving to do business with Mr. Higginbottom's committee at the town hall. On Dec. 4 last they sent in a tender, which was declined. On May 7 they again tendered for materials, but were successful as to only a portion of their tender, and so declined to take up the remaining portion. For the third time, about Sept. 14 last, they again tendered, and were at last successful. The Corporation's materials, value £24 odd, have been delivered to this company, and are found recorded in the "Sundry Sale Book," p. 183. The amount is at this moment still owing to the Corporation. I can explain in a word my view of the situation. It is, that this state of things is abominable, and the only "way out" is that which Alderman Hugo Shaw adopted.

21. You will perhaps be surprised to hear that the Electricity Committee is at present selling electricity to users of motors at less than half the price which you have paid to make it. This may seem astounding. It is time you looked into it carefully. Examine the figures. The cost of production and management, including interest and sinking fund, is 2·87d. per unit. We sell it to the motor people at 1·25d.—that is 1¼d. In other words, we sell £100 worth of electricity for £43. This works unjustly in many ways. Take one. I know a man who is giving up his gas-engine. Why? He says they make him pay full price for the gas he uses, a price which the Corporation make a profit out of. But he finds he can get electricity for his motor at less than half its cost price, and he takes out of the citizens' pockets the other half. He says the gas-engine makers must look after themselves; he prefers a motor which will run largely at your expense. The figures are striking. In the last financial year, we supplied to consumers, at the 5d. rate, 1,993,000 units, which brought us an income of £41,500; whereas, to the motor users at the 1¼d. rate, we supplied 479,000 units and received only £2,500. One result of this low price is that the demand for motors is constantly increasing. Another singular feature of the matter is this, that when I refer to the book in which are entered the applications for electric power for these motors, I find, under the heading "Fitter's Name," that the name of the firm of Higginbottom and Mannock stands opposite 23 motors. This does not include the cases in which this firm is the sub-contractor.

22. This clause begins as follows: Now I come to a matter which to me seems very serious. Perhaps more serious than any of the preceding cases. Alderman Higginbottom is a member of both the Gas and Electricity Committees. Both those committees use large and costly cranes in their works. Alderman Higginbottom's firm (Higginbottom and Mannock) make cranes. The following reads like a simple innocent transaction: "Minutes of the Gas Committee, March 19, 1897.—'Resolved that the tenders of Messrs. F. Pearn and Co., Limited, for the supply of two hydraulic cranes, one for each of the Gaythorn and Rochdale-road gasworks, for the sums of £164 and £190 respectively, be and are hereby accepted.'" Mr. Williams goes on to state that Frank Pearn and Co. do not make cranes, and alleges that they simply acted as agents for Higginbottom and Mannock. In support of this, he quotes a number of workmen's statements to the effect that they worked on the Corporation works erecting the cranes while they received their weekly remuneration from Higginbottom and Mannock.

23. In this clause the same charge is brought respecting the cranes on the electricity works, which, it is stated, were practically supplied from Mr. Higginbottom's firm, but were invoiced through another firm. Here, again, it is stated that the ironwork and rails were actually fixed by Mr. Higginbottom's men. This concludes the list of charges, and Mr. Norbury Williams ends up his case with the following words:

24. "No man can serve two masters. No man ought to be a penny the gainer through his membership of a representative and trading body like our City Council. I have laid before you this regrettable case, and it is for you, through your councillors, to decide what should be done. Is Mr. Higginbottom to become our Lord Mayor? Ought he, with all this network of business connections with the Corporation, to remain a member of that body? You must make up your minds, and that quickly. In my judgment the good name of the city is at stake, and by the decision to be shortly arrived at the country will decide whether Manchester stands on the high plane which it has hitherto occupied, or has descended to the level of those municipalities where selfish ends, and not the commonweal, have been allowed to gain the upper hand. I have dispassionately told you the facts so far as I know them. The serious responsibility of deciding what shall be done rests upon your shoulders."

(Continued on page 631.)

LIGHT RAILWAYS.

The proposed agreement with the North Metropolitan Tramways and Omnibus Company, Limited, for the construction by them of a light railway in the urban district of Cheshunt, has been approved by the County Council of Hertford.

An adjourned enquiry was held on Friday with respect to the proposed light railway or tramway in the Rhondda Fawr, from Pandy Square, near Llwynpia, to a point some distance beyond Hafod.

The Middlesex County Council have now finally approved an agreement between the North Metropolitan Tramway Company, the County Council, and the Metropolitan Tramways and Omnibus Company in relation to the construction, working, and ultimate purchase of the light railways projected or authorised under the county of Middlesex light railways joint order. The Council have decided to give notice of intention to promote a Bill in the next session to authorise them to purchase tramway undertakings in Middlesex.

The Lowestoft Council have satisfactorily settled the basis of a new agreement in regard to the East Anglian light railway order with the National Electric Traction Company.

At a recent conference of the Newry Urban District Council and the committee appointed by the Chamber of Commerce, the following resolution was arrived at: "That this meeting respectfully recommend the Urban Council to sanction the purchase of the shares of the Newry Navigation Company at £20 per share, cash, for their entire interest in the property, including assets of every nature represented therein, with the object of forming a harbour trust, and to guarantee the capital necessary to purchase such shares, said guarantee to be on the town rates, this proposal to be contingent on the procuring from the Government a loan of £150,000 at 3 per cent. for the construction of the Newry, Keady, and Tynan Light Railway."

The Commissioners recently held an enquiry into the proposed extension of Swansea tramways, at the close of which they intimated that speeches would have to be heard in London.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	613	Tunbridge Wells Electricity Works	637
Bury St. Edmunds Electricity Works	618	Legal Intelligence	640
The Electrical Engineers (R.E.) Volunteers	627	Companies' Meetings and Reports	640
Manchester Electricity Committee	627, 631	Contracts for Electrical Supplies	640
Light Railways	629	Traction Notes	641
Manchester and its Elective Auditor	630	Lighting Notes	643
Forthcoming Events	631	Provisional Patents	647
Cardiff Electricity Accounts	633	Specifications Accepted	648
Physical Society	633	Traffic Returns	648
Questions and Answers	634	Companies' Stock and Share List	648

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

MANCHESTER AND ITS ELECTIVE AUDITOR.

We have before us, as published in the *Manchester City News* of Oct. 27, a long discursive address to the ratepayers of the city of Manchester by one of the elective auditors of the city, by name Mr. Norbury Williams. This gentleman poses as a most conscientious individual, and we accept him upon his own pedestal. He has, however, in a supremely irritating conscientious manner assumed what he—from the internal evidence of his own address—does not possess—namely, the ability to understand what he criticises and relentlessly condemns. Conscientious critics of the calibre of Mr. Williams are usually young—though probably in the present case it is different. Here we have a knight-errant of the type of Don Quixote, the enemy against whom he tilts being the Electricity Committee and all connected therewith. The address consists of twenty-four paragraphs. A good many sentences in some of them relate to the pains and penalties which ought to reward the wicked. Mr. Williams signed a declaration to fulfil the duties of his position "*according to the best of my judgment and ability*," as he says, and it is the awful responsibility weighing upon him under this signature that, in spite of pleadings and remonstrances, has compelled him to issue this address. We think that he has been most unfortunate in his choice of a time at which to issue his address, as it could obviously have been equally well written a month or so ago, when the chief person concerned in the charges was not the Lord Mayor-elect of the city of Manchester. We quite agree with Mr. Williams that it is his duty to expose any irregularities he finds in the working of the municipal departments, but he should be quite sure that he understands himself the grounds on which he brings any charge against a committee or its chairman. A more obvious case of an incompetent critic could not be found than paragraph 21 of the address in question. In this the Electricity Committee are accused of selling electrical energy under cost price to certain classes of consumers. We have now before us Mr. Higginbottom's reply to this absurd charge, and learn from it that, as was to be expected, the motor load at Manchester is a remunerative one. Mr. Higginbottom adds that the price of electric energy for motors was only fixed at 1¼d. per unit after having extensive reports on the subject from their engineer. These reports were open to Mr. Williams's perusal, so that he need not have made this absurd charge, which displays both ignorance and carelessness. Coming now to the connection between the chairman of the Manchester Electricity Committee and two of the large manufacturing companies which have obtained contracts for the electricity department. In spite of Mr. Williams's careful researches, he is only able to show the remote connection that certain directors of one company are co-directors with Mr. Higginbottom in an electrical undertaking which has never supplied the department with goods. In fact, a tender was once received from this third company, but its consideration was not allowed by

Digitized by Google

Mr. Higginbottom because he had a directorship on the firm. The most serious charge of all—in fact, we might say the only charge which needs consideration—was that of the cranes supplied to the gas and electricity works. It is admitted by Mr. Higginbottom that his firm were sub-contractors for certain parts of these, and it remains for the committee to look carefully into this question. It is to the interest of all that it should be most carefully enquired into, but up to the present we have heard of no evidence to the effect that the chief contractor who supplied these cranes received any preferential treatment from either of the committees. We are strong supporters of the purity of municipal life, but do not go to the absurd lengths which certain Radical organs do in this respect. If these papers had their way, it would seemingly be a dishonest act for any firm to use, say, a Nettlefold's wood screw in the fulfilment of a Government contract so long as Mr. Joseph Chamberlain or any of his blood relations owned a single share in Nettlefold's Company. As regards the charges brought by Mr. Williams against the organisation of the electricity department, one of the chief is that the engineer has had complete control of his staff, and has engaged them, increased their wages, and, we presume, discharged them without always consulting his committee. In other words, Mr. Wordingham has had autocratic control under the general supervision of his committee. If Mr. Williams had proved that the result was not satisfactory as far as the staff was concerned, or that Mr. Wordingham had allowed extras without due cause or corresponding value being received, he would have scored a point. The evidence the other way, as shown by the success of the undertaking, is so great that we are obliged to endorse the action of the committee in giving their engineer such a free hand.

FORTHCOMING EVENTS.

SATURDAY, NOV. 3.

Institution of Junior Engineers.—At 3 p.m., visit to the Millbank Station of the London Hydraulic Power Company, Millbank-street, Westminster. (Postponed from Oct. 27.)

Dundee Institute of Architecture, Science, and Art.—At Dundee Technical Institute, opening meeting. Lecture to students' section on "Some By-Ways in Architecture," by Mr. G. S. Aitken.

MONDAY, NOV. 5.

Society of Engineers.—At 7.30 p.m., at the Royal United Service Institution, Whitehall, ordinary meeting. Paper on "Notes on English and French Compound Locomotives," by Mr. C. Rous-Marten.

TUESDAY, NOV. 6.

Institution of Civil Engineers.—At 8 p.m., opening meeting of the session. Presidential address by Mr. Jas. Mansergh and distribution of awards.

Institution of Engineers and Shipbuilders in Scotland.—Graduate section meeting.

WEDNESDAY, NOV. 7.

Society of Model Engineers (Liverpool Branch).—Ordinary meeting, at Balfour Institute, Liverpool.

THURSDAY, NOV. 8.

Institution of Electrical Engineers.—At 8 p.m., opening meeting of the season. Presidential address by Prof. J. Perry, and presentation of premiums for the session 1899-1900.

FRIDAY, NOV. 9.

Faradian Club.—At 8 p.m., at St. James's Restaurant, club smoking concert.

SATURDAY, NOV. 10.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., at Glasgow, adjourned discussion of a paper on "Slow-Speed Engine Design," by Mr. A. M. Downie.

MANCHESTER ELECTRICITY COMMITTEE.

(Continued from page 629.)

Mr. Alderman HIGGINBOTTOM's reply to Mr. Norbury Williams we have also had to condense in places. The speech in question was made before the Council on Wednesday last. It began as follows: "My Lord Mayor and Gentlemen,—I ask, as a matter of privilege, to be allowed to refer to certain allegations which appeared in the *City News* of last Saturday respecting the administration of the Electricity Committee, and allegations with reference to myself and my connection with that committee, and also in connection with numerous public companies which are supposed to be doing business with the electric department through my influence. I do not intend to make any observation upon the various items which especially concern the committee as a whole—namely, paragraphs 1 to 13—but I shall be quite prepared to deal with these matters in case a discussion upon that report arises in the Council. Nothing in that report, and nothing in the evidence given leading up to that report, made any charge or any insinuation against the engineer or officials of the Corporation or against my personal character. The committee decided upon certain new steps to be taken to make the working system and administration of a more perfect form, and some of those systems are already in operation. I would just remind the Council that the electricity undertaking has grown from a very small one to a very large one—the largest in this country—in a very short time, and it has been a most difficult task for the committee and the officials to keep pace with the demands made upon them for current, and the whole undertaking has been worked under most exceptional difficulties in supplying that demand. It is, therefore, not to be wondered at for one moment if, as happens in every large concern, certain irregularities not in conformity with Corporation precedent have arisen. I now propose to deal with the allegations against myself and my connection with the following companies as stated by Mr. Norbury Williams in paragraphs 14, 15, 16, and 20, in which reference is made to S. Z. de Ferranti, Limited; the British Insulated Wire Company, Limited; the British Electric Works Company, Limited; and the West Gorton Foundry Company, Limited. Take paragraph 14—S. Z. de Ferranti, Limited. I have no interest whatever in this company. I am not a shareholder, and no member of my family, either wife or relations, holds any shares in this company. Again, Mr. Ferranti is not a director of any company in which I have any interest. As to the work done and orders received by Ferranti, Limited, for the Corporation, to which Mr. Norbury Williams refers in paragraph 14, the following are the exact facts: At the time when meters were first ordered from Messrs. Ferranti, this firm was acknowledged to be pre-eminent in the manufacture of meters, and these instruments were the best and the most reliable for measuring the current supplied to consumers which could be obtained. Since then other meters have been perfected, and as a matter of fact no meters have been ordered from Messrs. Ferranti since October, 1897, three years ago. It is untrue to say that continuous orders have been sent this firm since 1893. The order for the two 1,000-h.p. engines and generating sets has already been fully explained by myself to the Council, and although exception was taken by several members of the Council to the order going to this firm, theirs being far the lowest offer, owing to their action during the engineers' strike or lockout, the Council fully endorsed the action of the committee in placing the order with this firm. Take the British Insulated Wire Company, Limited. I have no interest in this company, and, as far as I am aware, I have not seen a list of the shareholders. No relation of mine holds any shares in this company. Two directors of this company—Messrs. Briggs and Atherton—are co-directors of mine in the United British Electric Works Company, Limited, a company, by the way, which has never done any business with the Electricity Committee. As to the cables supplied by the British Insulated Wire Company, Limited, to the Corporation, of which Mr. Norbury Williams made such statements in paragraph 15, the following are the true facts: The total capital expenditure on mains, including the cost of laying up to June, 1900, is £359,857; the total amount paid to the British Insulated Wire Company is £44,957. The cost of laying is only a small proportion of the cost of the cables, so you can judge for yourselves as to the small proportion of orders which have gone to the British Insulated Company. But I would ask the Council to clearly understand what were the conditions under which the British Insulated Wire Company obtained their orders: (1) tenders were invited by the committee from all the principal cable makers in the country; (2) that all the tenders were carefully examined by the engineer and the committee; (3) that the British Insulated Company's tender was the lowest of five tenders for the high-tension cables which conformed to the specification of the engineer; (4) that when tenders were invited for the cables for this year's requirements, amounting to about £60,000 worth, the tender of the British Insulated Wire Company was not accepted, the prices being too high, and the orders went to five other

Digitized by Google

firms, some of whom had not previously supplied us. Where is the imputed favouritism exercised by me? Paragraph 16.—The British Electric Works Company, Limited. I am a director and chairman of this company, as stated by Mr. Norbury Williams, and, as I have stated before, two of my co-directors are Mr. Briggs and Mr. Atherton. Mr. Norbury Williams has gone very deeply into the number of shares I hold, and also into the shares held by my co-directors, and also another small holding of one of my family connections. He has, for purposes of his own, only singled out those names specially suitable for his purpose. Mr. Williams then refers in great detail to the starting of a Manchester depôt, and the engagement of Mr. Walton as its head, and imputes that it was a move of mine to enable this company to do business with the Electricity Committee. It is a shameful imputation. I have nothing to do with, and cannot be responsible for, the way in which the 'Directory of Directors' or the *Electrical Review* chooses to give paragraphs announcing the opening of depôts or the appointment of agents anywhere. The appointment of Mr. Walton came about in this way. For several months the British Electric Works Company had been seeking premises in Manchester to open a depôt, and were looking out for a suitable man to take charge of that depôt and act as agent for the whole of Lancashire. Various persons had been seen, but none were suitable. I mentioned the matter to several people who were most likely to know of a suitable man, and I was told that Mr. Walton, at the electric works, was thinking of leaving and starting in business for himself. I saw Mr. Walton, and ascertained that this was quite correct. He had reached the limit of salary to which he was entitled in the post he held, and as the engineer was not prepared to advance his salary he had told the engineer that, at an early date, he should leave the service of the Corporation. I reported these circumstances to the British Electric Works Company, and they offered him the appointment and he accepted it. But the imputation is that 'free competition is not now possible.' With whom is the competition? The electricity department do not buy electrical fittings of the type manufactured by the British Electric Company in any appreciable quantity—that is, only to fit up any office or premises in the works; and as regards consumers, all firms are upon an equal footing—that is, the Corporation electric department do not sell any fittings or electric apparatus whatever to anybody. The citizens or installation contractors who fit up the warehouses and shops with electric light buy the fittings, not from the Corporation, but from recognised makers who have submitted samples to the electricity department, and which samples have conformed to the published regulations of the Corporation. Paragraph 17.—With regard to the allegation that Corporation officials will be ready to pass the fittings of the British Electric Company, I must point out to you that these officials have no discretion whatever. There are certain fixed rules which are published and certain definite tests that all fittings have to conform to. The right is expressly reserved to any representative of a firm sending fittings to be tested to be present during such tests, and there is no room for favouritism, even though it were desired to be shown. Paragraph 19.—To say that 'Mr. Higginbottom's fittings are publicly exhibited at Dickenson-street station' is a wilful attempt to mislead. All registered fittings are exhibited at Dickenson-street, and there is a published list of those firms whose fittings have been tested and which have conformed to the Corporation requirements. There are in all 36 firms, and the total number of fittings exhibited is 407. The number of fittings exhibited that have been made by the British Electric Company is 12 out of a total of 407; 23 fittings have been submitted for registration by the British Electric Company, and of these 12 have been passed as being suitable for consumers to use, and 11 have been rejected as not conforming to the Corporation requirements. In this paragraph there is the statement that the British Electric Works Company have sent in one tender to the Electricity Committee. This was done without my knowledge. The tenders were opened by the committee and initialled, and, as usual, were passed on to the chairman to read out the prices. Upon my seeing that the British Electric Works had sent in a tender, I immediately turned to the electrical engineer, who had to examine the sketches sent in to see if they conformed to his specification, and told him that this tender must not be considered. It was not considered and not accepted. The result, therefore, is that the British Electric Works Company have not sold any goods or received any orders from the electricity department of the Manchester Corporation."

Mr. Higginbottom went on to consider the charge brought in paragraph 20, concerning the tender from the West Gorton Foundry Company, Limited. He showed that he and his family only held a small proportion of the shares in this company, and that the tender in question was one for £24 for some scrap cast iron which the electricity department had to sell. He adds that he did not know a tender was being sent in, and that he urged that it should not be accepted, but was overruled by the committee because the firm offered a higher price for the old materials than anyone else. He concludes his criticisms on paragraphs 13 to 20 by the following statement: "That I am a director in two companies—viz., the British Electric Works, Limited, and the West Gorton Foundry Company, Limited—neither of which companies has ever sold one pennyworth of goods to the electricity department, and in only the one instance of the West Gorton Foundry Company buying some old scrap metal from the department, and sold to them against my wish, and for which the Corporation received more money than any other person would pay."

Mr. Higginbottom then proceeded to criticise paragraph 21 of Mr. Williams's address, showing that the motor load was a profitable one, and that lighting consumers who burn their lamps for long hours got equally low rates. This part of his speech he concludes as follows: "The committee fixed the price at 1¼d. per unit, and they only did it after having several long reports from the engineer-in-chief, and if it has encouraged the use of motors so much the better for the electric department and the Corporation, as the current supplied to the motors is supplied at a profit. We have 500 motors at work in June, and I wish there had been 5,000, because, if so, the price for all classes of current both for lighting and power could have been reduced, and the consumer would have benefited thereby. Mr. Williams then says he finds my firm's name stands opposite 23 motors, as having fitted them up in Manchester—23 motors out of 500, three of which are in my own premises. Fitted them up, whom for? Why, for citizens of Manchester, who have asked my firm as hoist makers and who have made special study of electric hoists to put electric hoists in their premises, and of which the electric motor forms a part. What nonsense this is. My firm is to be debarred from doing business with the citizens of Manchester because I am a member of the Manchester Corporation and the chairman of the Electricity Committee. It is too absurd to consider. And out of these 23 motors my firm has not made any; they have been bought from electric motormakers—viz., other engineers.

"As to paragraphs 22 to 23—'cranes'—I have to deal with the allegation that my firm have been making cranes for the gas and electric departments. Messrs. Pearn have for years made hydraulic pumps, etc., for the gas department, and have done a very large business in hydraulic jib cranes for other firms in this county, and, as is quite common in the engineering business, made parts of these cranes themselves and sub-let other parts to other engineers—my firm amongst the number. That course was adopted in the case of the cranes referred to by Mr. Williams. Messrs. Pearn, amongst other firms, received enquiries for hydraulic cranes from the gas department. They asked my firm for tenders in the ordinary course of business. My firm tendered to them in the ordinary course. Messrs. Pearn received the order. They were then at liberty to make the cranes themselves. They called, however, upon us to make the cranes at the price we had quoted to them. We then made the cranes as we should for any ordinary customer, invoiced them to Messrs. Pearn at our contract price to them, and were paid in due course by Messrs. Pearn. The insinuation that I used the firm of Messrs. Pearn as a go-between to enable me to do business with the Corporation is too contemptible for me to take any notice of. With regard to the cranes at the electric works, Mr. Norbury Williams says: 'Mr. Higginbottom's Electricity Committee have also required cranes at their great station in Dickinson-street. Most of them have been made and erected by Mr. Higginbottom's firm. They were, of course, invoiced in other names.' Gentlemen, this is quite untrue, and again the insinuation that my firm have done business with the Corporation under the cloak of other names is entirely lacking in foundation. In no instance has my firm made a crane for the electricity department. We have made portions of them, under circumstances which I will explain. The matter is quite simple. My firm makes cranes and portions of cranes for nearly all the electric engineers in the country. If an electric crane is required for some customer in any town in this country, my firm very often receives the same enquiry from half a dozen electric engineers in the country who are tendering for this crane, leaving out the electric motors and electric apparatus on the crane, for which work they would price for themselves as the makers. If any one of these firms gets the order, and if my firm's price to them is right for the work we have quoted them for, we receive the order from them for one portion of the work. That is exactly what has happened at the electric station. The engineer reports that certain electric cranes are required. He is instructed to get out the specification for same. The committee then invite tenders from leading electric engineers in the country. Some of these electric engineers then ask my firm, amongst others, in the ordinary course of business, to quote them for certain portions of the cranes. My firm quotes them for the work asked for. They then make up their tender, including all the electric motors and electric apparatus which they make themselves, and send in their tender to the committee. If their tender is the lowest they get the order; if it is not, they do not get the order. If the lowest

Digitized by Google

tender happens to be from a firm to whom my firm has quoted for some portions of the work and my firm's price is satisfactory to them, my firm makes this portion of the work for them. My firm invoices the work done at the contract price, and is paid for it by the contracting firm, and not by the Corporation. The men erecting this work always work in the name of the contractor, and not in the name of the firm doing the sub-work. It is the usual custom, and what engineers are doing in all parts of the country to-day. My firm's business has always been carried on, and has been for 25 years, in a perfectly straightforward and honest manner, and I cannot see that we have departed from that course."

In conclusion, Mr. Higginbottom asked the Council to judge him fairly in the matter, and to say if they deemed him worthy or unworthy to take the chair. He left the matter entirely in their hands.

After considerable discussion it was decided to appoint a committee to look into the question of the allegations against Alderman Higginbottom, and to report to an adjourned meeting to be held on Monday next at half-past ten. The committee consists of the Lord Mayor, Mr. Alderman Copeland, Mr. Alderman M'Dougall, Councillors Edwyn Holt, Shann, Plummer, and Vaudrey.

CARDIFF ELECTRICITY ACCOUNTS.

From the accounts of the county borough of Cardiff electricity works just issued, it appears that the total expenditure on capital account up to March 31, 1900, amounts to £85,717. 15s. 5d. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc. :

REVENUE ACCOUNT.

Dr.	Generation of Electricity.	£	s.	d.
Coal or other fuel	£1,720 18 5			
Oil, waste, water, and stores	321 12 4			
Wages at generating stations	1,341 0 0			
Repairs and maintenance: buildings, £226. 2s. 5d.; engines and boilers, £235. 7s 6d.; dynames, etc., £211. 14s. 3d.	473 4 2			
Sundry and other expenses	98 1 11			
		3,954	16	10
Distribution of Electricity.				
Wages and other remuneration	121 11 7			
Repairs, etc., of mains	294 8 11			
Repairs, etc., of transformers	40 15 7			
Repairs, etc., of apparatus	80 4 9			
		537	0	10
Public Lamps.				
Attending and repairs	271 9 1			
Renewals of lamps	113 7 1			
		384	16	2
Rents, Rates, and Taxes.				
Rents payable	54 12 0			
Rates and taxes	316 1 10			
		370	13	10
Management Expenses.				
Salaries—Engineer's department	472 6 3			
Clerical staff	200 2 5			
Auditor	25 0 0			
Collector	100 0 0			
Printing and stationery	78 3 0			
General establishment charges	262 4 2			
		1,137	15	10
Law and parliamentary charges		81	18	5
Special Charges.				
Insurances, etc.	51 5 3			
Expenses for certification of meters	30 0 0			
		81	5	3
Total expenditure		6,548	7	2
Amount carried to net revenue account		1,964	1	0
		£8,512	8	2

Cr.	Income.	£	s.	d.
Sale of current—190 113 units at 6d.		4,752	16	6
3 500 units at 5d.		72	18	4
165,728 units at 3d.		2,071	12	0
27,251 units (various)		236	10	5
386,592		7,133	17	3
Sale under contracts		71	11	1
Public street lighting		1,159	11	2
Rental of meters and other apparatus		163	18	7
		8,528	18	1
Less irrecoverables		16	19	11
		8 511	18	2
Connections		0	10	0
		£8,512	8	2

GENERAL BALANCE-SHEET.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		49,324	19	11
Less premiums received with stock issues, *per contra*		885	7	5
Total debt created		48,439	12	6
Less loan instalment repaid		161	5	11
		48,278	6	7
Sundry creditors: consumers' deposits, £117. 12s.; various, £2,408. 12s. 5d.		2,526	4	5
Amount due to treasurer		37,878	7	11
Amount due to Cardiff Urban Authority account		138	4	3
Amount due to Cardiff Corporation waterworks account		54	2	4
Sinking fund		4,653	6	5
Net proceeds of law action, Corporation v. Ferranti		1,106	0	1
		£94,634	12	0

Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		85,717	15	5
Deduct premiums received with stock issues, £1,031. 14s. 3d.; less expenses raising stock, £146. 6s. 10d.		885	7	5
		84,832	8	0
Stores on hand		817	7	6
Sundry debtors for current supplied		2,471	3	4
Other debtors		17	7	2
Balance at debit of net revenue account		1,647	14	10
Suspense account (renewals of arc lamps)		216	6	3
Amount due from borough fund account		125	4	5
Cash in hand of engineer		15	0	0
Investments, etc., of funds for redemption of stock		4,492	0	6
		£94,634	12	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units			673,633
Quantity sold	Public lamps	121,964	511,300
	By contract	2,744	
	Private consumers by meter	386,592	
Quantity used on works			25,838
Total quantity accounted for			537,138
Quantity not accounted for			136,495
Number of public lamps (arcs)			64
Total maximum supply demanded (kilowatts)			495

PHYSICAL SOCIETY.

At the ordinary meeting held on Oct. 26, 1900, Dr. Lodge, president, in the chair, the **Chairman** read a letter from Prof. Cleveland Abbe, of the United States Coast and Geodetic Survey, stating that the *Monthly Weather Review* would be sent regularly to any member of the Physical Society expressing a wish to receive it. On the other hand, the chief of the Weather Bureau would at any time be glad to receive communications referring to the physics of the atmosphere.

Dr. Shelford Bidwell then exhibited some "**Experiments Illustrating Phenomena of Vision.**" The first phenomenon illustrated was that known as "recurrent vision." A vacuum tube, illuminated by an induction coil, was made to rotate about a horizontal axis, and was seen to be followed at an angle of about 40deg. by a feebly luminous reproduction of itself. A spot of white light, projected upon a screen and caused to move slowly in a circular path, was also followed by a less luminous spot. The same effect was shown by spots of green and yellow light, but in the case of red light no ghost was visible. The phenomena of recurrent vision are due principally, if not entirely, to the action of violet nerve fibres. The next experiments related to the non-achromatism of the eye. The lenses of the eye do not constitute an achromatic combination, although under ordinary conditions a bright object is not surrounded by fringes of colour. The effects of chromatic aberration are disguised by the luminous haze which surrounds the object, produced by a defect in the eye regarded as an optical instrument. A six-rayed star, formed by cutting a hole in an opaque screen, was illuminated by a gauze-covered condenser containing an incandescent lamp. The star was fairly clearly defined, and there were no fringes. More attentive observation showed a luminous haze. This haze is formed in consequence of the cellular structure of the eye, and the brightest rays—orange, yellow, and green—are chiefly instrumental in forming it. If, therefore, these rays are obstructed, the conditions are more favourable for the observation of chromatic aberration. The rays were consequently cut off by means of coloured glasses, and the general hue of the star was purple. To some it appeared bordered with dark blue, while to others (long-sighted) it appeared bordered with red. Two oblong patches, one red and the other blue-violet, and of approximately the same intensity, were then produced side by side upon a screen An observer with very good eyesight was able at a distance of 10ft. to focus the patches alternately with perfect distinctness. In general, the blue patch was said to be more or less blurred. With an achromatic eye it should be possible to focus both together.

Dr. Bidwell then showed some lantern slides illustrating the complex form seen when viewing a small luminous spot through a gauze-covered lens placed so as not to be in exact focus. Some

Digitized by Google

experiments were performed illustrating the principle of the colour top. When a bright image is formed on the retina after a period of darkness it has, in general, a red border, which lasts for a fraction of a second. A dark patch suddenly formed on a bright ground has a blue border, which lasts for a similar time. These effects were attributed by Dr. Bidwell to a sympathetic action of the red nerve fibres. When the various nerve fibres occupying a limited portion of the retina are stimulated by ordinary white or yellow light, the immediately surrounding red nerve fibres are for a short period excited sympathetically, while the violet or blue and green fibres are not so excited, or in a much less degree. Again, when light is suddenly cut off from a patch in a bright field, there occurs a sympathetic insensitive reaction in the red fibres just outside the darkened patch, in virtue of which they cease for a moment to respond to the luminous stimulus. The green and violet fibres by continuing to respond uninterruptedly give rise to the sensation of a blue border. By a simple experiment it was shown that the explanation of the colour top depending upon changes in the convexity of the eye and non-achromatism, was untenable. By the use of a strong light it is possible to get negative after-images after looking at a brightly-coloured object. These images are complementary in colour to the object, and are formed even if the object is only viewed for a fraction of a second. By means of proper illumination and a disc rotating at the proper speed a red wafer was so arranged that upon looking at it it was impossible to recognise the wafer itself, but only the continuous green after-image.

The Chairman expressed his interest in the last experiment, in which it was possible to see the negative after-image of an object and not the object itself.

Prof. S. P. Thompson said these experiments threw a doubt on some of the accepted notions about the properties of the eye. Dr. Bidwell asks us to believe that the yellow haze is due to a cellular structure in the eye. Is there such a structure? Can it be observed with a microscope? And do its meshes correspond in magnitude with those necessary to produce the effects? By diminishing the size of the pupil the haze is diminished, and the sharpness of the image is increased. The effects seem to be due to ordinary aberration. Prof. Thompson said that the achromatism of the eye was simply shown by covering half the object glass of a telescope, and viewing a bright object with it. The object then seems bordered with coloured fringes.

Mr. Blakesley, referring to the colour patches used by Dr. Bidwell, pointed out that although the patches were the same distance from the lens, yet they did not possess the same magnification. The last experiment shown did away with the theory of persistence of vision, because the space between the object and the negative after-image was evidently not illuminated.

Mr. Trotter asked if red and green were the only colours which gave complementary negative after-images?

Dr. Bidwell, in reply, said the effect was obtainable throughout the length of the spectrum.

A paper "**On the Concentration at the Electrodes in a Solution, with Special Reference to the Liberation of Hydrogen by Electrolysis of a Mixture of Copper Sulphate and Sulphuric Acid**" was read by **Dr. H. J. S. Sand**. In this paper an equation has been derived for calculating the concentration at the electrode of a solution of a single salt from which the metal is being deposited, under the conditions (1) that the solution is contained in a cylindrical vessel bounded by the electrodes; (2) that no convection currents occur; and (3) that the diffusion of the salt obeys Fick's law, and its transport values are constant. This formula can be made the basis for roughly determining diffusion coefficients. In the case of mixtures it is possible to arrive at limits for the concentration, and it has been experimentally proved that hydrogen always appears at the electrode of an acid solution of copper sulphate, in which no currents of liquid are taking place between the limits of time for the concentration to go down to zero. The time which it takes for the hydrogen to appear can be calculated from an empirical formula, which is similar in form to the one used for a single salt. The great part played by convection currents in determining the ratio of the two constituents given off at the electrode of an acid copper sulphate solution has been shown by proving experimentally that artificial stirring causes hydrogen to disappear altogether in cases where it would otherwise have presented over 60 per cent. of the equivalents carrying the current from the solution to the electrode.

The Chairman drew attention to the fact that no hydrogen was liberated until all the copper had gone, and said the formula for the concentration might be used again in further investigations.

Dr. Donnan asked if the time at which hydrogen was liberated had been taken as the time at which hydrogen actually made its appearance in the form of bubbles, or whether any allowance had been made for saturation?

Dr. Sand said the time was taken up to the appearance of bubbles.

A paper by **Dr. R. A. Lehfeldt** on "**Electromotive Force and Osmotic Pressure**" was postponed until the next meeting.

The meeting then adjourned until Nov. 9.

ERROR.—With respect to the article in our last issue entitled "Some Remarks upon a Hitherto Unrecognised Planetary Law," by Mr. R. C. Shettle, M.D., line 15, second column, p. 593, the words "principle of the induction whirl machine" should read "principle of the induction electric machine."

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

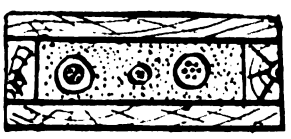
QUESTIONS.

321. Why does the temperature of the outer conductor of a concentric cable increase to nearly double the temperature of the inner when working at its full carrying capacity?—F. H.

322. Being in charge of an alternating station having a motor-alternator, I have noticed that, when this is being driven off big plant to charge cells, the excitation on big plant is considerably less (about 15 per cent.) than when it is on lighting load alone, although the motor-alternator adds about seven high-tension amperes to this lighting load. If field resistances be altered to bring excitation on big plant to normal, the machines merely drive badly. Required cause.—R. B.

ANSWERS.

Question No. 315.—I am in charge of a few miles of underground cable in this city, and I have recently experienced great trouble with them, and would like to ask whether any of your readers have had a similar experience and found the remedy. Our supply is on the three-wire continuous-current system, 220 volts between the outers; the mains are all singles, lead-covered, paper-insulated, laid in tarred sand, protected by hardwood boxing (as shown in sketch).



At every street corner we have 12 cables meeting in a box, and they are all bonded together by a copper wire soldered to the lead sheathing. At each customer's service box they are also bonded, and in many cases earthed to water-pipe or earth-plate. The lead sheathing has been badly eaten away in certain blocks, but the recent trouble has arisen in those places where the cables are good, on feeders which have no services on them, and which appear quite perfect, except just where the fault has developed and burnt a hole in the sheathing, the lead around the fault being a dark-blue colour and free from any sign of corrosion, whereas all the previous faults were in cables that were so damaged that the paper was visible in spots through the holes eaten by some chemical action. This chemical action seems to be confined to certain blocks in the city, whereas the mysterious faults have occurred in back streets where the cables have hitherto been perfect and still look perfect. It is a curious thing that all these mysterious faults have occurred since the erection of our new switchboard with its quick-break switches, and since we have used the compounding on the balancer machines. The balancers are steam-driven, and were shut down once by a reversal of the current, so they were run as shunt machines until lately. With the new board they run safely with the compound.

Best Answer to No. 315 *(awarded* 10*s.)*—The question asked by Mr. W. J. Young is not an easy one to answer, and without a complete knowledge of the facts one can but make a guess at what has happened. The first which it would be well to know is as to the tests which were made on the cable in which the faults occur. The burn out which Mr. Young describes is exceedingly like faults which are due to imperfections in the insulation, and which result in time in a short-circuit being established between the conductor and the lead. This solution seems to be somewhat improbable, as it is to be inferred from the question that the cables are not recently-laid ones, and that they have been in work for some time. The use of a quick-

Digitized by Google

break switch will have in certain cases influence on the life of a cable if there are defects in the same. It will be found, if experiments are made with a condenser, that a surging of voltage can be set up in the same by suddenly switching off a comparatively low voltage such as Mr. Young mentions. It would be interesting to try if the addition of a carbon break to the switch gear in question would have any deterrent effect on the establishment of the faults When the current is suddenly broken by a quick-break switch the actions are also dependent upon the self-induction of the machines which are rendered idle, and it is quite probable that the use of the compounding coils may have an effect as the questioner suggests. Another point which does not seem to have struck Mr. Young is that his lead-covered cables are exceedingly well earthed, owing to the way they are bonded together, and it is quite likely that they offer a much better path to lightning than other conductors in the ground. Take, for instance, an iron water-pipe. The joints between successive lengths are frequently made with materials which have not any appreciable conductivity, while the stream of water in them has also a high resistance. It is hence quite possible in certain streets where the subsoils are very dry that small discharges of lightning down the rain-water pipes, etc., will find their way into the lead covering of the cables. The result produced would be, according to the experience in other places, somewhat as described. In either case, it seems clear from the facts given that it is a discharge which causes the burn out rather than a slow electrolytic action. The writer would be inclined to ascertain if the insulation had got defective places in it by a high-voltage test with alternating currents. If some 2,000 volts were applied for an hour it would be quite sufficient to prove the uniformity of the insulation, and might localise any incipient faults which were developing.—P. T.

Answer to No. 315 (*awarded* 5*s.*).—I have known faults occurring in cables laid on the solid system, as described in the question, owing to irregularity in the compound in which the cables are placed. If the tarred sand is not properly mixed, moisture will be able to get at the lead of the cables in places, and this will cause electrolytic action, which will eat away the lead. In one town in the North of England, where tiles were laid over the compound in the wood troughing, it was found that the lead was attacked at intervals which corresponded to the gaps between successive tiles. This clearly indicated that moisture was getting down through faults in the compound to the lead. I would suggest to Mr. Young that bitumen is a much preferable protection to the lead covering than the tarred sand which has been used.—S. C.

Question No. 316.—Describe the necessaries in the construction of a multipolar continuous-current dynamo, in order to obtain sparkless commutation with a fixed position of lead for all loads.

Best Answer to No. 316 (*awarded* 10*s.*).—This point is attained fairly successfully in almost all modern multipolars by a number of small improvements in design rather than by any one definite deviation from the older machines. There have been many attempts within the last few years to find an artificial method of obtaining the result, the best known of which are the following: (1) Swinburne's method of fixing a small horseshoe magnet at the no load neutral point of the machine to produce the necessary commutating field. This magnet was series wound, so that the reversing field increased roughly in proportion to the armature current. (2) Sayer's armature winding, by means of which commutation takes place under the *trailing* horn, which is strengthened by the armature reaction, instead of under the *leading* horn, which is weakened. (3) Ryan's dynamo, in which, by means of a series winding placed in slots round the pole-faces, the armature reaction is not only neutralised, but the actual induction density at the commutating point is even increased slightly as the load on the armature increases.

The last two of these methods are used to a small extent commercially, but by far the greater number of multipolars are made to dispense with any such arrangement. In place of them, special attention is given to the following points: (1) Carbon brushes are invariably used, in spite of the considerably larger commutator required on this account. (2) The induction density in the air-gap is made large, so as to ensure a "stiff" field. (3) The tips of the leading poles, under which commutation takes place, are proportioned so as to become highly saturated under normal conditions.

Carbon brushes, by greatly increasing the contact resistance, cause the current flowing between a segment just about to leave the brush and the brush itself to fall to practically zero an appreciable length of time before contact between the two is actually broken. This effectually prevents sparking by an action more or less independent of the value of the commutating field available and of the current to be dealt with.

The advantage of a high induction density in the air-gap consists in the fact that the higher the initial (no load) density, the higher will be the minimum density with the full armature cross-magnetising ampere-turns distorting the field. Densities of 10,000 to 12,000 C.G.S lines per square centimetre are commonly used. At the same time, in order to keep the ampere-turns on the field coils down to a reasonable figure, the *length* of the air-gap must be reduced to the minimum allowed by mechanical considerations.

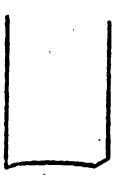


FIG. 1A.

FIG. 1B.

Saturated pole-tips are only of use in diminishing the amount by which the commutating field is altered by a given change in armature current. In the case of laminated poles, saturated tips can be readily obtained by using stampings of the shape shown in Fig. 1A, with one corner cut away, and building up the core with the stampings placed alternately one way and then the other, so that the finished core looks as in Fig. 1B. These tips have only half the sectional area of the rest of the core, and will consequently work at a considerably higher density.

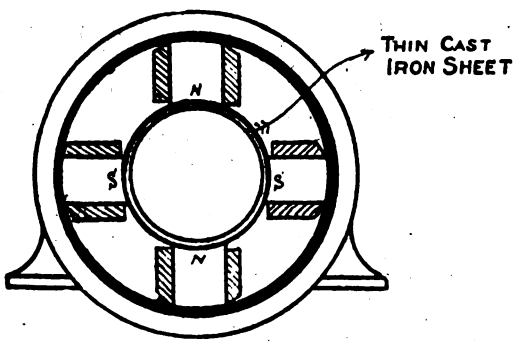


FIG. 2.

Another method is to place a thin cast-iron shell or bush in the bore of the magnets, as shown in Fig. 2. This causes some additional leakage from pole to pole, but at the same time produces a highly saturated pole-piece which is not easily weakened by armature reaction. Sometimes a deep slot is cut in the centres of the poles, as shown in Fig. 3, which has the same effect in reducing the weakening action of the armature, especially if the cores are worked at a high saturation.

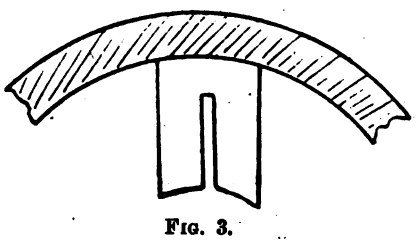


FIG. 3.

The combined effect of the above points in the construction of a machine has been found in practice to give quite successful, if not absolutely sparkless, commutation under all conditions of load and without any brush adjustment.—Q.

Digitized by Google

Answer to No. 316 (*awarded* 5s.).—A consideration of the causes naturally precedes any devising of means for the prevention of sparking. These are mainly: (*a*) That an armature coil has the direction of its current reversed during the passage of its commutator segment under the brush. There is thus an E.M.F. produced by the coil's self-inductance, tending to maintain its previous current, and opposite to that of the windings it is about to connect with the brush. Unless an equal and opposite E.M.F. is produced in it by external influence during the period of its short-circuiting under the brush, this E.M.F. of self-inductance creates a spark between the latter and the receding segment. This counter E.M.F. is usually obtained by giving the brushes lead—*i.e.*, commuting the current at such a position that the coil is under the influence of the field lines issuing from the edge of the leading pole-piece. Usually, too, since the self-induced E.M.F. is proportional to the current carried, the lead must be increased and the coil moved into a more powerful reversing field as the load increases. (*b*) Irregularity in the arrangement of the armature coils is productive of sparking. From this, however, a well-designed machine may be considered exempt. (*c*) In the case of multipolar parallel-wound armatures, inequalities in the width of air-gap, such as may be produced by not properly packing up the brasses as they wear, are apt to cause sparking. A well-constructed machine kept in good order may also be considered exempt from this.

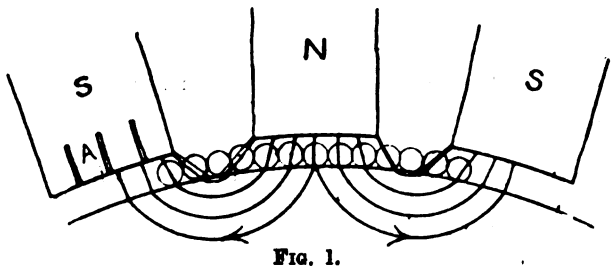


FIG. 1.

The machine under discussion is required to have constant lead and not to spark. This lead must evidently be such that at maximum load the coil is in a sufficiently strong reversing field. The question now arises as to the relation between this field (at a given point) and the armature current, also as to its effect on the coils when these carry a current less than the maximum. Dealing with the first point, Figs. 1 and 2 show the field produced by the field windings and the armature coils respectively. It is thus apparent that the armature reaction weakens the field under the leading horn of the pole-piece, and this effect is, of course, proportional to the currents flowing in the armature. If sufficient at full load, the reversing field is, therefore, from a double cause excessive at less load.

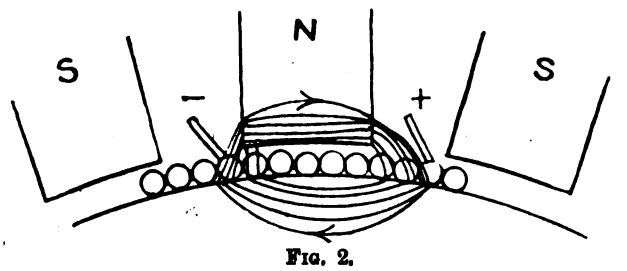


FIG. 2.

With a shunt machine the excess is more, and with a series machine it is obviously less, than with one having a fixed field excitation. The effect of this excess is that those coils which are approaching the brush enter a field of opposite sign to that of their own pole and produce some back E.M.F., thus slightly lowering the E.M.F. and output of the machine. By suitably adjusting the field distribution, it would thus be possible to make this back E.M.F. to some extent compensate for the rise of terminal E.M.F. owing to the diminished armature drop. The essentials are now deduced—viz, that armature reaction and self-inductance should be small. Hence (1) air-gap should be wide in order that the magnetic resistance to reaction lines may be great. This necessitates a field excitation strong compared with that of armature coils, and suggests a laid-on in place of a slot winding. (2) The pole-piece may advantageously be slotted, as shown at A (Fig. 1), for same reason as (1). (3) Turns per commutator segment should be few, since self-inductance varies as the square of their number. (4) Armature should be drum wound, as the inductance of internal bars is thus absent. (5) The number of poles should be as great as is consistent with the size of the machine. If there be N poles, $\frac{1}{N}$th of the total current is carried by the coil. Hence the self-induced E.M.F. is $\frac{2}{N}$ths of that in the equal bipolar machine. (6) The toe of the brush may be wide, thus allowing a longer time for the counter E.M.F. to be produced by the reversing field. Excessive width, however, would lead to undue heating.

It is assumed that the machine is parallel wound; otherwise, of course, condition 5 does not hold.—ZERO.

Answer to No. 316 (*awarded* 5*s.*). — For a machine to fulfil the above conditions it must either be one designed to work with carbon brushes or else be a machine with a special winding on the armature, such as that patented by Mr. W. B. Sayers, or some device consisting of auxiliary poles or combination of such. We shall leave out of our notice any consideration of these special devices, the majority of which are purely experimental toys, or are from a commercial point of view not altogether satisfactory. It may be as well to say that it is impossible to construct a continuous-current machine which will run sparklessly at all loads with fixed *copper brushes*, *unless* this machine be provided with some such special device as above mentioned. We propose, therefore, to consider a multipolar machine with a single winding on the armature, which is to run with fixed carbon brushes at all loads without sparking, this being a machine which is most common in modern practice.

A machine will run sparklessly if, in the commutation of a coil, the current be first brought to zero value and then raised to its exact former value in a reverse sense; at the instant of completion of this cyclical operation the coil must be on the point of leaving the brush—this is a broad statement which, of course, holds good for any type of commutating machine. In the machine to be considered this operation is brought about by the combined action of the reversing field under the leading polar horns, together with the reversing effect of the carbon brushes—this effect will be discussed later on. In order that an armature coil may be reversed by the magnetic field, it is necessary that the density of lines in the air-gap under the leading horns should be of a sufficiently high value. This may be ensured by making A T expended over the air-gap by the forward magnetism bear a relation to the distortion, A T, of the armature equal to 1·3 to 1·5. (A T = ampere-turns.)

$$\frac{\text{A T on air-gap}}{\text{Distortion A T}} = 1{\cdot}3 \text{ to } 1{\cdot}5.$$

Having now fixed a safe limit to the ampere-turns on our armature relative to the ampere-turns expended on the air-gap, we may now discuss the winding of the armature. It is essential that in an armature winding the reactance voltage per section when undergoing commutation should be kept low, as this is the chief or primary cause of sparking—neglecting the resistance of a section. Reactance volts per second = $2\pi \times \frown\!\!\!\sim \times M \times C$. $\frown\!\!\!\sim$ = cycles per second or periodicity of commutation; M = mutual + self-induction of short-circuited coil measured in henrys; C = current in coil.

The periodicity may be taken as the reciprocal of twice the time taken for one section to pass under the brush, so that the governing factors for the periodicity are: peripheral speed of commutator, width of commutator section, and thickness of brush. All these should be so proportioned as to keep the periodicity low. Mutual and self-induction of short-circuited coil should be kept as low as possible. Self-induction may be reduced by proper designing of slots—*i.e*, wide slots—and keeping the turns per armature section down to a minimum. Mutual induction may be kept low by distributing the sections or turns in the armature slots so that no sections or coils lying in the same slots are undergoing commutation at the same time. The current

Digitized by Google

per coil should be minimised, having due regard to manufacture from a commercial point of view, by making use of a multiplex winding—as, for example, by making use of a multiplex series-wound multipolar armature, or else a multiplex parallel-wound multipolar armature. This has the effect, not only of reducing the reactance volts per coil, but prevents a quivering of the main magnetic field due to armature reaction.

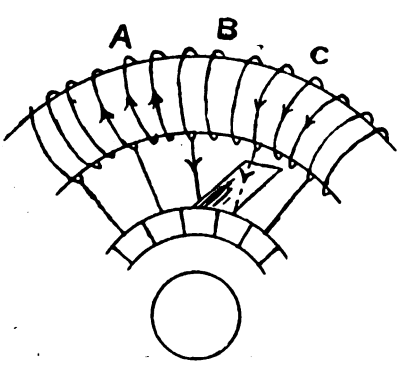
By bearing in mind the above points in design, we find that the reactance volts per coil commutated may be as low as one to two volts. This figure enables us to fix the lead of our brushes, and any alteration in the reversing field under the leading pole-tips due to the variation in the loading of the machine, is compensated for by the virtue possessed by carbon brushes in setting up a difference of potential between the leading and trailing tips of the brushes. This difference of potential is caused by the varying current density at the brush face as a coil is commutated, producing a difference in the C R drop between the leading and trailing tip. C = current in brush, R = resistance of surface contact of brush.

It may be remarked that in small machines, say up to 8 kw., it is commercially possible to construct them with so small a reactance volts per section as to enable the commutation to be brought about entirely by the action of the carbon brush, and without any assistance from the reversing field under the leading polar horns. We might amplify all the above points by *actual* design, but feel that we cannot go any further into the matter of commutating machine, as we have already trespassed too much on your space and time.—H. P.

Answer to No. 316 (*awarded* 5*s.*).—The chief cause of sparking at the brushes of dynamo-electric machines is due to the shifting of the plane of commutation when the load, and consequently the amount of the armature reaction, varies. By employing relatively strong field magnets the distortion of the field is greatly diminished, and remains more constant.

The cross-magnetising effect of the armature may be reduced by such devices as slotting the pole-pieces in a direction parallel to the shaft; shaping the pole-tips so that they may be saturated by a weak field, and are therefore of a low permeability; or increasing the air-space between the armature and the pole-pieces, thereby increasing the reluctance of the path of the lines of force due to the current in the armature. The last-mentioned method, although extensively used, possesses the disadvantage that the reluctance of the useful magnetic circuit is also increased, requiring additional ampere-turns in the field windings, and thus losing one of the gains of the use of embedded armature conductors.

Having now got a fixed field, let us observe what takes place in a coil at the moment of commutation. In the diagram the current from one-half of the armature is



flowing round A to the brush, and from the other half round C in the opposite direction. It is evident, then, that the current in B must be stopped and started again to an equal value in the opposite direction before the commutator bar leaves the brush, else sparking will ensue. The self-induction of the coil retards this stoppage and reversal, so that the coil, short-circuited by the brush, is really not idle, but is cutting lines of force and generating an E M.F. which just counteracts that of the self-induction. Attention must be directed to the shape of the pole-tips in order to produce a fairly uniform field through the short-circuited coils of correct intensity to promote this reversal of the current in them. Then the self-induction is lessened by using few turns per coil. The shape of the armature teeth also determines, to a certain extent, the value of the self-inductive effect, as was explained in the answer to Question No. 274. A multipolar machine, without cross-connections in the commutator, permits of the commutation of the current being done in detail, which is advantageous, especially when large currents are dealt with. By inserting resistance in series with the short-circuited coils it is made possible to cover three or four commutator segments with the brush, thus allowing of small variations of the plane of commutation without the attendant sparking. The use of German-silver wires for connecting the coils to the commutator bars accomplishes this, or, as is now almost universally adopted, the substitution of carbon for copper brushes.

Again, if the teeth of the armature core are too far apart, the lines of force are gathered into them in "tufts," and vicious sparking is caused as the teeth approach and recede from the pole-tips. This is eliminated when the teeth are close together and cover a large part of the armature surface, or if the armature is wound over with iron wire. One form given to pole-tips consists of a thin cast-iron ring joining the pole-pieces, which answers the same purpose.—J. D. S.

TUNBRIDGE WELLS ELECTRICITY WORKS.

The following is an abstract of the report of the borough electrical engineer of Tunbridge Wells on the fourth completed year's working of the electricity undertaking:

I have the honour to present my annual report on the fourth completed year's working of the electricity undertaking in the borough. In this year's report I propose dealing chiefly with a description of the extensions we are undertaking, which extensions will enable us to supply an additional 24,000 8-c.p. lamps connected to the mains. These extensions were recommended to you in January, 1899, but owing to various circumstances they were not undertaken until February, 1900, and are now well on the way to completion.

Buildings.—The buildings which are now in progress will add another 52ft. in length by 78ft. in width to our present works, and comprise a boiler and engine house. In order to make room for these it has been necessary to take away a portion of the existing stables. In the engine-house there is room for accommodating another three engines, which can be ordered as required. In the boiler-house I have made provision for four Lancashire boilers, which necessitates the building being wider than would be the case if tubular boilers were employed, so that the buildings, when full of machinery, will be large enough to supply 94,200 8-c.p. lamps; and at the present rate of increase this would take 12 years before it will be necessary to again extend the buildings. I have arranged openings in such a position that the minimum amount of labour is entailed in handling the fuel used, coupled with great rapidity of discharge, as there has been difficulty in unloading coal hitherto.

Boiler House.—There are five Babcock and Wilcox boilers now working, each capable of evaporating 4,000lb. of water per hour. These boilers are being supplemented with two Lancashire boilers, 8ft. 6in. diameter by 30ft. long, each boiler being capable of evaporating 8,000lb. of water per hour, and working at a pressure of 160lb. to the square inch. To make room for these new boilers, I have designed an underground flue, which will connect with our present flue, and with the new shaft when built. The boilers are being provided with the best-known fittings in the market, including superheaters in order to gain every possible economy in coal consumption and working cost. The steam is delivered from these boilers to the superheaters, and then through the main steam ring to the engines. Superheaters are not in general use, but are becoming so in all the modern works. The boilers, main flue, foundations, etc., are costing us £3,295. 15s. 2d. A new feed pump is being installed capable of delivering 5,000 gallons of water per hour against a pressure of 160lb. The condensing plant will be between the old and new boilers, consisting of air and circulating pumps, capable of dealing with 30,000lb. of steam exhausted from the engines per hour, returning the condensing steam to a storage tank called the "hot well." A grease separator is provided for extracting the grease from the steam. This is inserted in the main steam exhaust pipe in a suitable position. On the feed service a well-known filter of the "Edmiston" type is placed, so that we should have no trouble with oil or grease getting into the boilers, having thus taken double precautions. The condenser itself consists of a number of brass tubes, exposing a cooling surface of 3,000 square feet. There are two 14in. mains connecting the condenser with the cooling tower. When the condenser, the hot-well, the pumps, and all the requisite machinery for converting the steam into water are completed, the plant will be second to none in the

Digitized by Google

kingdom, as everything is specified to be of the most approved pattern. The condensing part of the scheme, with the cooling tower, pumps, engines, piping, foundations, etc., will cost £5,221.

Water Reservoir.—In connection with the condensing scheme, we have built a large water reservoir, capable of holding 100,963 gallons of water. In the construction of this reservoir over 600 tons of concrete have been used. The reservoir forms the foundations for the cooling tower, which cooling tower is 60ft. high, and capable of dealing with the heated circulating water when cooling 30,000lb. of steam per hour. At present this is the largest tower erected of its sort south of the Thames, and will be of material value to us in providing a good supply of fresh water, which has been well exposed to the air continually, as well as heated and cooled many times, so that the cooling tower and the reservoir form (1) a large storage tank for water, (2) a means of cooling the circulating water after leaving the condenser, (3) a water purifier. These cooling towers, where there is an insufficient supply of water for condensing purposes, are becoming general.

Engine-Room.—In the engine-room we are putting down a 400-kw. Willans-Ferranti set, which will bring the capacity of our plant up to 1,070 kw. This set, together with the foundations, will cost £4,553. 14s. 8d.

Switchboard.—A switchboard of the latest approved type for controlling high-pressure electricity supply is being provided, and will be situated in the corner of the engine-room now occupied by the rectifiers, which rectifiers will be removed to the new buildings. The switchboard provides controlling gear for the alternators, and has a capacity of 400 kw. It will cost £780. 10s.

Distribution Department.—Mains have been laid in all the important streets of the borough, the aggregate length of the cables being 40 miles. We have continued our policy of doing away with the small house transformers, and connecting the consumers to the 220-volt network. During the year we have only been troubled with damage to one of the cables, which was done when the road was opened up for the purpose of laying a water supply. The mains have been kept in perfect repair, and, so far as one can ascertain by testing, they are as perfect to-day as when first laid.

Shaft.—In future extensions I have always contemplated building another shaft at the opposite end to the present one, and for this purpose the main flue has been extended right along the whole length of the building, not because we require a new shaft at present, but we shall do so in the near future, and I note with satisfaction that Sir William Preece confirms my original idea, as there is considerable difference in opinion as to the capacity of a shaft; the American practice being twice what the English practice is, and in America our present shafts would be considered ample for years to come provided the draught were not affected, whereas in England it would now be considered sufficiently loaded.

Nuisances.—During the year we have been troubled, and somewhat severely handled, by complaints with respect to smoke and vibration, and I would respectfully inform you that the extensions to the works, suggested in my report presented to you on Jan. 4, 1899 (18 months ago), should remedy all reasonable causes for complaint. With regard to the smoke nuisance, the new extensions which you decided to carry out in January, 1900, and for which contracts have been entered into with Messrs. Tinkers, the boilers are designed in such a manner, and with smoke-consuming devices, which should obviate most of the difficulty, as I think you are now aware that the cause of the trouble is brought about by (1) the inferior quality of the fuel supplied by the contractors (for which we obtained damages); (2) on account of the particular type of boilers we were using, and the fact that these boilers were hard pressed, so that it was only possible to burn certain classes of fuel in order to hold steam. The new ones will provide ample boiler power, and will be equal to an addition of four of the old type. The new type of boiler is not a "smoke producer," and can be worked more easily with a minimum amount of smoke, especially as it is fitted with smoke-consuming arrangements.

Bad Water.—I have during the year had 10 analyses made of the Jackwood Springs and the town water for steam-raising purposes. The experts have given me as their opinion that it is not amenable to treatment, and below is a copy of the report I presented to the committee with reference to our water supply. I have carefully studied the question of the purification of our well water, based upon our following analysis:

Well Water.	Grains per gallon.
Calcium carbonate	·70
Calcium sulphate	7·43
Sodium chloride	5 61
Oxide of iron	·81
Nitrates and nitrites of lime and magnesia	3·95
Total	18 50

The well water is not a good one for boiler purposes. It contains a considerable quantity of mineral matter in solution, and if not treated before going into the boiler it will cause the formation of a very hard scale on the plates and tubes. It has also corrosive properties, due probably to the nitrites and nitrates, and possibly to the chlorides. Although there is no free acid in the water, the reactions which take place at the high temperatures which are attained in our boilers probably give the water acid properties, and there being nothing in the water to neutralise these they attack the metals with which they are in contact. The scale-forming impurities could be removed by the addition of good soda ash before the water is used in the boiler, but we should require settling tanks for this purpose. If you continue to use the well water I should advise you to adopt this course, as a little soda ash would make the water alkaline to a certain extent, and would tend to mitigate the corrosive action. It will be seen from the above analysis that the presence of nitrates and chlorides in the water tend to indicate that it is polluted by sewage or other impure water draining into the well, or percolating through the soil. Unfortunately, the samples of well water differ, showing that the character varies from time to time. The analysis of the town's water is as follows:

	Grains per gallon.
Calcium carbonate	1·75
Calcium sulphate	·53
Magnesium sulphate	·72
Magnesium nitrate	·90
Sodium chloride	2·64
Total	6·54

The following is a copy of an analysis made by Mr. Kent Smith:

Soap Test.	
Temporary hardness	Nil.
Permanent hardness	11 80
Total hardness	11·80

Alkalinity equivalent, ·35 grain calcium carbonate per gallon.

Residue.	Grains per gallon.
Calcium carbonate	·13
Calcium sulphate	5 90
Magnesium carbonate	trace
Magnesium sulphate	nil.
Magnesium chloride	·93
Sodium chloride	4 95
Alumina, etc. (soluble)	2 73
Silica	·15

Sample of scale: Mark, Tunbridge Wells (one piece only received).

Result of Analysis.	Per cent.
Calcium sulphate	91 20
Calcium carbonate	·54
Magnesia	2·70
Alumina and peroxide of iron	·80
Insoluble siliceous matter	2·48
Combined water and organic matter	1·84
	99·56

The following is a copy of an analysis made by Mr. Cecil H. Cribb:

	Grains per gallon.
Total solid residue	31·15
Chloride	3·71
Chloride of sodium (calculated)	—
Nitrogen as nitrates and nitrites	—
Nitrate of soda (calculated)	—
Temporary hardness	none
Carbonate of lime (calculated)	—
Permanent hardness	19·0
Sulphate of lime (calculated)	25·8
Total hardness	19 0
Remarks—free carbolic acid	9·0

The sample is quite devoid of free non-volatile acid, being slightly alkaline after boiling.

I have also been in communication with Mr. Dewrance, with Mr. Hiller (of the Boiler Insurance Company), Captain Sankey, and several others, all of whom admit it is a very difficult water to treat. One of the most successful treatments for the purification of water is known as the "Archbutt-Deeley" process, by which the carbonate of lime, or calcium carbonate, can be got rid of, and the hardness reduced from anything to about 4 per cent. Unfortunately, it will be noticed that in our water the carbonates are low, the sulphates predominating. Calcium sulphate is one of the most objectionable constituents of boiler water on account of the hard scale it produces. I am of the opinion that sulphate of magnesia is formed, as carbonate of lime, when boiled with sulphate of magnesia is transformed into sulphate of lime, and, when the temperature is high enough, changes into hydrate of magnesia, the chemical change forming a hard scale like porcelain, similar to that which we had in our boilers. An excellent paper was read by Mr. Leonard Archbutt before the Institution of Mechanical Engineers, on the subject of "The Softening of Water," in which he showed clearly that certain classes of water do not render themselves amenable to treatment, and in many cases the source has to be given up and a fresh one sought after. I, therefore, think it is advisable for the committee to wait and see the effects of the condensing plant, as I have designed it in such a manner that we use the water over and over again, adding about 12 per cent. as make up, which 12 per cent. I propose taking from the discharge side of the condenser, and this water, after having been cooled, softened, and heated many times, should be fairly pure. We have tried both town and Jackwood Spring water for this purpose, and do not find that by using the town water the result is any better than the Jackwood Springs for steam-raising purposes, and taking into consideration the expense of using the town water as compared with the Jackwood spring water, the advantage is strongly in favour of using the latter. I have given a great deal of attention to this subject and the correspondence, reports, etc., would fill a small book, and I have fully appreciated the fact that it is our most serious trouble, and for that reason I may say that the new plant when erected should remove most of this, as we shall be using distilled water, with the exception of about 12 per cent. make-up, which will be purified and treated, so that the difficulties with the corrosive action in the tubes and

Digitized by Google

deposit may be removed. This will effect a saving to us of at least £300 per year in repairs.

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of Electricity.			
Fuel	£2,445	12	9
Oil	90	7	8
Water, waste, and engine-room stores	80	4	4
Wages—Generating	566	13	9
Repairs, materials	196	7	0
Total works costs	3,379	5	6
Distribution.			
Repairs to mains—wages	10	14	10
Repairs to meters—wages	12	14	10
Repairing meters, transformers, etc.	4	1	7
Meter inspector	21	17	6
	3,428	14	3
Public Lamps.			
Wages of trimmers	198	4	8
Carbons	49	16	5
Globes, fittings, repairs, etc.	30	12	6
	3,707	7	10
Rent, rates, and taxes	299	12	9
Management expenses	1,048	9	1
Insurance	41	12	4
Miscellaneous	73	3	11
Total expenditure	5 170	5	11
Interest on capital	1,213	16	6
Redemption fund	1,142	9	2
	7,526	11	7
Net profit for year after paying 3 per cent. on the capital outlay, and setting aside 3 per cent. redemption fund	764	12	10
	£8,291	4	5

Cr. Income.	£	s.	d.
Sale of current per meter	6,767	15	9
Public lighting	815	6	8
Wages, repairs, carbons, and interest	552	16	7
Rental of meters	266	4	9
Sale of ashes	21	19	6
Extra tests	6	6	0
Miscellaneous	62	11	2
	8,493	0	5
Less allowance for bad debts	201	16	0
	£8,291	4	5

Financial.—Referring to the revenue account, the profit for the year available for dividend if the undertaking were owned by a company is £3 120, as against £3 984 for the previous year, and after paying the interest and redemption fund on the borrowed capital there remains a net profit of £764. Comparing the gross profits with the previous year the sum is less by £864, which is attributable to the large reduction in the prices charged for electricity in the borough both for private and public lighting; the average price obtained from private consumers being 4·8d. per unit, and for public lighting 1·19d. per unit, which price for public lighting is lower than any other town in the kingdom. The previous year the average price charged to private consumers worked out at 5 68d. per unit, or nearly 1d. more, and the average price obtained for public lighting was 2 93d. per unit, or 1¾d. more per unit This means that the private consumers have been getting their electricity at nearly 25 per cent. reduction, and the public lighting (the general district rate) have been supplied at a reduction of 140 per cent. It is not surprising, therefore, that the profits should be considerably reduced. It is interesting to note the relative prices obtained from various classes of consumers in Tunbridge Wells: public houses and hotels, average price paid for electricity per unit, 3 9d.; shops, 4·8d.; private houses, 4 89d.; offices (early closing), 6 00d.; churches, 6·00d.; from which it will be seen that public-houses and hotels obtain their supply at an exceedingly low rate, and far cheaper than they could ever hope to generate it for themselves. The fuel works out at an increase of ·22d. per unit. The stoker's bonus system has worked well during the year, and tends to reduce the amount of smoke emitted from the shaft. In the other items, which comprise the works costs, it will be seen that they have been reduced, although not so much as I should like. If we had not reduced the price, our net profits this year would have been £3,130. It will be seen from the income side of the account that the wages, repairs, carbons, and interest on the capital, which may be properly debited to public lighting, amount to a large proportion of the total revenue obtained for public lighting, and, of course, this sum must be deducted from the total revenue for public lighting in order to ascertain the true price charged per unit, as it then places public lighting on the same basis as a private consumer, which consumer has to wire his house and supply his fittings at his own expense.

Mr. Boot also gives a table, showing the progress of the undertaking, and states that so far as the costs go, and owing to unfavourable circumstance, he has been unable to show a decrease in the total costs. However, this was general with all undertakings, and was caused by the increased price of fuel. A table is then given showing the works costs at neighbouring towns, and it is interesting to note that Tunbridge Wells comes fifth, the cost per unit sold being 1·63d. and the number of units sold 496,297. The dividend on stock and redemption fund are responsible for £2,355, which is equal to 1·13d. per unit, from which it will be seen that the capital outlay bears very important relationship to the success of the undertaking.

ANALYSIS OF COSTS SHOWING PROGRESS.

—	1899-1900.			Cost per unit.	1898 9. (approx.)	Cost per unit.
Coal and other fuel	£2,445	12	9	1·18d.	£1,350	·96d.
Oil, water, waste, and stores	170	12	0	·07d.	109	·07d.
Wages of workmen	566	13	9	·27d.	511	·357d.
Repairs and maintenance	196	7	0	09d.	112	·07d.
Works costs	3,379	5	6	1 63d.	2,082	1·48d.
General costs—						
Rents, rates, and taxes	299	12	9	·14d.	213	·152d.
Management expenses	1,163	5	4	·557d.	899	·643d.
Total costs	£4 842	3	7	2·327d.	£3,194	2·275d.

STATEMENT OF ELECTRICITY GENERATED AND SOLD.

Quantity generated in B.T. units			620,558
Quantity sold	Public lamps	164,924	496,297
	Consumers by meter	332,273	
Total maximum supply demanded (kilowatts)			423

Number of lamps, 28,502 (66 arcs).

The statement of electricity generated and sold is satisfactory. The number of lamps connected has gone up considerably, the maximum supply demanded has increased from 306 kw. to 423 kw., or an additional 200 h.p., and we now have as many lamps connected to the mains as we have inhabitants, which is a record result.

Net Profit.—Adding our net profit for this year to the balance brought forward from last year (after giving last year 1d. to the general district rate), there remains a surplus to date of £2,039 for the Council to deal with, and I would recommend that £1,000 of this amount be put to the reserve fund, the remaining £1,039 being carried forward to next year's account. I regret that I cannot recommend the Council to further reduce the price of electricity, but hope at some future date, when the price of coal and other materials have gone down to their normal, that I shall again be able to recommend a further reduction, as I believe a "cheap and efficient supply" is the correct motto for a successful electricity works. We have sold more than 40 per cent. of our total units to private consumers at 3d, the figures being 125,007 at 3d. and 207,266 at 6d. A table is given showing a comparison of the average price obtained for private and public lighting in similar towns, Tunbridge Wells coming about second in the list.

Public Lighting.—The Council have during the year decided to light 262 additional electric incandescent lamps. This will mean that the borough will be lighted by arc and electric incandescent lamps, with the exception of the outlying streets, where no cables are laid.

As to workmen's dwellings, it is suggested that if the Council decide to build houses for the working classes they should instal the electric light, as they could well afford to supply workmen's dwellings at 10s. per 8-c.p. lamp per annum. The lamps would remain the property of the Corporation. Free wiring was quite as necessary to-day as ever, and there was a future before a firm who would work the business on sound commercial principles and give satisfaction. Many householders who let apartments appeared to have appreciated the value of electricity as an illuminant, and many of them have had the electric light installed. As to the supply of lamps, owing to many complaints due to faulty lamps, Mr. Boot thinks it would be in the interests of the undertaking to supply lamps to the consumers of a well-known make at cost price plus a small additional sum to cover expenses. When the new works are finished there will be room to accommodate over 2,000 kw., or sufficient plant to supply 120,000 8-c.p. lamps connected. At present, however, only orders for plant to the extent of 1,170 kw. are being placed. He also considers it advisable to extend their lighting area, as they could supply neighbouring towns and villages at a much lower rate than they could afford to if they established their own works He would recommend the Council to purchase motors and heating apparatus, and to let them out on hire to the consumers. This has been done with considerable success in many of the large towns, and he thinks there would certainly be a market and demand for same in this town.

Mr. Boot then says: "Before concluding, I desire to thank the chairman and members of the committee, who have given most valuable time to the town in the interests of the undertaking, as well as the staff employed, for their loyal services, and the officials belonging to the other departments for their kind assistance."

Appended to the above report is a copy of the report presented to the Electricity Committee, in which Mr. Boot sets forth the advantages of electric tramways. For Tunbridge Wells, it may be remembered, he recommends the use of the overhead trolley system, and gives the routes along which the tramways might run. The best route, and the route which would be of most service to

Digitized by Google

the inhabitants of the town, would, he thinks, be from the Brighton Railway Station *vid* Montacute-road, Eridge road, London-road, High-street, Mount-pleasant, Grosvenor-road, St. John's, London-road (Southborough), the total distance being three miles. The narrowest point on this route is 25ft., and the heaviest gradient 1 in 9, which, however, is short. The sharpest radius is at the bottom of High-street, being 11ft. The length of the alternative routes is about the same; the narrowest point being on one of 24ft. The heaviest gradient is 1 in 15. On the other the heaviest gradient is 1 in 9.

A rough estimate by the author as to the cost of construction is as follows:

Track construction, including by-passes	£15 000
Overhead construction	5,400
Six cars	3,600
Car-shed	7,000
Sundries, say	2,000
Total cost of equipment	£33,000

It would, of course, be necessary to add to the machinery at the works, but this would not be very expensive, as the load factor on a tramway system is high. As to the working expenses, he puts it at 8d. per car mile, on account of the hills. The number of car miles estimated to be run in 313 days, working 10 hours per day, with four cars on the route, was 75,120 car miles. Thus the cost per annum equalled £2,504; interest and sinking fund on the capital expenditure, at 6 per cent., equals £1,980—making a total of £4 484 per annum. Each car could carry 44 passengers when taking about 44 kw. Each car would be equipped with two 25-h.p. motors geared to the axles, and the current supplied to the motors would be controlled by the motorman through a series-parallel controller.

LEGAL INTELLIGENCE.

COVENTRY GASFITTING, ELECTRICAL, AND ENGINEERING COMPANY.

In the Companies' Winding-up Court, on the 25th ult., Mr. Justice Wright heard the petition of A. Davies and another for the winding-up of the Coventry Gasfitting, Electrical, and Engineering Company, Limited.

Counsel said since the presentation of the petition a scheme for reconstruction had been laid before a meeting of the company, and a resolution had been passed by the directors asking that the petition should be allowed to stand over for six weeks.

Mr. Buckmaster, representing two creditors, said his clients knew nothing of the scheme, which should be laid before them in a formal and proper way. He suggested that there should be an adjournment for a fortnight.

His Lordship adjourned the petition for six weeks, with liberty to restore it to the list within that period if necessary.

LONDON ELECTRICAL CABS.

In the Companies' Winding-up Court on the 31st ult. Mr. Justice Wright gave his reserved judgment in the matter of the petition of Colonel C. E. Foster and others for the compulsory winding-up of the London Electrical Cab Company, Limited.

The directors opposed the petition on the ground that compulsory winding-up would render valueless their only remaining assets, which consisted of two licenses.

Mr. Counsel, for the petitioners, said all personal charges against the directors had been withdrawn.

Mr. Justice Wright said the interests of the shareholders ought to be protected so far as the licenses were concerned, and the business of the Company ought not to be terminated. The alleged secret agreements had not been supported by evidence, and he was willing to appoint a provisional liquidator if asked to do so.

The matter was allowed to stand over until next Wednesday.

RECORDING TELEGRAPH, LIMITED.

Mr. Justice Wright also heard a winding-up petition of this company this week. It was mentioned that the company's assets consisted of shares in another company, which it was expected would become more valuable in a short time. The petition was ordered to stand over so that evidence might be filed.

REFUSE DESTRUCTION.

On Tuesday, at Lambeth, the South London Electric Supply Company were prosecuted for causing a nuisance by burning refuse at their works at Loughborough Junction. The company are by contract with the Vestry compelled to take over the refuse and destroy it.

The case was adjourned on the undertaking that no more refuse would be burnt.

FIXING UP A TELEPHONE.

Mr. H. E. Childs, Liverpool-road, Islington, sued Messrs. Charles Atkins and Nisbet, 1, Water-lane, in the City of London Court last week, for £3. 3s. for fixing up a telephone at their premises. The defendants paid £2. 10s. into court, and said they thought that was more than the plaintiff was entitled to—an incompetent workman had been sent in the first place, and the work might have been done by an ordinary bellhanger. The plaintiff said his charges were quite reasonable. The learned Commissioner pointed out that the defendants had not made any bargain as to price. A jury would have to decide what was reasonable under the circumstances. The plaintiff must summon a jury within three days, or be non-suited.

COMPANIES' MEETINGS AND REPORTS.

ST. HELENS CABLE.

This Company held their first annual meeting on Oct. 21 at St. Helens.

Mr. Heyl-Dia, taking the chair, proceeded to report on the progress of the past 13 months, which was so satisfactory that although the Warrington electric cable works had only been working for the past six months, the Board were in the pleasant position of being able to recommend that a dividend of 6 per cent. on the ordinary shares be declared and paid forthwith. The prospects of the Company were as bright as could be wished, as the works were going night and day, and the continued addition of new plant was being fully occupied as it was put down.

The report was adopted unanimously, with the usual amenities amenities attending the conclusion of a satisfactory meeting.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The directors, in their report for the half year ended June 30 last, state that two quarterly dividends of 1½ per cent. each have been paid, leaving £116,953, from which £120 has been deducted for dividend on new shares, and £100,000 transferred to the general reserve fund, leaving the balance of £16,833 to be carried forward. The gross receipts amounted during that period to £313,227, against £324,361 for the corresponding half-year of 1699. The working expenses, including £28,261 for maintenance of cables, absorb £108,660, against £107,267 for the corresponding period of 1899, leaving £204,567. During the half-year the unissued balance of 50,000 shares of the Company's share capital was issued to the shareholders at a premium of £3 per share, or £13 each, and an official quotation has been obtained. The balance of 5 per cent. Australian Government subsidy debentures has been paid off.

CAPE ELECTRIC TRAMWAYS.

The report of the directors for the year ended June 30, to be presented at the meeting to be held in London on 14th inst., shows a net balance to credit of £65,204, which added to £15,615 brought forward, makes a total available of £80,820. The directors have already paid two interim dividends amounting to 9 per cent. upon the capital. The directors have also placed £8,000 to the credit of the reserve fund, and have created a special reserve to the credit of which they have placed £12,000. The directors recommend a bonus of 3 per cent. upon the capital, which will absorb £12,000, leaving £12,820 to be carried forward. During the 12 months' working the Cape Town system has carried 11,332,627 passengers, as against 8,489,490 passengers in the preceding year. The Port Elizabeth system has carried 2,967,420 passengers, as against 2,563,259 passengers in the preceding year. The grand total of passengers carried on both systems for the preceding year was 11,052,749. For the year under review the total number is 14,300,047, which shows an increase of 3,247,298.

WESTERN TELEGRAPH.

The ordinary general meeting of the Western Telegraph Company, Limited, was held on the 30th ult. at Winchester House, E.C. Mr. W. S. Andrews presided. The report and accounts, already noted by us, were passed.

The **Chairman** said the joint working of the two companies had proved to be more advantageous than the separate workings had been.

A final dividend of 3s. per share (making 6 per cent. for the year) and a bonus of 2s. per share was declared.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Midland Railway Company.—Particulars of contracts for stores, 1901, will be found in our advertisement columns. Tenders close Nov. 13.

Kendal.—The Corporation invite tenders for the supply and erection of various plant. Tenders by Dec. 1. Details in our advertisement columns.

Farnworth.—The Urban District Council invite tenders for the wiring of premises on a deferred payment system. Tenders by Nov. 12. Details in our advertisement columns.

Newcastle-upon-Tyne.—The New Tramways Committee of the Corporation invite tenders for arc lamps and accessories. Tenders by 21st inst. Details in our advertisement columns.

Digitized by Google

Pemberton.—The Council invite tenders for boilers (preferably Lancashire), engines and dynamos, battery, switchboard, crane, and conductors. Tenders by Nov. 8. Details in our advertisement columns.

Nottingham.—Tenders are invited for the installation of an electric lighting plant at the new workhouse. Specifications may be obtained from Mr. G. Muncaster Howard, clerk, Poor-Law Offices, Nottingham.

Grantown-on-Spey.—The Commissioners of the burgh invite tenders from electric light companies to supply electric light for public and private consumption within the burgh. Tenders by Nov. 6. Details in our advertisement columns.

Wolverhampton.—The Tramways Committee invite tenders for erection of car depôt, paint and repair shops, etc., at Cleveland-road. Plans, etc., may be seen at the office of Mr. J. W. Bradley, C.E., M.I.M.E., borough engineer, Wolverhampton. Tenders by Nov. 19.

Glasgow.—The Executive Committee invite tenders for the wiring for arc and incandescent lighting and electric motors at the Glasgow International Exhibition, 1901. Full particulars can be had on application to Mr. Thomas Young, the engineer, 4, West Regent-street, Glasgow.

Manchester.—The Tramways Committee invite tenders for the supply of cast-iron bases for tramway poles. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by Nov. 9. Details in our advertisement columns.

Walker (Northumberland).—The Urban District Council invite tenders for the erection, complete, exclusive of buildings, of a two-unit dust destructor of the Meldrum type, etc. Specifications can be obtained from the engineers, Messrs. Handcock and Dykes, 1, Victoria-street, Westminster, London, S.W. Tenders by Nov. 13.

Harwich.—Tenders are invited for gas-engines, dynamos, cables, battery of accumulators, combined lighting and traction switchboard, street boxes, corrugated iron buildings, engine and dynamo foundations, double-decked cars, track laying, and traction equipment. Tenders by Nov. 17. Details in our advertisement columns.

Leeds.—The Leeds Tradesmen's Benevolent Institute invite tenders for the installation of electric light required in alterations and additions to 41, Park-square, together with three shops and business premises, Park-lane, Leeds. Plans, etc., can be obtained from Messrs. Butler, Wilson, and Oglesby, architects, 12, East-parade, Leeds.

London (City).—The Streets Committee of the Corporation invite tenders for the hiring of a mechanically-driven dust-cart for collecting and removing the dust, trade refuse, and street sweepings from the City to the Corporation's depôt at Lett's Wharf, Commercial-road, Lambeth, S.E. Tenders by Nov. 10. Details in our advertisement columns.

Stockport.—The Tramways Committee invite tenders for the overhead equipment and supply of rail bonds for six sections of their electric tramways, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Specifications, etc., may be obtained from Mr. A. J. H. Carter, electrical engineer, or Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Stockport.—The Tramways Committee invite tenders for the laying of the permanent way of their electric tramways, including concrete foundation, but excluding bonding and paving, in six sections, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Plans, etc., may be obtained on application to Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

London, S.W.—The London County Council invite tenders for the supply, within 10 weeks of the order being given, of about 150 arc lamps, required in connection with the electric light installation for the Victoria-embankment and Westminster Bridge. Approximately, 80 of the lamps will be for current of 10 to 12 amperes, and 70 for current of 5 to 6 amperes. The lamps will be run in both cases 10 in series, and the supply will be from one or more dynamos, the pressure available being from 460 to 480 volts. Each person tendering will be required to submit a drawing of the kind of lamp which he proposes to supply, showing details of construction, and the materials to be used. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1. Tenders by Nov. 13.

RESULTS OF TENDERS.

Bradford.—The Council have confirmed a contract with Messrs. Pollit and Wigzell and the Electric Construction Company, Limited, for the supply of an engine and alternator, at £3,975.

Louth (Lincs.).—The Free Wall Paper Company, Limited, have placed the contract for the electric lighting and power distributing plant in their works with Messrs. Crowther and Co., Manchester.

Birkenhead.—The Corporation have accepted the tender of the Callender's Cable and Construction Company, Limited, 90, Cannon-street, London, E.C., for the supply, delivery, and laying of feeder mains, etc.

Aberdeen.—The Tramways Committee have received a tender for the supply of 25 electric cars, the electric equipment of six of the horse cars, and the supply of spare parts from the British Westinghouse Company, Limited, at £18,439.

Bradford.—The Corporation have accepted the tender of Messrs. Newton, Bean, and Mitchell, Bradford, for engine and dynamo, etc.; and that of Messrs. Collinson Bros., Bradford, for switchboard, arc lamp-posts, etc., for their destructor works Southfield-lane, Bradford.

Hackney.—The Vestry have accepted the following tenders for their electricity works: Dorman, Long, and Co., Victoria-street, constructional ironwork, £3,145; British Insulated Wire Company, mains, including trenching, troughing, cables, boxes, and house service, £46,416. A note referring to these and a number of other tenders will be found in another column.

Eastbourne.—The Corporation have accepted the following tenders for the supply and erection of a water-tube boiler, with fittings, feed pump, etc., a 400-kw. steam alternator, with exciter (vertical enclosed high-speed engine), and main switchboard and connections: Stirling Boiler Company, two boilers, etc., £2,033; Ferranti, Limited, two alternators, etc., £7,850, switchboard, £982.

Longton.—The Gas and Electricity Committee have accepted the following tenders for electric lighting machinery: Electric Construction Company, Wolverhampton, engines, dynamos, boiler, balancer, and switchboard; Chloride Electrical Storage Syndicate, near Manchester, accumulators; E. Green and Son, Limited, Manchester, economiser; Babcock and Wilcox, London, boilers H. J. Coles, Derby, travelling crane.

Brighton.—The Town Council have received the following tenders in connection with rewiring the abattoir premises Hollingdean-road, for electrical installation:

G. Hignett, 5, Clifton-terrace, Brighton	£119 15 0
C. J. Reed and Son, North-street, Brighton	98 10
H. G. Galliers, 21, St. James's-street, Brighton (accepted)	95 0
Page and Miles, Limited, 60, Western-road, Brighton.	54 15

BUSINESS NOTES.

TRACTION.

Paisley.—Mr. Murphy has made yet another offer. A poll of ratepayers is to be taken.

Lowestoft.—The Town Council have agreed to Mr. Walter Beer's terms, and instructions are to be given to him to proceed with his surveys of the proposed tramways.

Darlington.—A motion to rescind a former resolution of the Town Council in support of the Imperial Tramways Company was on the agenda for the last meeting of the Town Council, but was withdrawn.

St. Helens.—The town clerk of St. Helens has been instructed to take all necessary steps with a view to the construction of a loop line along Pecker's-hill-road and Junction-lane, Sutton, in connection with the tramway from Robin's-lane to the borough boundary in Bold-road.

Merthyr.—The arbitration conference upon a variety of important points in which the Merthyr District Council are concerned, on the one side, and the British Electric Traction Company, on the other, in regard to the construction of the new tramlines, etc. commenced in London on Monday last.

Folkestone.—The Corporation have decided to promote a Bill for tramways for the town. As already reported, the scheme will cost £95,000. The Sandgate and military authorities have accepted the scheme. The Chamber of Commerce have passed a resolution expressing their full support of the scheme.

Islington.—At the last meeting of the Vestry a letter was read from the London County Council stating that it proposed to introduce a Bill in the next session of Parliament for powers to construct tramways from the Archway Tavern along the Archway-road to the county boundary, and from the junction in Mildmay-park to Ball's Pond-road.

Darwen.—The Tramways Committee of the Town Council are to confer with Messrs. Leslie and Co. with regard to a proposal to construct a tramway from Bolton to Cadshaw Bridge. The surveyor is preparing a statement showing the cost of street improvements and the purchase of property and fully constructing and equipping the line to Sough.

Bury.—Plans submitted by the borough engineer for a large number of tramway sections have been approved, and will be included in the proposed Bill. The estimated cost of the Bury tramway scheme is about £200,000, and it is thought that in the course of about two years there will be a complete network of electric trams in the borough.

Wigan.—The Town Council's application for consent of the proposed tramway in Standish will be considered at the meeting of the Council on Nov. 5. The Aspull District Council having refused to consent to the construction of the proposed tramway within their district, so much of the proposed tramway as is situate within the township of Aspull will be withdrawn from the Bill.

Digitized by Google

Gosport.—A special meeting of the Gosport and Alverstoke Urban District Council will be held on the 6th for the purpose of considering the following resolution: "That notice be given to the Gosport Tramways Company that it is the intention of the Gosport and Alverstoke Urban District Council to purchase the tramways in accordance with Section 43 of the Tramways Act, 1870."

Newcastle.—The New Tramways Committee have adopted a suggestion of the electrical engineer (Mr. Hopkinson) recommending a larger proportion of double-decked cars in place of long single-decked bogie cars. They have also agreed to let the contract for the new sections of work, including the Stanhope-street and Barrack-road sections, and that the work should be commenced immediately.

Branksome.—The tramway from Poole railway station through the Poole-road to Parkstone, and along the Ashley-road to the County Gates, Westbourne, is making rapid progress. A large proportion of the permanent way is laid, and the iron standards with the long arms for the overhead wires are erected all along the line of route. It is anticipated the lines will be open for traffic soon after Christmas.

Belfast.—A Board of Trade inspector made an official inspection of the tramways laid on the Newtownards-road and the Cliftonville-road on the 31st ult. The tramway company announced that they proposed to commence working on these extensions on Nov. 1, and, doubtless, this intimation will give general satisfaction to citizens, especially those residing in the districts more immediately concerned.

Mr. Yerkes Again.—The *Daily Chronicle* says Mr. C. T. Yerkes announces in the *New York Sun* that, in addition to his Charing Cross-to-Hampstead underground, he will seek to establish surface electric lines, radiating in all directions fan-like from his northern terminus to a common centre. He does not, however, propose doing for South London or the East-end what he is about to undertake for the North.

Halifax.—A letter having been received from the clerks of the Southowram Urban District Council asking for an assurance that the Corporation would take trams into their district, the town clerk has been instructed to reply that the Corporation had obtained powers to construct tramways, with the intention of carrying them into every district named in the Act of Parliament within the period fixed for completion.

British Electric Street Tramways, Limited.—This Company has been registered with a capital of £300,000 in £10 shares, the object being to construct or purchase and equip electric tram and rail roads, etc., to adopt an agreement with the Electric Tram Construction and Maintenance Company, and, further, to carry on in all or any of their respective branches the businesses of mechanical and electrical engineers, electricians, etc.

Lake District Tramways.—The promoters of the proposed electric tramways between Bowness, Windermere, and Ambleside will offer and advertise a scheme, with new plans, for the coming session of Parliament. The company are endeavouring to meet the views of the Ambleside, Bowness, and Windermere Councils as to road widening, and it is expected that much of the recent opposition will not be renewed against the new scheme.

Clerkenwell.—The Vestry have decided to agree with the following resolution of the Paddington Vestry: "That a communication be sent to the Local Government Board embodying a strong expression of opinion in opposition to the suggestion of the President of the Board of Trade to the effect that the London County Council should have further facilities to make proposals for new tramways without the consent of local authorities."

Huyton.—At a special meeting of Huyton-with-Roby Urban District Council, held on the 31st ult., Mr. J. B. Atherton and Mr. F. J. Leslie attended, and on behalf of the South Lancashire Tramway Company explained a scheme for laying a tramline from the city boundary at St. Thomas-road, Broad Green, where the Liverpool city tramways would join it, along Broad Green-road, Roby-road, Archway-road, Huyton, and Huyton-lane to Prescot.

Bolton.—The Tramways Committee have approved of a large number of additional tramways and extensions, and they have requested the Parliamentary Sub-Committee to give directions for the promotion of the Bill authorising the construction of such additional works and for the relaying and doubling of the existing track where necessary. An estimate is to be obtained for the supply and fixing of patent lifeguards to all the cars, and an arrangement will be made for an early interview with the Farnworth District Council as to the electrical equipment of the Farnworth tramways.

Stratford.—At a meeting of the West Ham Town Council on Tuesday a report of the Lighting and Tramways Committee on arrangements to be made for proceeding with the tramway scheme, authorised by the Council's Act of last session, was adopted. The report recommends that Mr. Waller be directed to proceed generally with the plans for the tramway scheme, with the exception of the electrical equipment, in accordance with the terms of his engagement approved by the Council; that the electrical engineer and consulting electrical engineer be directed to proceed with the plans for the electrical part of the undertaking; and that the borough engineer with the plans of the generating station and other buildings required.

Cardiff.—The Tramways Committee on Friday heard the report of a sub-committee on an interview with Mr. Glen, engineer to the Cardiff Tramway Company, stating that Mr. Glen objected to the bonding of the lines at present so as to make them serviceable for electric traction. However, he would recommend his directors to reconstruct the lines in such a way that they would be suitable for electric motive power, and have the system handed over complete to the Corporation at the end of 1901, if a mutual agreement could be arrived at with regard to the valuation of the lines. The sub committee thought that such valuation should be taken. It was decided to obtain the remarks of the town clerk on the report. An offer from the Tredegar estate management was read of a 60 years' lease of the railway siding for the power station on the Newport-road site, and was accepted.

Manchester.—At the meeting of the City Council on Wednesday the Council was asked to approve of a recommendation of the Tramways Committee to the effect that the sub-committee appointed in reference to the Manchester Corporation Tramways Bill of 1900 be authorised to enter into agreements with the Manchester Carriage and Tramways Company and the several local authorities in reference to the reconstruction of the lines, and to the fixing of the dates of accruer of the right of purchase of tramways or otherwise in connection with any arbitration or arbitrations arising under or in consequence of the Manchester Corporation Tramways Acts, 1899 and 1900. Surveys are again being made in the meadows between Eccles and Barton for the line of the Manchester-Liverpool Electric Express Railway prior to the Bill being deposited in the House of Commons.

Gloucester.—The Mayor made a statement at Tuesday's meeting of the City Council with regard to the proposed acquisition of the tramways by the Corporation, and the conversion of the same into an electric tramway (a scheme which has been recommended by the committee). He said that it would be necessary to give a month's notice for any resolution authorising such acquisition, and he, therefore, suggested the postponement of the minutes in regard to the matter. This was agreed to, and it was stated that the meeting to take up the consideration of the matter would be held in the middle of December. We might mention that in consequence of the extension of the city boundaries the whole of the Council was re-elected yesterday, and the number of representatives increased, and considerable local interest is being evinced as to the policy the new Council will adopt on the tramways and other municipal questions.

Rhyl.—At a special meeting of the Rhyl Urban District Council on Tuesday the Council decided to apply for the necessary additional loan required to cover the cost of the installation, £15,000 having already been granted. A lengthy discussion took place regarding the agreement between the Council and the tramway company, by which the former agreed to supply the latter with current. The Council had insisted upon a guarantee that the company would take 150,000 units of electricity per annum, and in turn the company asked that they should be paid a penalty in the event of the Council failing to keep up a regular supply. The Council asked for a car mileage penalty based on the average takings of the company, but the latter suggested that the penalty should be at the rate of £10 per hour. The agreement was referred back to the committee, with a proviso that the penalty should not exceed £2 per hour, and that the Board of Trade be asked to withhold confirmation to the order until the Council had completed the agreement.

Southampton.—At the last meeting of the Town Council the following minutes of the Parliamentary Committee were adopted: "The town clerk submitted the minutes of evidence taken before the Select Committee in the House of Commons, Messrs. R. S. Smith and Co.'s petition thereto, and Chancery writ. Also read the correspondence with Mr. C. Lamport and Messrs. Speechly and Co., in reference to the tramways in Bridge-street and High-street. Mr. Waller submitted and explained his plan showing proposed altered curve in the line in High-street and Bridge-street. It was resolved that unless Mr. Waller's plans be agreed to by the engineers to Messrs. Smith and Co. within 14 days from this date, the town clerk be directed to immediately apply to the Board of Trade to appoint an engineer to arbitrate, pursuant to the terms of the order, as confirmed by Parliament." The Council also approved of a draft agreement with Messrs. Griffiths and Millington, Limited, in substitution for the existing agreement relating to advertising in cars for a period of five years. The old agreement was for £21. 5s. per car, and £13 for the omnibus. The sum mentioned in the proposed new agreement was £18. 10s. per car, £13 for each omnibus, and £10 for the trailers.

Falkirk.—The agreement mentioned in our issue of Oct. 12 has been signed. It is to be a fair and good arrangement. The conditions the company offer to the burgh are the following: For the first five years the company pay to the Commissioners annually at the rate of £100 a mile in name of maintenance and upkeep, after the expiry of five years they were to pay the Commissioners £120 a mile annually for the use of the road. Wherever the line passes through the burgh and for 18in. on either side of the line the road is to be causewayed by the company to the satisfaction of the Commissioners, and in the case of a street already causewayed the Commissioners are to get the causeway setts taken out, the value of these setts being about £2,000. Altogether the burgh will get from the tramway company £300 a year for the first five years, and £400 after that and all these privileges. The use of the streets will be granted to the company for 25 years, when it will be within the option of the Commissioners to acquire the undertaking as a whole on payment to the company in name of goodwill a sum amounting to the profits of the four preceding years. At the end of 30 years the burgh can take it over by arbitration, and the amount they would have to pay in this case would be the profits of the two preceding years. Supposing they did not purchase it even then, they can do so at the end of 37 years under the most favourable method of purchase—under the Tramways Companies Acts—without paying for goodwill, etc.

Digitized by Google

Central London Railway.—It is impossible to say to day what the effect of Monday's crowd will be on the traffic returns of this favourite London line. The weekly receipts have been growing apace, and they have gone up to £6,102 for the week ending Oct. 27, making a total of £64,498 for the 13 weeks the line has been in operation. This works out at exactly £5,000 per week. Considering that the average of the last 10 weeks is a very much higher one, it might safely be assumed that the annual total will not fall short of £280,000. Assuming that at present the ratio of expense will be 50 per cent.—and we have little doubt that after a short time this figure will be reduced to 40 per cent.—the shareholders will have nothing to grumble at. The total share capital is £2,850,000—all issued—and besides that the Company had power to issue £900,000 of debenture stock, none of which had been issued at June 30 last. Probably £750,000 worth of debentures will have to be issued shortly, £2 000 for expenses already secured on capital account, and £500,000 for the contractor's deferred payment. This, at 4 per cent., means £30,000 a year for interest. That would still leave £150,000 to be kept in reserve for unforeseen needs. Taking the expenses at 50 per cent., this would give a net profit of £140,000, and after payment of £4 on debentures, 3 8 per cent could be divided on the ordinary shares, making £4 for preferred and about £3 12s. 6d. on the deferred stock. At the 40 per cent. ratio this 3 8 would at once jump to 4 8, which would mean over £5. 10s. on deferred stock. Both classes of stock, as well as the debentures, are, therefore, well worth a premium of 20 per cent.

Plymouth.—Mr. J. H. Rider, the borough electrical engineer, has supplied the following reassuring memorandum, to which we are indebted to the *Western Morning News*, at the suggestion of Councillor Page: "As there have been a number of incorrect statements made regarding the accident on the Prince Rock line on Tuesday last, it may be well if I briefly state the facts: (1) The accident was due to a telephone guard wire, and not to a trolley wire; (2) the guard wire did not fall through any defect in itself or in its supports, but because it was knocked down by the trolley of an electric car; (3) the car in question was not one of the regular cars, doing its ordinary rounds, and carrying passengers, but was a new car under test and on a trial run, in the sole charge of the contractors; (4) the trolley left the wire either because the car was being driven too fast round the curve, or because the trolley was improperly set; it broke the guard wire support, which allowed the guard wire to fall upon the trolley wire, where it was burned through, and the ends then fell to the ground. Had the contractor's representative, who was driving the car, remained on the spot until the current had been switched off, and prevented any person from going near the fallen wire, all would have been well. But for some unexplained reason he proceeded into town with his car, leaving the wire unprotected. Telephone guard wires have to be fixed by order of the Board of Trade and the Postmaster General, and they are often the cause of more accidents than they prevent. So long as they are not in contact with the trolley wire they are harmless, but when in contact any person who touches them may receive a shock. As the pressure on the trolley wire is not more than 500 volts, there is practically no danger to human life, a burn, more or less severe, being the usual result. In the event of a similar accident occurring in the future, the best thing is to keep quite clear of any fallen wire, to prevent anybody or anything from touching it, and to send at once to the car-shed or to the electricity works. When it is imperative that a wire should be handled, the hand should be protected with a glove or a cap, or similar article, and no shock will be felt."

Portsmouth.—The scheme of electric tramways for Portsmouth was advanced a stage on Monday, when the Mayor (Councillor H. R. Pink) laid a commemorative tablet in the walls of the electrical tramway power station, which is in course of erection at the rear of Fratton road A large number of persons witnessed the ceremony. The engine-room is, of course, the chief part of the new building; in this instance it is 116ft. long, 49ft. wide, and 23ft. high. The floor, which will be 3ft. higher than the level of the roadway, will be constructed throughout of brick. Three engines, all of the horizontal Corliss type, by Messrs. Yates and Thom, of Blackburn, are destined to do the work of this station. The electric generators will be of the usual engine type, and the dynamos will be by the English Electrical Manufacturing Company, Preston. In the engine-room will also be situated condensers, with independently-driven pumps, and an overhead travelling crane capable of lifting 25 tons. Underneath the engine room will be a basement for pipes, cables, and other accessories required in connection with the engine. A cable subway from this basement will lead under the passage to the roadway at the far end of the engine-room. Space is left for a fourth engine when necessity requires, and provision has been made for fitting and repairing shops. Water-cooling towers are to be used in connection with the surface condensers, by reason of which the cooling water is used over and over again, being pumped up to the top of the towers, whence it descends through a network of small pipes, reaching the bottom quite cold. Electrically-driven fans will be used in connection with the towers to force a current of air through the water as it descends. The whole of the condensing plant in the cooling towers will be made by the Workington Company, London, the pipework being supplied by the Alton Company, London. The roof of these buildings is to be formed by a large cast iron water-tank, in which will be stored about 25,000 gallons, and this immense weight will be carried on trussed steel rafters. The chimney shaft will be 125ft. high, with an inside diameter of 6ft. 6in In the boiler-house will be three Babcock and Wilcox water-tube boilers, each of sufficient capacity to run one of the larger engines. A Green's economiser will be fitted to each boiler, which will also be fed by steam superheaters. Space is provided for a fourth boiler, which would raise the boiler capacity to about 2,500 h.p. The contract price of the building is £10,515, and the machinery £29 656, but it is estimated that the cost of the whole undertaking, including the buying out of the Provincial Tramway Company, who formerly served the town, will be little short of £600,000, or a charge on the town of £30,000 a year for 20 years. The power station is being built by Mr. J. W. Perkins, of Portsmouth, from plans by Mr. E. Porter, electrical engineer.

LIGHTING AND GENERAL.

Aberdeen.—The electrical engineer is about to invite designs and tenders for a single-deck electric car.

Accrington.—The Town Council are making application for power to borrow £1,511 for electric lighting.

Worksop.—The Public Works Loan Commissioners have refused to grant a loan for the electric lighting works.

Dundee.—The extension of electric lighting during the past month is represented by the installation of 697 lamps.

Oban.—The Town Council have decided to apply to the Board of Trade for a provisional order for the electric lighting of the burgh.

Neath.—At a special meeting of the Town Council on Tuesday it was resolved to apply for an electric lighting order for the borough.

Warrington.—It is reported that there is every probability that the electric light will be ready in ample time for the Christmas displays.

Falkirk.—The Town Council intend to apply to the Board of Trade for a provisional order for electric lighting in terms of the Electric Lighting Acts.

Electric and General Investment Co.—Allotment letters in respect of the issue of 19,900 6 per cent. cumulative preference shares have been posted.

Colwyn Bay.—The Urban Council have obtained loans of £5,200 and £364 for electric light, fire brigade, and part of new promenade expenditures.

Shipley.—An order has been received from the Local Government Board authorising the borrowing of £22,000 for the purposes of the supply of electricity.

Cardiff.—Immediate steps are to be taken to institute a canvass of the town to obtain the view of the ratepayers on the advantages of the Post Office telephone.

Beverley.—Application is to be made for a provisional order to enable the Corporation to supply electricity for all public and private purposes within the borough.

South African Lighting Association.—The directors have declared a dividend of 4 per cent. (8 per cent. per annum), free of income tax, being the same as last year.

Stratford-on-Avon.—The following have been elected members of the Electric Lighting Committee: Alderman Hawkes, and Councillors Flower, Holton, North, and Park.

Dover.—The Admiralty Pier is being lighted electrically throughout. The work has been entrusted to Messrs. Donnison, Berlyn, Sillem, and Co., of London and Liverpool.

West Hartlepool.—Messrs. Bennett and Ward-Thomas, consulting engineers, of Manchester, have been instructed to report on a municipal telephone exchange for West Hartlepool.

Todmorden.—The Town Council intend to apply for a provisional order to supply electricity for lighting and motive power, and for all public and private purposes within the borough.

Glasgow.—The number of lamps applied for from Oct. 4 to 18 was 2,337 of 8 c.p. for lighting purposes, and 112 h.p. for motors, equal to 2,928 8 c.p. lamps, making a total of 5,625 8 c.p. lamps.

Poplar.—The District Board have decided to give Mr. Blackman, the electrical engineer, a gratuity of 250 guineas and to strongly recommend the new Council to increase his salary to £500 a year.

Dewsbury.—Colonel J. T. Marsh has held an enquiry into an application of the Town Council for power to borrow £7,500 for the purpose of supplying various districts within the borough with electric light.

Stafford.—An enquiry was held at Stafford on Wednesday before Mr. H. P. Boulnois into the application of the Town Council to borrow £10,000 for the purpose of extension of the electric lighting works.

Wednesbury.—We learn that, whilst as yet nothing definite has been decided upon by the Town Council, it appears certain that no electrical scheme involving any great outlay will be embarked upon at present.

Paisley.—At a special meeting of the Town Council on Tuesday it was agreed to forward a petition to the Secretary for Scotland, asking for additional borrowing powers to the extent of £25,000 for electric lighting purposes.

Bath.—During the quarter ended Sept. 30, 1,652 8 c.p. lamps have been installed by 29 new consumers. When these installations are completed there will be a total of 26,630 8 c.p. lamps connected to the supply mains.

West India and Panama Telegraph Co.—The directors have decided to draw partly upon the reserve fund for the payment of the usual dividends on the cumulative preference shares and 6d. per share on the ordinary shares.

Digitized by Google

Huyton Quarry.—With regard to the recent fire at the Premier Electric Lamp Works, Huyton Quarry, we learn that beyond some damage to the fittings and a quantity of globes ready for exportation destroyed, the loss is inconsiderable.

Hendon.—At Monday's meeting of the Urban District Council the following motion was lost: "That the resolution of the Council passed on Dec. 4, 1899, that the Council themselves carry out a scheme of electric lighting, be rescinded."

Batley.—Mr. Sandford Fawcett held an enquiry on Wednesday into the Corporation's application for sanction to borrow £25,602 to cover the cost of a generating station and the laying of cables for electric lighting in the centre of the town.

Gourock.—The Commissioners are taking steps to ascertain particulars about cost, borrowing powers, etc., with regard to the introduction of electricity into the burgh. The general feeling in the Commission is in favour of a comprehensive scheme.

Leeds.—The Lighting Committee have decided to advertise for tenders for the erection of the extension to the electric lighting works in accordance with the plans of Mr. Charles Brance, of Bradford, who was the architect for the present buildings.

Luton.—The borough engineer and electrical engineer have been asked to confer on the subject of street boxes and standards for arc lamps. The report of the electrical engineer upon tenders for the supply and delivery of meters has been deferred.

Bilston.—The Midland Electric Corporation for Power Distribution have notified the District Council that, in pursuance of orders obtained from it and the Willenhall Council, a number of the main streets in Bilston will shortly be taken up for the purpose of laying mains.

New Edition.—We are informed that Messrs. Whittaker and Co., of Paternoster-square, E.C., have just issued a second edition of "Electric Wiring, Fittings, Switches, and Lamps," by W. Perren Maycock, M.I.E.E. The work made its first appearance just a year ago.

Pacific Cable.—To the present Government of New South Wales belongs the credit of passing through all its stages the often-postponed Bill enabling New South Wales to join the other Colonies and Great Britain in the construction and maintenance of the Pacific cable.

Mansfield.—The Council have passed a resolution affirming that it is desirable to promote a Bill in Parliament for a number of matters, and it is understood that the electric light scheme will be proceeded with even if the part of the Bill relating to the tramway should fall through.

Stratton and Bude.—A Bill to purchase the Bude Harbour and Canal Company's undertaking is to be applied for by the Council during the next session of Parliament, and if obtained it is intended to use the surplus water for the electric light for Stratton and Bude.

London Gazette.—Notices of intention to apply for orders have appeared in the *Gazette* as follows: (1) Electric lighting—Standish-with Langtree Urban District Council, Ripon (City), Atherton Urban District Council; (2) electric lighting and tramways—Atherton Urban District Council.

Pentypridd.—The District Council are consulting Mr. Wilson with a view of selecting a site for electrical works. They have passed a resolution that application be made for a provisional order to authorise the Council to supply electricity for public and private purposes within the urban district.

Wigan.—The Town Council on Wednesday decided to apply for a provisional order of the Board of Trade empowering the Council to supply electricity within the borough. Mr. Miller, C.E., Liverpool, will be retained to advise the Corporation upon all matters relating to the proposed application.

Wandsworth.—The London County Council have consented to the laying of electric light mains by the County of London and Brush Provincial Electric Lighting Company in the following roads: Greyhound-lane, Wimbledon Park-road, Southdean-gardens, Macaulay-road, Beaumont road, Augustus-road.

Southgate.—The Council have sealed an agreement between the Urban District Councils of Enfield, Edmonton, Tottenham, Wood Green, and Southgate, for the promotion of a joint Bill in Parliament to confer powers upon a joint Board of the Councils mentioned to establish electric lighting in the districts.

Price-List.—We have received from Messrs. J. Spencer, Limited, of the Globe Tube and Engineering Works, Wednesbury, a copy of the twentieth edition of their price-list of steel and iron tubes, gauges, screwing machines, trolley poles, etc. The list is very complete, and catalogues tubes for use in all kinds of engineering work.

Rochdale.—At the conclusion of the meeting of the Town Council on the 25th ult. the members walked in procession to their electrical works in Gashouse-lane for the purpose of formally opening them. The Mayor presented Mr. Alderman William James Petrie (the chairman of the Gas Committee) with a golden key with which to perform the ceremony.

Strike.—A further attempt has been made to settle the strike of electrical tramway men at Ashton, Oldham, and Hyde. The men on Saturday withdrew the offer made on the 26th ult. to submit the dispute to arbitration, but it was announced on Wednesday that the Board of Trade have appointed Mr. G. R. Asquith as arbitrator, who at once intimated that all the men should return to work pending his decision.

British Westinghouse Co.—We have received from this firm their circular No. 1,033, which deals with their direct-current engine-type multipolar 125-volt generators for lighting service. The circular contains a full description of the various parts of the machines, these parts also being separately illustrated. Outline drawings are also shown in connection with tables which have been drawn up showing the approximate dimensions of the standard machines. This type of generator is also illustrated when direct-connected both to Westinghouse steam and gas engines.

Hampstead Electric Supply.—A fool and his money are not so soon parted nowadays as formerly. And a good thing, too, it is for the fool. We notice that the shares in the above Company are still being peddled about the country. They don't seem to find too many purchasers, and those who intend to invest in them might, in our opinion, keep their money for better purposes. Although the Company was formed in the summer of 1898 to take over the business of the local Battery Company, no report was available for the compilers of the 1900 "Stock Exchange Year Book." It is significant that there is no market in either preference or ordinary shares on the London Stock Exchange.

Appointments Vacant.—The Ashton-under-Lyne Electric Lighting Committee invite applications for the post of borough electrical engineer to have charge of their electricity supply undertaking.—The Wolverhampton Lighting Committee invite applications for the appointment of chief clerk and canvasser in their electricity department.—The Wrexham Town Council require a borough electrical engineer.—The Farnworth Urban District Council require an engineer for their electrical undertaking.—An engineer competent to supervise staff of assistants and technical workshops, inspect stations, etc., is wanted by Marconi's Wireless Telegraph Company, Limited. Particulars of these vacancies and of others relating to articled pupils, junior station assistants, shift engineers, foreman, etc. mechanical and electrical engineer, will be found in our advertisement columns.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 14 as a special settling day for Dublin United Tramways Company's (1896) 60 000 ordinary shares of £10 each fully paid, Nos. 1 to 60 000, 59 987 6 per cent. preference shares of £10 each fully paid, within Nos. 1 to 60,000, and £300 000 3½ per cent. mortgage debentures of £100 each, Nos. 1 to 3,000. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Castner-Kellner Alkali Company's further issue of 150,000 shares of £1 each; and Electrolytic Alkali Company's ordinary shares of £1 each, and 7 per cent. cumulative preference shares of £1 each. The committee have further been asked to allow the following securities to be quoted in the official list: Charing Cross and Strand Electricity Supply Corporation's further issue of 30,000 4½ per cent. cumulative preference shares of £5 each; and Hove Electric Lighting Company's 11,000 shares of £5 each, fully paid, Nos 1 to 11,000. (renewed application).

Wolverhampton.—The Town Council on Wednesday adopted a report of the Lighting Committee, in which it was pointed out that there was a necessity, in order to meet the increasing demand for electricity for lighting and power purposes, to put down extra plant, and recommending that application be made to the Local Government Board for permission to borrow £58 942 on the security of Corporation stock. The amount will include £4,620 for buildings and foundations, £18,140 for boiler-house equipment, £19,580 for engine-house equipment, £15,000 for feeders, etc, and £1,602 to cover the amount overspent on a previous loan. Mr. Gough Allen, in moving the adoption of the report, said it was necessary, owing to the constantly increasing demand for electricity, to have a stand-by plant so as to keep it up to a safe point in case of a breakdown. The committee had never been ahead of the demands which might be made upon them, and it was necessary to be prepared owing to the laying down of the new tramways. The money would not be expended all at once, but as required. If this loan were sanctioned the capital expenditure of the committee would reach £149,000.

W. T. Henley's Telegraph Works.—We have received from the W. T. Henley's Telegraph Works Company, Limited, a handsomely bound and illustrated book, containing an account of some of the work carried on at the North Woolwich works of the Company during the last 50 years. From the book we learn that the business was founded some 50 years ago by the late Mr. W. T. Henley, and up to the time of his death in 1882 the works were almost exclusively devoted to the construction of submarine telegraph cables and underground telegraph lines. After 1882 the business extended in other directions, and electric light and power cables and telephone wires were also made. A list is given of the more important cables manufactured and laid by the firm since 1858, when the Tasmania-to-Australia cable was finished. The Halifax-Bermudas cable is specially mentioned as having been laid in a fortnight and in adverse weather. The length of this cable is 850 knots. The total weight of this cable was over 2,000 tons. A list is also given of the towns, etc., for which cables for electric light and power work have been manufactured. There are at present, we learn, over a thousand hands employed at the works alone, not including those employed outside in the laying of the cables. The new buildings on the river front of the works are described as very large and convenient, and include electrical testing rooms, in which every order executed by the firm is subjected to stringent electrical and mechanical tests. The greater part of the machinery in the works is driven by electricity, and every new workshop opened is run by this means. The illustrations in the book are very well executed, and we must congratulate Messrs. Henley's on having produced such a neat and interesting souvenir of their 50 years' work.

Digitized by Google

Wigan.—The Council have adopted a report from the electrical engineer, stating he had received a much larger number of applications for current than had been anticipated, and it would, therefore, be necessary to put down additional plant. Tenders for the extra plant required will be called for at once.

Partick.—Mr. Maxwell, of Worcester, has been appointed resident electrical engineer for the burgh. Mr. Maxwell will take up his duties immediately. Current will be obtained from the Corporation of Glasgow until the Corporation's own installation is in working order, and it is expected that the light will be turned on in the Dowanhill district before the New Year.

Abercarn.—A conference of representatives from the Nantyglo and Blaina, Abertillery, Abercarn, and Risca District Councils was held on Monday for the purpose of considering the advisability of promoting a joint scheme of public lighting of the Western Valley by means of electricity. It was resolved to recommend the various councils to jointly employ an expert to give a report.

Longton.—At a recent meeting of the General Purposes Committee a communication was read from Messrs. Bennett and Ward-Thomas, consulting telephone engineers, with reference to the subject of municipal telephones. It was decided to defer the further consideration until after the report of the autumn general meeting of the Association of Municipal Corporations had been received.

Ripon.—On Thursday last the Corporation Gas Committee introduced a scheme for spending an extra £7,000 on the gasworks, which several members strongly opposed in view of the introduction of the electric light. Messrs. G. Harrison and Co., electrical engineers, afterwards attended the Council with reference to their report on the electric lighting of the city, which was adjourned for future consideration.

Camborne.—The company which has the undertaking of the Camborne electric lighting supply have made an arrangement with the Urban Electric Supply Company, who are the owners of the Camborne and Redruth tramway order, to furnish them with a supply of electric energy for use in Camborne, and they hope to receive this supply during the course of the next year, when they will be in a position to fully comply with the requirements of the order.

London County Council.—At the weekly meeting of the Council on Tuesday, it was agreed to lend the Bermondsey Vestry £21,000 for dust destructor and electric light installation, and the Poplar District Board £25,000 for electric light installation. Mr. G. L. Gomme, statistical officer to the Council, was appointed clerk in succession to Mr. C. J. Stewart, who recently resigned in order to become chairman and managing director of Samuel Allsopp and Sons, Limited.

Huddersfield.—On Friday evening last the staff and employés met at the electricity works to present Mr. J. R. P. Lunn, the mains superintendent, who is leaving to take the position of borough electrical engineer at Darlington, with a timepiece and ornamental figures, which had been subscribed for by the staff and employés. Alderman Calvert (chairman of the committee) made the presentation, the deputy chairman (Councillor Longbottom) supporting the same.

Bermondsey.—The Vestry are at the present moment carrying out an important combined scheme of electricity generation and dust destruction, as arranged for them by Messrs. Kincaid, Waller, and Manville. The works are now well on the way, and on Monday, the 29th ult., a foundation stone tablet on the chimney shaft was laid by Mr. Thomas Cox, the chairman of the Electric Lighting Committee of the Vestry. A handsome trowel and mallet, with suitable inscriptions, were presented to Mr. Cox by the engineers (Messrs. Kincaid, Waller, and Manville) and the contractors (Messrs. Hughes and Stirling).

Birkenhead.—From and after Dec. 31 next the charge to ordinary customers of electrical energy for lighting purposes within the borough will be reduced to 6d. per unit for the first hour of maximum demand (instead of for the first hour and a half as at present), 3d. per unit for second hour, and 1½d. per unit thereafter; and that the charge for energy for power and heating purposes be reduced from 4d. per unit to 4d. per unit for the first hour, 3d. for the second, and 1½d. afterwards. A new committee is to be appointed to manage the electrical department, which at present is under the Gas, Water, and Electrical Committee.

Cape Electric Tramways Co.—A meeting of this Company will be held at Winchester House on Nov. 14, at 12 o'clock noon, to receive and consider the report of the directors and the statement of accounts to be then presented, to elect directors and auditors, and fix their remuneration, to sanction the declaration of a loan, and to transact the other ordinary general business of the Company. The following resolution will be proposed—namely: "That the capital of the Company be increased by the creation of 100,000 additional ordinary shares of £1 each, ranking for dividend and in all other respects *pari passu* with the existing ordinary shares of the Company, and that the directors be empowered to dispose of such shares to such persons and upon such terms as the Board may think fit." The transfer-books of the Company will be closed from Nov. 12 to 17, 1900, both days inclusive.

Inquest.—At the Greenwich Coroner's Court on Friday last an inquest was held on Arthur Robinson, of 25, Collins-street, Blackheath, who was killed instantaneously at the works of the Blackheath and District Electric Company on the previous Monday. Mark Turner, an apprentice to Mr. E. J. Ford, a builder, of Blackheath, stated that the deceased was employed by Mr. Ford as a carpenter. Whilst fixing fillets round the switchboard on Monday witness heard a groan, saw a flash, and, on looking round, saw the deceased lying on the ground apparently in great agony. He died a few seconds later. They had been warned that it was dangerous, and that they were to be very careful of the switchboard. Another apprentice said he saw the deceased fall back dead whilst apparently in the act of withdrawing the bolt. Witness's opinion was that the deceased's hand slipped in some way on to the switchboard. Dr. Hugh Davies, of East Greenwich, deposed that death was due to an electric shock. Mr. E. Negus Wood, the deputy-coroner, adjourned the inquest for further enquiries to be made. On Wednesday a verdict of "accidental death" was returned.

Criccieth.—A public meeting was held on Saturday to ascertain the views of the ratepayers with regard to the proposal of a Manchester syndicate to introduce the electric light into the town. Mr. Thomas Burnell (chairman of the Urban District Council), who presided, said a gasworks scheme had been dismissed on the grounds that it would be a nuisance, and the price too high. The syndicate would supply the electric light at 6d. per unit, which was equal to 3s. per 1,000 for gas, so that it would be cheaper by 1s. 7d. per 1 000 than at Portmadoc, and cheaper by 2s. 5d. than at Pwllheli. He pointed out that the scheme would be a joint undertaking with the proposed light railway from Portmadoc to Beddgelert, and a scheme to light the town of Portmadoc with electricity. The scheme provides for 12 arc lamps of 1,000 c.p. each. The lamps would have to be provided by the Council, and would cost £10 each, the repayment to extend over a period of 20 years. The annual cost of lighting these lamps would be £109. 10s., or £43 more than the present system of lighting by means of oil lamps cost them. It was finally agreed that the Council should make enquiries as to what it would cost for the Council to go in for a scheme of its own and appoint an expert.

London Docks.—On Tuesday Mr. C. J. C. Scott, the chairman of the London and India Docks Joint Committee, inaugurated the new electric light installation for lighting the London and St. Katharine Docks by switching on the first lamp at the generating station, which is situated at the Hermitage entrance. The electric engineer, Mr. Stanley Bright, was warmly complimented on the admirable manner in which the work has been carried out by his staff, and satisfaction was expressed by the warehouse keepers and the men generally at the brilliancy and uniformity of the light. The illuminating power for lighting the above is equal to 4,000 lamps of 8 c.p. each. The generating plant consists of three Galloway boilers with mechanical stokers, and three sets of Bellis-Crompton engines and dynamos, each set being capable of supplying the current for 2,000 8-c.p. lamps. The wiring is carried out on the three-wire system, with a pressure of 220 volts on either side of the middle wire. The mains are of hard-drawn bare copper mounted on oil insulators, and are run over the warehouses. The seating of plant and running of mains, wiring, etc., has been effected by the Joint Committee's engineering staff. In addition to the warehouses, etc., already mentioned, current is supplied to many of the other warehouses in these docks.

Barnsley.—On Thursday evening, Mr. Councillor Walter Brady, as chairman of the Electric Light Committee, switched the light on to the first 15 arc lamps which have been erected. According to the *Barnsley Independent*, Mr. Brady said the ceremony of that evening might be considered the conclusion of the first part of their electrical works. When they laid the foundation stone of their works a little over 18 months ago, they made an appeal to the inhabitants for loyal support, and he was pleased to say that that appeal had been responded to in an excellent manner. The way in which the light had been taken up was—for a small town like Barnsley—really remarkable. It had been remarked at the time the scheme was suggested that the Council would find out that they had made a great mistake in introducing the light. That remark had been thoroughly falsified. The Corporation had not had to ask the ratepayers for a farthing, and he believed that the undertaking would be entirely self-supporting. He concluded by expressing a hope that the light turned on that night might be typical of the moral and temporal enlightenment which they needed in the town of Barnsley. He then turned on the light amidst cheers. The lamps at present fixed are 15 in number. The pillars are 22ft. high, and have 2,000 c.p. arc lamps. Each pillar is provided with two side arms, having incandescent lamps, which will be used when the current is switched off the arc lamps. After the switching on ceremony, the members of the Corporation adjourned to the King's Head Hotel, where Mr. Councillor Brady entertained them to dinner.

Hackney.—The Electric Lighting Committee of the Vestry having considered a large batch of tenders, with the report of the consulting engineer thereon, recommended the Vestry to accept the following prices from various firms: condensing plant, £1,749; cooling apparatus, £1,960; pipework and valves, £5,065; feed pumps, £733; switchboard and instruments, boosters and motors (part 1), £2,976; ditto (parts 2 to 5), £2,160; public arc lamps and switchboard, £5,248; house meters, £3,632; overhead travelling crane, £638; workshop equipment, £772; arc lamp pillars, 302 at £13. 5s. each. The committee considered 18 tenders for constructional ironwork, the highest being £6,304. They recommended the acceptance of the lowest, that of Messrs. Dorman, Long, and Co., Victoria-street (£3,145), which was in accordance with the specification. The committee further submitted seven tenders for electricity mains, including trenching, troughing, cables, boxes, and house services, and recommended the acceptance of the lowest, that of the British Insulated Wire Company, Limited (£46,416). This firm are now carrying out their first contract in a satisfactory manner, and it was stated that it would be to the advantage of the parish to have all the work carried out by the same firm. The report

Digitized by Google

was adopted after some discussion, during which Mr. Richmond impressed upon the Vestry the fact that since they had received these tenders metal had fallen 10s. per ton, and next week a similar fall was expected. By Christmas iron alone would be down to the tune of 30s. per ton, and copper and other metals were also on the fall. Not a brick of the chimney shaft was yet laid, and until that was completed nothing could be started in the lighting station. After its completion fires would have to be kept under it for a month or six weeks, and it would be 12 months before the chimney could be completed.

City of London.—In his report to the Streets Committee, Mr. A. A. Voysey, electrical engineer and inspector to the Corporation gives a short summary (1) of the events which led up to the granting of the City of London Electric Lighting Order, 1899, to the Charing Cross and Strand Electricity Supply Corporation; (2) of the circumstances under and the conditions on which the City of London Electric Lighting Company obtained permission to alter the standard pressure of supply from 100 to 200 volts; (3) of the circumstances attending the approval by the Board of Trade of the additional system of supply by continuous currents by the City of London Electric Lighting Company. The report also deals with the following subjects: (4) electrical testing; (5) public electric lighting—main streets; (6) public electric lighting—side streets; (7) private electric lighting. We have already dealt fully with the first two items, and we quote the report on the additional system by continuous currents as follows: "On Dec. 20, 1898, the Board of Trade forwarded to the town clerk a description of the additional system proposed to be adopted by the City of London Electric Lighting Company. The Board of Trade were requested by the Corporation, in view of the existing circumstances affecting the question of electricity supply in the City, to delay their approval of the proposed additional system. Their approval was accordingly delayed. In view of the possible introduction of a second electricity supply company into the City, it was obviously undesirable from the point of view of the Corporation that the existing undertakers should establish a second system of mains. The Board of Trade, however, on Aug. 15 gave their consent to the proposed additional system, and should any inconvenience or loss arise from the establishment of such system, the responsibility will not be with the Corporation. I am informed, however, that the use of continuous currents is intended ultimately to supersede the use of alternating currents, a fact full of significance and interest, and it may be hoped that no great inconvenience will arise in connection with the change through the necessity of opening the streets. Only 11 meters were submitted for testing during the year. Nine of them were found to be sufficiently correct, one was found to be 14·4 per cent. fast, and another 3·4 per cent. slow. The Aron meter was approved by the Board of Trade for use on alternating-current circuits, and a number of tests were made with a view to determine the kind of examination that would be necessary before certifying such meters, in accordance with the provisions of the electric lighting orders. Negotiations with the City of London Electric Lighting Company and the Charing Cross and Strand Electricity Supply Corporation are in satisfactory progress for the testing of all meters at Guildhall without any expense to the Corporation. A table is added, giving a comparative statement for the years 1896, 1897, 1898, and 1899 of the interruptions which have taken place in the lighting of the public electric lamps, based on the reports of the police, supplemented by those made by Mr. Voysey. The total number of arc lamps in lighting on Dec. 31, 1896, was 493, and 507 in 1899: the number of lamp failures reported by the police were 609 (1896) and 562 (1899); the number of lamp failures reported by the electrical engineer came to 150 (1896), and to 356 in 1899. The average time per lamp of extinction in minutes was 167 and 180·94 respectively. The total amount of penalties, which was £362. 11s. 3d. in 1896, has fallen to £173 6s. 3d. in 1899, but the proportion of the total time of failure to the time of possible failure—*i.e.*, the total number of lamps multiplied by the total number of minutes during which they should by contract be lighted—rose from 0·1 per cent. to 0·13 per cent. In 1897 it was as high as 0·27 per cent. Dividing the failures into those affecting single lamps and those affecting groups of lamps, we find that the proportion of the time of single lamp failures to the total time of failure rose from 31 per cent. to 35·7 per cent., while the proportion of the time of group failures to the total time of failure fell from 69 per cent. to 64·3 per cent. The number of occasions on which group failures occurred was 12 in 1896, 24 in 1897, 6 in 1898, and 11 in 1899. The arc lamps used for the public lighting are of two types, and the figures given below show approximately the relation between the percentage of failures of each type of lamp for the last four years. Failures of lamps in groups are excluded from the statement, because they have almost always been due to causes outside the lamps. The two types of lamps are respectively designated A and B and the figures showing relation of percentage of failures are (A) 1·35, 1·65, 1·82, 1·99; (B) 1·00, 2·06, 3·20, 2·80 for the four years under review. The Corporation is still without means of testing the value of the supply given to the public lamps. The Board of Trade have not formally approved of any type of instrument for the purpose, but one of the conditions on which the City of London Electric Lighting Company are allowed to change the standard pressure from 100 to 200 volts, is that they establish concurrently with the said change, and under the direction of the Board of Trade, a means of testing the value of the supply to the public lamps." The remarks on the lighting of the side streets are of particular interest. This question has been delayed for several years, in the endeavour to obtain a legal settlement of differences with the City of London Electric Lighting Company as to the meaning of the public lighting agreements. In February the matter came before Mr. Justice Kekewich, whose judgment on the most important point was satisfactory to the Corporation. On another important point—possibly the most important to the company—the judgment was not so satisfactory, and your worshipful committee, acting on the advice of counsel, decided to appeal on that point. Before the appeal was heard, however, the question of the validity of the agreements arose, and it was therefore necessary to postpone the hearing of the appeal. Mr. Voysey says the delay is much to be regretted, because it is undoubtedly possible, by the use of electric lamps, to make a great improvement in the lighting of the side streets without in any way increasing the present cost of lighting by gas. He adds the following upon the electric supply to private consumers: "I was advised during 1899 of two important interruptions in the supply of electricity to private consumers—one affecting the whole of the City, and the second affecting only a portion of the City. Defects in the pressure of the supply occurred on 11 different occasions. At present I have no adequate means of ascertaining how far the City of London Electric Lighting Company comply with their obligations in respect of the maintenance of a proper pressure of supply to private consumers. The company, however, have been put under the obligation to provide such means as the Board of Trade shall direct."

Gloucester.—At a meeting of the City Council held on the 30th ult. the following report by Mr. Robert Hammond, consulting electrical engineer, was presented: "Under Clause 29 of the general conditions attached to the specification issued by me for your electricity works plant, it was stipulated that the tests made at makers' works should be supplemented by 'tests on completion on site,' at your works in Gloucester; and that on these tests being made to the satisfaction of the engineer . . the Corporation 'shall be deemed to have taken over the plant.' In view of the latter stipulation, it was obviously desirable that before the 'tests on completion' were made, the plant should for a month or two prove capable of satisfactorily coping with the work of lighting the city, for which it has been designed. The plant has been so running since July 19, and I have now to report that I have just completed a series of trial runs and tests of every portion of the plant, the work having begun on the evening of Oct. 5, and having extended over the 6th, 7th, 8th, and 9th. In thereby completing the task entrusted to me in connection with your pioneer electricity works, and handing them over to your engineer, I take the opportunity of congratulating the committee upon the gratifying reception given by the citizens to the undertaking, as evidenced by the demand for the light. The works, as you know, after keeping in hand reserve plant sufficient to secure continuity of lighting, have an available capacity of:

Available capacity in kilowatts.	Equivalent in 8-c.p. lamps—All burning at one time.	Equivalent in 8-c.p. lamps—If installed on consumers' premises, say
300	10,000	15,000

and against this capacity your resident engineer advises me that you have actually on the books to-day:

Private consumers—	Equivalent in 8 c.p. lamps—All burning at one time, say	Equivalent in 8 c.p. lamps—If installed on consumers' premises.
Connected and at work	7,206	10,813
Connections ordered	450	675
Signed applications	1,547	2,320
Hitherto reserved for public lighting	2,000	—
If the electricity reserved for public lighting were used for private lighting	—	3,000
	11,205	16,808

It will be seen that these figures exceed the available capacity of the plant, and if all the lights detailed above were actually connected to the circuit there would be grave risk of breakdown. The committee are wisely avoiding this risk by minimising for the present the extent of the public lighting, which on its present basis is only equivalent to 730 8 c.p. lamps all burning at one time. In this connection I beg to remind you that out of the sum sanctioned by the Local Government Board for public lighting there still remains unexpended a balance of £2,300. By dint of delaying any extension of the public lighting until the new plant is at work, you will be able to continue to cope comfortably with the present load by means of the present plant. It is, however, extremely fortunate that the Council had the foresight to put the new set of plant on order, as otherwise no extension of the public lighting could be carried out, and it would be necessary at an early date to refuse new business from private consumers. The additional plant, however, will double the available capacity of the works, bringing it up to 20,000 8 c.p. lamps all burning at one time, or 30,000 8 c.p. lamps if installed on consumers' premises. Even with this capacity it will be incumbent on the committee to carefully watch the progress of the connections, bearing in mind that usually nine months elapse between the date of specification and the setting of new plant into operation. I beg to point out that if an arrangement be come to with the tramway company to supply them with current, additional plant will at once be needed. With regard to the total commitments on capital account to date, I beg to submit the following statement: amounts sanctioned by the Local Government Board—(*a*) original works, £43,450; (*b*) extensions, £9,425; additions to buildings, furniture, etc., £250; cost of preliminary running expenses, stands, stores, coal, etc., prior to July 19, £200—£53,325 (less balance in hand unexpended on public lighting, £2,300); commitments to date of public light

Digitized by Google

undertaking, £51,025. With regard to the buildings, I beg to acknowledge my indebtedness to my colleague, Mr. Harry Dancey, who has been most painstaking in carrying out his portion of the work. The additions and improvements to the buildings which suggested themselves during the progress of the work have, it will be noted, only involved an excess expenditure of £250, and in the case of the engineering work the total of £36 074 has only been exceeded by £200, for both of which items you have good value to show. I trust that the undertaking will prove as successful to the citizens as the prospects appear to promise at the present time." The Electricity Supply Committee unanimously resolved: "That as the prescribed tests have been carried out, and the electricity works have now been handed over to the Corporation, the Council be recommended to appoint Mr. W. J. Bache as resident engineer, at a salary of £250 a year, the appointment to be terminable by a month's notice on either side." A memorial was received, signed by upwards of 200 ratepayers residing near and frequenting Lower Barton street, requesting the Corporation to provide arc lighting for that portion of the city as early as possible. The Council were recommended to erect additional arc lamps (on two circuits) in Lower Barton-street, and to give the necessary orders forthwith if arrangements can be made for the work to be completed within a reasonable time. The city surveyor and Mr. Bache were instructed to further consider the general question of extending the arc lighting, and to report upon the matter in time to allow of any further extension that may be agreed upon being completed by the autumn of next year. Mr. Bache reported that he had carefully considered the question of the charges that should be made in respect of the arc lighting, and recommended that for the present limited number of arc lamps the charges should be as follows: for lamps burning all night, £24 per lamp per annum; for lamps burning till midnight, only £20 per lamp per annum. The Council were recommended to adopt these charges for the present. The committee decided in lieu of the present meter rents, the Council be recommended to adopt the following charges for the hire of meters: up to the equivalent of 20 meters of 8 c.p., 1s. 6d.; 50, 2s.; 100, 3s.; above 100, 4s. per quarter. In cases in which Section 1 of the fourth schedule of the Gloucester Corporation Electric Supply Order, 1896, would authorise a minimum charge of 13s. 4d. per quarter, a charge of only 10s. is to be made until further order, and the accountant was authorised to settle any accounts already sent out for the minimum charge of 13s. 4d. on payment of 10s. The appointment of Mr. Bache was confirmed by the Council and the minutes adopted. Shortly after nine o'clock on Monday night the electric light in the streets of the city and on the premises of a few private consumers suddenly went out. The throwing of the principal thoroughfares into darkness caused some little excitement on the part of the passers by, but the inconvenience proved to be but temporary, for in about 10 minutes the light was once more shining brilliantly. At the meeting of the Council the Town Clerk, at the request of the Mayor, explained that he was at work at the time of the mishap overnight, and he went at once to the electricity works. He found Mr. Bache at the switchboard, and discovered that the occurrence was not of a serious nature. Mr. Bache wrote that morning that an accident occurred to the brush-holders, but this was remedied, and the plant was running again at half-past one. In reply to a question, it was stated that steps were being taken to obviate the possibility of a recurrence.

PROVISIONAL PATENTS, 1900.

OCTOBER 22.

18806. Improvements in trolleys and junction frogs for use on electric railways and tramways. David Blythe Foster, George Percival Gibson, and Herbert Foster, 6, Victoria-road, Leeds.

18813. Improvements in electric locomotives. Bertram Hopkinson, 26, Victoria-street, Westminster, London.

18816 Improved electrical indicator for use with alternating-current apparatus. Charles Lorenzo Clarke, 321, High Holborn, London. (Complete specification.)

18826. Improvements in electric arc lamps. Hugo Bremer, 42, Neuenweg, Barmen, Germany.

18834. Improvements in voltmeters. Nicolas Vasilesco-Karpen, 72, Cannon-street, London.

18855. Improvements in connection with electrically driving machine tools or other mechanism. Thomas Humpage and Epicyclic Manufacturing Company, Limited, 55, Chancery-lane, London.

18865. Improvements in apparatus for the production of electrical oscillations. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

OCTOBER 23.

18874. A revolving centre-piece for two-storey electric cars. Wm. Henry Dunn and Edward Scott, 112, Park-lane, Little Horton, Bradford.

18880. An electrical indicating or recording apparatus for restaurants or other places. James Ferris McLaren, 115, St. Vincent-street, Glasgow.

18889. A new or improved electrically-operated billiard marker. Vernon Hope, 55, Market-street, Manchester.

18898. Improvements in electric recording instruments for motorcars. Paris Singer, Oldway, Paignton, S. Devon.

18904. Improvements in or relating to thermo-electric batteries. West James Crawford and Thomas Battle Turley, 111, Hatton-garden, London. (Complete specification.)

18914. Electric meters. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18921. Improvements relating to electric furnaces. Gustaf Benedicks, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

18924. Improvements in electric switches. William Howard Chipperfield and Edward Samuel Cook, 4, Dane's-inn, Strand, London.

18925. Improvements in electric switches. William Howard Chipperfield and Edward Samuel Cook, 4, Dane's-inn, Strand, London.

18934 Improvements relating to electric incandescent lamps. Robert Trimmel, 45, Southampton-buildings, Chancery-lane, London.

18940. Improved means for the electrical illumination of the dials of ships' telegraphs and for similar purposes. Eversheds and Vignoles, Limited, and Sydney Eversheds, 1, Queen Victoria-street, London.

18967. Improvements in electric incandescent lamps. Robert Bolton Ransford, 24, Southampton-buildings, Chancery-lane, London. (Albert William Wallace Miller, United States.) (Complete specification.)

18975. Thermo-electric generator. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Merle J. Wightman, United States.)

OCTOBER 24.

19039. Improved process for the electrolytic oxidation of solutions of chromium oxide salts. Conrad Schneider, 39, Middleton-buildings, High-street, Islington, London.

19050 An improved electric circuit closing thermometer. Frank Cossor, 53, Chancery-lane, London.

19058. Improvements in electrical brakes for railway cars. Frank Clarence Newell, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 28, 1900, being date of application in United States.)

OCTOBER 25.

19071. Improvements in and relating to a magneto-electric generator with governing arrangements for ignition purposes on motorcars, stationary gas and oil engines, and other purposes. Frederick Truby Reid and William Shepherd, 117, Sidwell-street, Exeter.

19072. Improvements in electric accumulators. George James Gibbs, 76, Heslington-road, York.

19076. Improvements in or in connection with means for electrically lighting miners' safety and similar lamps. John Charles Best, 30, Park-row, Leeds.

19095. Improvements in or applicable to electric ceiling roses, electroliers, and the like. Charles William Watling, jun., 4, St. Ann's-square, Manchester.

19099. An improved electrode for accumulators of electricity. Jacob Myers, 11, Ramen Hoorn, Holland. (Complete specification.)

19114. Improvements in or applicable to searchlight and signalling apparatus. Mervyn Hanbury Lowther Clark, 321, High Holborn, London. (Complete specification.)

19118. Improvements in secondary electrical batteries or accumulators. Peter Stiens, 65, Chancery-lane, London.

19119. Improvements in or connected with the electro-deposition of metals or metallic alloys. George Edward Vaughan, 57, Chancery-lane, London. (Helmuth Koegel, Germany.)

OCTOBER 26.

19151. Improvements in trolley heads for overhead conductors of electric railways. Ridley James Urquhart and Henry Goodwin, 5, Clayton-square, Liverpool.

19163. A frictionless balance for weighing gravitational, electric, or other forces. William Thomson, Baron Kelvin of Largs, 154, St. Vincent-street, Glasgow.

19167. Improvements in and relating to electrical resistances variable by light and certain other rays or waves, and in the manufacture of the same. James Tarbotton Armstrong and Edgar Alfred Goddin, 40, Vartry-road, South Tottenham, London.

19183. Improvements in and connected with electrical pushes and switches. Edgar Godwin Harcourt, 5, Corporation-street, Birmingham.

19208. Improvements in the production of chlorine and pure solution of alkaline hydrates by the electrolysis of dissolved alkaline chlorides. Paul la Cour, 4, South-street, Finsbury, London. (Complete specification.)

19218. Improvements in dynamo-electric machines and motors and in means for regulating the same. Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

19220. Improvements in unions or connections for electric light pendants and other fittings. Hugo Hirst and John Hillery Collings, 165, Queen Victoria-street, London.

19223. Improvements in or relating to electrical ignition devices for explosion engines. Zebulon Wirt, 111, Hatton-garden, London.

Digitized by Google

OCTOBER 27.

19227. Aerial or wireless telephony. Charles Adams-Randall, 98, Prince of Wales-mansions, Prince of Wales-road, London.

19238. Improvements in or relating to machinery or apparatus for covering electric cables, wires, and other cores. Isaac Lovell Berridge and Benjamin Kerr, 111, Hatton-garden, London.

19251. Improvements relating to arc lamps. Albert De Puydt, 34, Castle-street, Liverpool. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 22, 1900, being date of application in Belgium.) (Complete specification.)

19280. Improvements in electric arc lamps. The Jandus Arc Lamp and Electric Company, Limited, John Marshall Gorham, and Adrian Denman Jones, 18, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Nov. 17.

1899.

20925. Process for directly obtaining the caustic lyes and ammonia and earth alkaline hydroxides by electrolysis. Luckow.

21656. Controlling electric motors and electrically-propelled railway trains. British Thomson-Houston Company, Limited. (Sperry.)

22535. Electrical distribution and starting rotary electric converters. British Thomson-Houston Company, Limited. (Potter.)

24120. Electrical maximum demand indicators. Wright and Mutual Electric Trust, Limited.

24645. Automatic lead starting apparatus applicable to synchronous alternating-current motors. Rosenqvist, Bergtheil, and Young.

24887. Electric arc lamps. Digby.

25350. Electric incandescent lamps. Scholz.

1900.

367. Means for adjusting or regulating the shades or covers employed in connection with electric lights, gas lights, and others for the purpose of concentrating and diffusing the light therefrom in any desired or required direction, and apparatus for effecting the same. Crankshaw, Crankshaw, and Crankshaw.

839. Incandescence electric lamps. Lake. (Shearman.)

[illegible]061. Lightning conductors and arresters for overhead electric conductors. Poché.

10142. Printing telegraph apparatus. Murray.

10765. Automatic electric block systems for railroads. Shoecraft and Gardiner.

14101. Cells or helices for electrical purposes. Heys. (Scott, Varley, and Anderson.)

16656. Electrically-propelled motor vehicles. Ryan.

16698. Conduit flows for electric railways. British Thomson-Houston Company, Limited. (Hoffmann.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Oct. 27	612	495	+ 117	15,721	13,642
Birmingham Trams.	,, 27	4,563	4,290	+ 273*c*	188,253	178,986
Blackburn Corp'rat'n	,, 26	439	421	+ 18	19,395	17,190
Blackpool Corporatn.	,, 25	314	309	+ 105	26,261	19,396
Blackpool-Fleetwood	,, 27	217	238	- 21	18,881	18,871
Bolton Corporation..	,, 28	1,254	—	—	42,293*a*	—
Bradford City Trams	,, 28	544	379	+ 165	15,637	12,107
Bristol Tramways Co.	,, 26	2,973	2,905	+ 68	—	—
Carlisle Tr'mw'ys Co	,, 27	136	—	—	3 335*f*	—
Central London Ry.	,, 27	6,102	—	—	64,498*e*	—
City & South London	,, 28	1,866	1,045	+ 821	26,458	16 299
Cork E. T. and L. Co.	,, 26	413	403	+ 10	17,876*c*	16,421
Dover Tramways ...	,, 27	181	180	+ 1	9,056	8,643
Dublin & Lucan E.R	,, 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	,, 26	3,403	2,644	+ 759	—	—
Dublin S.D. Electric	,, 26	740	739	+ 1	—	—
Glasgow Corporation	,, 27	9,402	9,149	+ 252	—	—
Halifax Corporation	,, 28	722	663	+ 59	24,027	18,911
Hull Corporat'n E.S.	,, 27	1,331	639	+ 692	38,914*a*	— *c*
Liverpool Corporat'n	,, 20*b*	8,349	7,043	+1,306	330 681	288,718
Liverpool Overhead	,, 28	1,512	1,630	- 112	28,894	27,804
St. Helens Tramwys.	,, 24	—	—	+ 217	—	—
Sheffield Corporation	,, 28	2,472	—	—	—	—
Southampton Trams	,, 25	665	—	—	—	—
Southport Corporat'n	,, 27	374	—	—	2 399*a*	—
Swansea Tramways..	,, 5	447	263	+ 184	7,093	4,462

a Since April 1. *b* Partly electrical, *c* Since Jan. 1. *e* From July 30. *f* From June 30.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	⅜ ½
British Insulated Wire, Ord., 1-40,000	5	—	10-11
—— 40,001-70,000	5	—	10 1/16-10 3/16
—— 6 per cent. Cum. Pref., 1-40,000	5	..	6¼-6½
—— 5 per cent. Mortgage Debentures	100	—	98-102
British Electric Works, Ordinary, 50,001-95,000	1	—	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅛-¼
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-1⅞
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	102-104
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-12¾
—— 5 per cent. Pref.	5	—	5-5¼
Crompton and Co.	5	—	3¾ 4¼
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	5	—	1¾-2¼
—— 5 per cent. Debentures	5	—	3¼-4¼
—— 4 per cent. Deb. Stock, Red	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	..	96-100
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-12¾
—— 4½ per cent. Preference	5	—	5-5¼
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	30-31
—— 4 per cent. Debentures	100	—	99-102
Telegraph Construction and Maintenance	12	—	36 40
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10¾-11¼
—— 5 per cent. Cum. Pref.	5	—	5¼-5½
Willans and Robinson, Ordinary, 1-30,000	5	—	10¾-11¼
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	106-109
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	12¾-13¼
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	102-106
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8¼-9¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¼-6¾
Charing Cross and Strand	5	..	9¾-10¼
—— 4½ per cent. Cum. Pref.	5	—	5¼-5
Chelsea Electricity Supply	5	—	6¼-6¾
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	—	12¾-13¼
—— 5 per cent. Debenture Stock	100	—	126-130
County of London and Brush Provincial, Ordinary	10	—	8¾-9¼
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	102-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¼-5
—— 4½ per cent. First Mort. Deb.	100	—	101-104
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10¼
London Electric, Ordinary	3	—	1¾-2¼
—— 6 per cent. Pref.	5	—	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-103
Metropolitan, Ordinary	10	—	13¼-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100	—	112-115
—— 3½ per cent. Mortgage Debenture, Red	100	—	97-100
Notting Hill Electric Lighting	10	—	15-16
Oriental, 1879	1	—	1¼-1⅜
—— £5 Shares	5	—	7-7¼
—— £4½ Shares, New	4½	—	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 6 per cent. Debenture Stock	100	—	85-95
South London, Ordinary	3	—	2¼-2½
St. James's and Pall Mall, Ordinary, 101-30,080	5	—	15-16
—— 7 per cent. Pref.	5	—	8-9
—— 3½ per cent. Deb.	100	—	98-101
Westminster, Ordinary	5	—	12-13
—— 80,001-100,437	5	—	11-12
Electric Railways.—			
Central London, Ordinary	10	—	10-10¼
—— Pref. Half-Shares	5	—	4¾-5¼
—— ,, deferred	5	—	5-5¼
City and South London, Consolidated Ordinary	100	—	58-61
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	118-123
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	..	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9¾-10¼ xd
British Electric Traction, Ordinary	10	—	13-14
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	3¾-4¼
—— 5 per cent. Deb. Stock, Red.	100	—	105-108
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9¾-10¼
New General Traction, Ordinary	5	—	3¾-3¾
—— 6 per cent. Cum. Pref.	5	—	4¾-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	13-13
—— 5 per cent. Cum. Pref.	10	..	10¾-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11¾-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9¾-10¼
—— 4½ per cent. Debenture Stock	100	—	104-107
Telephones.—			
National Telephone, Ordinary	5	—	4¼-4½
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 4 per cent. Deb. Stock, Red.	100	..	101-104
—— 3½ per cent. Deb. Stock, Red.	100	—	96 99
Oriental Telephone and Electric Company	1	—	¾-1 xd

Digitized by Google

NOTES.

Motor Fire-Engines.—With respect to another note appearing in this issue, it is interesting to note that the London County Council at their meeting on Tuesday last resolved to try some experimental motor fire-engines. It was stated that if these turned out to be successful, the whole of the engines would be similarly equipped.

Institution of Junior Engineers.—On Saturday last a large party of the members of this institution visited the Millbank-street station of the London Hydraulic Power Company. The company have four pumping stations in operation, and a fifth in course of erection, over all of which the party were conducted. At the conclusion of the visit Mr. Percival Marshall, chairman of the institution, expressed the thanks of the members for the attention shown to them.

The Electrical Men on Parade.—In the sound money parade which took place on a recent Saturday in New York, the Electrical Industries Association was largely represented. It is difficult in this country, where we do not have to elect the supreme head of the State every four years, to understand the excitement which such an election causes. Thus, while we can quite see that large interests are at stake, it is not clear how these interests are served by some 100,000 men marching in procession through the heavy rain in order to show on which side their sympathies are. We gather from a short notice of this parade in one of our electrical contemporaries that from 3,000 to 5,000 electrical marchers were expected to be present.

Wireless Telegraphy.—Further experiments have, we learn, been conducted at Dovercourt with the Marconi system of wireless telegraphy. For a considerable time past the Marconi Wireless Telegraph Company have had a station at Dovercourt, and on Monday last it was decided to have a trial of the apparatus at that place. The messages were passed between the land and the Belgian mail steamer "Princess Clementine," which had on board as operators Messrs. F. Stacy and C. Ricard. The signals were commenced when about half-way on the journey, and the messages were quite successful. The working of the apparatus was explained to the Japanese Ambassador at Paris (Mr. M. S. Kurino), who happened to be crossing.

Royal Institution.—The annual course of Christmas lectures for young people at the Royal Institution is, we are informed, to be delivered by Sir Robert S. Ball, F.R.S., Lowndean Professor of Astronomy in Cambridge University, the subject being "Great Chapters in the Book of Nature." The first lecture will take place on Thursday, Dec. 27, at three o'clock, the remaining lectures being delivered on Dec. 29, and Jan. 1, 3, 5, and 8. At a general monthly meeting of the institution on Monday last the special thanks of the members were returned to Dr. Frank McClean, F.R.S., for his donation of £50 to the fund for the promotion of experimental research at low temperatures, and to Dr. Rudolph Messel for his present of a bronze bust of Sir Humphry Davy.

A Novel Escape.—An interesting piece of information comes from Tennessee, U.S.A., which states that two convicts made a good bid for escape from the penitentiary at that town by using pulleys on the telephone wires. The story of the escape, which is truly American, is related by a contemporary as follows: "Two desperate convicts recently made their escape by sliding down two telephone wires from the top of a three-storey building to a point outside of the high stone walls. Both worked in the harness department, and after roll-call managed to return to the building and gain the roof. They had provided themselves with two big pulleys and a wadding used in the manufacture of bridles. The convicts mounted two slender telephone wires, bicycle fashion, and on this took their coast to freedom, the men passing 15ft. over the wall." It was some time before the escape was discovered, but the men were eventually caught.

Car Fenders.—It has been often said that the guard attached to an electric car is of no value as a preventive of serious accidents. This, however, does not appear to be quite correct, as two accidents which occurred recently in Liverpool would tend to show. During the afternoon an Irish pig, which was in Gill-street market stalls, managed to escape into the street and ran down into London-road, where it rushed full tilt against an electric car. The animal was knocked down, picked up by, and landed on the guard, where it sat squealing until taken off. The other accident was a more serious case. It appears that a girl, aged eight, was crossing West Derby-street, when she was accidentally knocked down by an electric car. She was picked up and carried about 20 yards on the guard, and was ultimately rescued from what might have been a shocking death, having only received a few bruises on the forehead.

Rontgen Society.—Dr. J. B. MacIntyre, in the course of his presidential address to the Röntgen Society recently, said that the use of X-rays in war had everywhere created a great amount of interest. The first definite work in this direction had been done in the Soudan Expedition, where some good results were obtained. They were eagerly awaiting a paper from one who had had experience with the X-rays in the South African War, but it was too recent then to say anything as to their use. He was, however, able to report through the courtesy of Surgeon-General Jamieson, the Director-General of the Army Medical Department, that the X-rays were found most useful in the hospitals at the base and on the lines of communication although not actually on the field. There was now a regulation list of apparatus for army work; 17 sets were sent to South Africa, and they were being adopted in all the larger military hospitals.

Calcutta Telegraph Office.—In marked contrast with the good work done by the Telegraph Department of India in laying telegraph lines across difficult country, etc., is the way in which the local telegraph service appears to be carried on in Calcutta. Thus messages which may or may not be important are constantly being wrongly delivered, and any scrawl is taken as a receipt by the man who delivers the telegrams. Complaints have, we learn, been frequently made by leading persons in Calcutta, but instead of the charges being investigated, they are treated with indifference by the officials at the chief office. It is a great pity, therefore, that the Indian Government does not take notice of these complaints which often appear in the Calcutta local Press, and ensure, by strict measures if necessary, that the business of such an important town as the capital of India shall not be interfered with by the indifference of a few telegraph officials.

Power Scheme.—There is, we learn, now being arranged an important scheme for the electrical distribution of power for manufacturing and other purposes throughout the Middlesbrough, Stockton, Hartlepool, and Cleveland district, and a Bill applying for the necessary parliamentary sanction is to be introduced next session. The scheme, which is supported by many of the most influential manufacturers in the district, is to be drawn up on similar lines to the Lancashire, South Wales, and Durham District Power Bills, which were passed last session. The engineer in connection with the scheme is

Digitized by Google

Mr. A. A. Campbell Swinton, M.I.C.E, of Victoria-street, Westminster, Messrs. Jackson and Jackson, of Middlesbrough, being the solicitors. We must congratulate the promoters of the scheme on securing the services of so eminent an engineer as Mr. Campbell Swinton, under whose direction the scheme, if passed in Parliament, cannot fail to be successful.

Power Factor Indicator.—In the *Electrical World* for Oct. 27 Mr. A. J. Bowie, jun., describes the theory of an instrument by which the power factor of a given supply may be practically measured. The principle of the instrument is the use of two dynamometers on the same suspension. The instrument would, we understand, consist of a single controlling field, which would be fixed, and through which the current supplied would pass, and two moving coils. These moving coils would receive respectively the voltages of a non-inductive supply, and cross the supply terminals of which the power factor is required to be known. The angle of these two moving coils would not be the same with respect to the fixed field. The author then develops the formula by means of a calibration instrument made to work out mathematically, but he advocates that, besides this, independent readings should be made to prove the accuracy of the scale. Such an instrument would be extremely useful in practice.

The Smoke Problem.—It is pleasant to hear, on the authority of Mr. Stevens, of Brighton, that the terrible question of smoke prevention has been solved at last. To this end Mr. Stevens has invented a machine, and now only requires the necessary money to work the invention. This he hopes to get by the sale of a patent washerless tap. The machine which is to prevent the smoke nuisance is apparently an electrical machine, which, if given a first help off, will go on working, and when working produces more electricity to work itself. This machine would, therefore, in addition to solving the smoke problem, appear to solve the problem of dear coal. The electricity, which will always be on hand when wanted, is to be used for everything for which coal is now used, and also many things for which it is not. We are afraid, however, that until the sale of the tap has reached much greater dimensions than is usually the case with such things, London and other places will still have to patiently endure their fogs.

Electrical Works Extensions.—Our recent note on the large number of new works which are now being erected throughout the country, has resulted in us receiving a letter from the Luton Chamber of Commerce calling attention to the advantages of Luton as an industrial centre. A joint committee of the Town Council and Chamber of Commerce will be pleased to supply all information to firms requiring sites. The letter we have received is signed both by the town clerk and the secretary of the Chamber of Commerce, which shows that the two bodies are working together in perfect harmony. In the selection of such sites it is not only the local advantages which have to be considered, but also the treatment which the new firm will receive at the hands of the local authority. In too many instances this treatment as far as rating is concerned is not just, and hence the desire of firms to get into districts where they will be free from municipal responsibilities. We should say, however, that in the present case the above remarks would not apply.

Electro-Harmonic Society.—A ladies' night evening concert in connection with the Electro-Harmonic Society is to be held on Friday, 16th inst., at the St. James's Hall Restaurant. Special interest will attach to this concert from the fact that Major Crompton, who recently returned from South Africa, is to preside. There has been prepared a very full and select programme, which should provide the audience with quite a feast of music. There are to be several part songs by the Westminster Glee Singers, and each of the gentlemen composing this quartette is down to sing a separate song. Miss Elsie Mackenzie is to give two songs, and piano solos are to be provided by Mr. A. E. Izard. The glassophone solos by Mr. G. Nelson should be very pretty, and one may expect to have a good hearty laugh when Mr. R. A. Roberts gives his humorous selections entitled "Shrimpot Sands," and "A Travesty in Rhyme." The musical directors of the concert will be Mr. A. E. Izard, R.A.M, and Mr. T. E. Gatehouse. The concert will commence at eight o'clock precisely.

The Dangers of Electrical Safe-Breaking.—Much has been said as to the ease with which a safe or strong-room can be broken into by the use of the electric arc. That this is not so simple as it would appear at first sight is shown by the experience of two gentlemen in Ohio. Thus, the big iron safe in the Middleport shoe factory refused to open, and the book-keeper, Mr. Louis Jaquith, and engineer, Mr. Walter H. Rice, conceived the idea of burning out the combination by use of the electric arc. It took several hours to accomplish their purpose, but they finally succeeded, but not until they had stood for several hours in the glare of the electric light, taking turns at holding the wire and carbon. When the work was over both complained of a dizziness and pain in the head which increased as the hours passed, and in a short time both went suddenly blind at about the same time. All efforts to restore their sight have been unavailing, for while the eyeballs appear all right, the sight is destroyed. The unfortunate conclusion to this experiment should, we think, warn any professional safe-breaker against the use of this improved means of accomplishing his ends.

Evening Technical Schools.—The issue of the *London Technical Education Gazette* for September and October is a double number, and contains a list of all technical evening classes in London, with the exception of those in connection with the London School Board. The Technical Education Board is, we learn, preparing a complete list of evening Board school classes in London, and this list will contain particulars as to the subjects, etc., which are taken in the evening schools. The subjects taken in the various schools are classified into seven sections—viz., science, engineering, trade and technical classes, domestic economy, art, economic and commercial subjects, and music. In Section 2 one finds the engineering subjects, there being listed 19 schools and institutes which take mechanical engineering, nine which take electrical engineering, and eight which take civil engineering. In Section 3 the subjects taught are classified under the headings of the various trades, there being taught in the electrical classes instrument making, electrical wiring and fitting and electro-plating. Altogether, the list should be very useful to those wishing to gather information as to the subjects taught in the various London technical institutes, and as to the cost per course or term for the teaching of these subjects.

A Danger to Ships.—In its issue for Oct. 6 the *Scientific American* had an article dealing with the electrolytic action caused on ships' bottoms by the combination of copper and iron and sea-water. The electrolytic action of these three substances was commented on as being very dangerous to ships. Mr. E. A. Suverkrop now writes to our contemporary to the effect that it was common practice some years ago to put copper strainers or bilge "strums" at the ends of the suction pipes of bilge pumps in wooden steamships. In course of time, when iron replaced wood in shipbuilding, the copper strainers were retained; several

Digitized by Google

mysterious losses of ships at sea during fair weather occurred. One steamer went down at her moorings in the Mersey. When she was raised, it was found that there was a round hole in her bottom where the copper strainer had been. This led to investigation, and it was discovered that in many iron boats, where the inner coating of Portland cement which is usually put in the bilges of iron and steel vessels had been removed by any means, so that the copper strainer could rest directly upon the iron shell, the galvanic action had eaten the iron almost entirely through. It is evident, therefore, that considerable attention should be given to this subject, and a means found for preventing this eating away of the iron from such a cause.

Horse v. Automobile.—A decision which should have the effect of encouraging the use of the automobile in the United States was recently given by Justice Sutherland at Rochester, U.S.A. The claim was one for damages caused by a runaway horse after having been frightened by an automobile. A decision had previously given in favour of the owner of the horse on the ground that the owner of the automobile was liable because his machine had frightened the animal. An appeal was brought, however, and Justice Sutherland reversed this decision, and declared that the law on the subject would be as follows: "The horse has no paramount or exclusive right to the road, and the mere fact that a horse takes fright at some vehicle run by new and improved methods, and smashes things, does not give the injured party a cause of action. If the defendant's motor carriage is practicable for the purpose of travel, and the noise and vapour caused by its use are kept within reasonable limitations, and are no greater than are fairly incident to the use of motor carriages which are found adapted to the needs of the general public, then I cannot see how the defendant can be held liable in the absence of evidence that at the particular time complained of the carriage was operated carelessly. The temporary inconvenience and dangers incident to the introduction of these modern and practical modes of travel upon the highway must be subordinate to the larger and permanent benefits to the general public resulting from the adoption of the improvements which science and inventive skill have perfected."

King's College Science Laboratories—The new scientific laboratories at King's College were opened on Tuesday, Oct. 30, by Lord Lister. Amongst those present were Dr. Robertson (the principal of the college) and others connected with the staff, the Lord Mayor, the Lord Chief Justice, etc. The Principal, in introducing Lord Lister, said that the work which had made that gentleman famous was connected with King's College. Lord Lister then said it might seem strange that so large a gathering of distinguished men should come to witness the opening of certain laboratories. Yet the occasion was not unworthy of celebration, it being an event of significance in regard to the provisions for higher education in the Metropolis. It was recognised that mere lectures were not sufficient, that practical instruction was imperatively necessary. Some branches of King's College were long ago well equipped to this end, but not all. The dissecting-room was by no means adequate, and the accommodation for the practical teaching of physiology was miserable, while there were smaller defects in other departments. Of these the council had long been conscious, and to remedy them had provided the new laboratories, which were highly satisfactory. It was a happy coincidence that this great addition to the resources of the college had been made at the time when it was entering on a new career as one of the colleges of the new University of London. He himself would have liked to see the old examining university retained and a separate teaching university established, but other views prevailed, and a compromise had been effected under which examining and teaching existed side by side in the same institution. He wished the compromise all success, and hoped that now the matter was decided all would work together for the common good. The Lord Mayor moved a vote of thanks to Lord Lister, which was seconded by the Hon. W. F. D. Smith, M.P., and adopted. Lord Lister then formally declared the laboratories open. In all the new rooms electric light has been fitted, and great care has been taken with the natural lighting. The fittings in all cases are of the latest design.

Municipal Electrical Association.—We have received from Mr. A. B. Mountain a copy of the *Proceedings* of the Municipal Electrical Association for the years 1899 and 1900. The copy for the year 1899 contains the presidential address delivered by Mr. H. Faraday Proctor on June 14, 1899. After this come papers read by Councillor G. Pearson on "Municipal Trading"; "Appropriation of Profits, etc.," by Bailie Mackay; "Combined Traction and Lighting Works," by Mr. J. H. Rider; "The Municipalisation of the Telephone," by Mr. A. B. Mountain; "Notes on Distribution of Electricity," by Mr. C. D. Taite; "Condensers for Electric Light and Power Stations," by Mr. J. F. C. Snell; "The Arrangement of Steam-Pipes," by Mr. J. E. Edgcome; "Notes on the Performances of Single-Phase Motors," by Messrs. J. R. P. Lunn and P. S. Thompson (associates' prize); "The Choice of Meters," by Mr. C. A. L. Prussman; "Electric Light Mains," by Mr. D. Clothier. Reports of the visits of the association, annual dinner, business meeting, hon. secretary's report, and the report of the committee on dangerous trades are also given. The *Proceedings* for 1900 contain the presidential address by Mr. A. B. Mountain. The papers published are those read by Alderman Potter and Mr. H. C. Bishop on "Means for Stimulating the Demand for Electrical Energy," and on "Electricity Works for Small Towns," by Messrs. C. S. Vesey-Brown and G. M. Harriss; "Electric Motors," by Messrs. T. P. Wilmshurst and C. A. L. Prussman; "The Combined Management of Tramways and Lighting Departments," by Mr. R. C. Quin; and "Methods of Reducing Light-Load Losses," by Mr. H. L. P. Boot; "The Distribution of Electricity in Scattered Areas," by Messrs. L. Andrews and G. Wilkinson; "Maintaining Certain Portions of Electrical Distribution Systems at Earth Potential," by Mr. C. H. Wordingham; "Impressions of Present American Tramway Practice," by Mr. A. E. Le Rossignol; and "Protection of Telegraph and Telephone Wires," by Mr. R. C. Quin. The *Proceedings* conclude with the usual reports, etc. These volumes, which contain a large amount of very useful information, can be had from Mr. A. B. Mountain, Corporation Electricity Works, Huddersfield, at the price of 3s. 6d. per copy.

Automobile Trials.—The first of the electric automobile trials under the auspices of the Automobile Club, and of which we gave details in a recent issue, took place on Tuesday last. The run was to be over a given course for an unlimited distance on one charge, the driver to declare to the official observer when the run was finished. The course on Tuesday was a circular route from Chislehurst, the total distance being 34¾ miles. If, however, it was wished to make a continuation of the run, a small circular route from Chislehurst of about 8¾ miles could be gone over as many times as wished. In connection with the trials on Tuesday, the route was severe and the roads in a very heavy state, owing to the large amount of rain which had fallen for the few days beforehand. The vehicle which covered the greatest distance was the

Digitized by Google

"Powerful," which was entered by the British and Foreign Electrical Vehicles Company. This vehicle, which covered 59 miles, carried two passengers. The same company's "Columbia Stanhope" traversed 7½ miles, and their delivery van chose an easier route, going seven miles, but failed to carry her three passengers all the way. Mr. Hart's "Toujours Contente" travelled 34 miles with two passengers, and the National Motor Carriage Syndicate's "Joel" car carried two passengers 37 miles. Two cars entered by the Electric Motor Power Company ran 17¼ and 35 miles respectively, each carrying two passengers. The Canadian Electric Motor Company's "Still" carriage carried four passengers 18 miles, and the Electrical Undertakings car conveyed two passengers 35 miles. On Wednesday there was a hill-climbing trial on a route between Chislehurst and Knockholt, the distance being some 30 miles. On this route the road between Green Street Green and Cudham rises from 300ft. to 680ft. above the sea, and at Knockholt it rises to some 735 above sea-level. The results of this trial have not yet come to hand. On Thursday was to be a trial over 30 miles of average road, and on Friday an optional trial over an unlimited distance on one charge. A note at the end of the official programme bestows praise on Prof. Boys, Mr. Holden, Mr. H. Edmunds, Mr. Harmsworth, Mr. Llewellyn Preece, and Mr. Hanning for the assistance they have rendered in various ways in helping towards the success of the trials.

Nickel Extraction.—The Nickel Copper Company, of Ontario, have recently been experimenting with a new process of nickel and copper extraction. The process is the invention of Mr. H. A Frasch, and it is said to be very successful. As applied to the Sudbury copper-nickel matte, the process consists, says the New York *Engineering and Mining Journal*, in the electrolysis of a brine solution in such a manner that, while the sodium ions are set free at the cathodes with the formation there of caustic soda, the chlorine ions are liberated in the anode section containing the matte and immediately form a chloride solution of the metals present. In this way brine is electrolysed to form caustic soda, at less expense, it is claimed, than with the insoluble anodes in the Castner-Kellner or Rhodin processes, and at the same time the chlorine, instead of being made into bleach, is utilised for the formation of the chlorides of copper, nickel, iron, and other metals that are in combination in the matte at the anode poles. The metallic chlorides can be directly treated for the contained metals by electrolysis or chemical methods, or after being electrolysed of half the content of copper they may be used for lixiviating the metals in the raw matte, the copper chloride acting chemically as a solvent for the metals in the matte, and making the electrolyte solution suitable for further electrolysis. Eventually the metals in the solution are recovered by electrolytic deposition, or in the case of nickel and cobalt the nickel is separated from the cobalt as a chemical salt by a method which is not as yet made public. The matte is crushed and conveyed to the vats, where it is charged directly on a layer of carbonaceous material forming the anode section at the bottom. On this layer of matte is placed a thin layer of sand, which gives a good diaphragm for the separation of the resultant solutions of caustic soda and the metal chlorides. The anode section of the vat is then filled to the sand layer with a saline or weak chloride solution, and the balance of the vat is filled with water or a weak caustic solution. After the passing of the solutions through the vats, the subsequent handling of the solid material, which remains in the anode section after treatment, consists of the removal of the upper layer of sand, which can be washed and used again, followed by the removal of the leached material, from which, perhaps, it might be well to extract the sulphur. Tests carried out by the Nickel Copper Company are said to have given excellent results, and it is claimed that the entire cost of the process will be fully met by the value of the caustic soda and other by-products.

Electrical Fire-Engines.—As may be remembered, some few weeks ago the firemen of Paris gave an exhibition of fire drill before their provincial and foreign colleagues, the apparatus used on this occasion being of an improved character. Three new types of automobiles in connection with the fire service have, we gather, been introduced, each type being used in the drill at Vincennes. The electrical hose wagon has been in use for some months past, and consists simply of an automobile capable of seating six men, and is provided with lengths of hose, life-saving tackle, and ladders. Another vehicle is the electric fire pump, which is of an entirely new type. It consists of a metallic tank capable of holding 100 gallons. This is mounted on an automobile carriage, together with a pump, hose, and nozzle. The motor which drives the automobile is switched off on arrival at the fire, and is switched on to work the pump. This is effected by an ingenious system of gearing, which is applied to work the pump or otherwise. The hose is wound on a cylindrical piece of metal, and is so fixed that on arriving at a fire a stream of water is at once available, and the 100 gallons of water in the tank are pumped out during the usual fitting up of the hose to the water-main. In running order the engine weighs, with men and a full tank, some 6,380lb. The pump itself has three chambers. It forces the water through the axis of the reel into the rubber hose which carries the nozzle for producing jets of different sizes. The apparatus both on the engine and hose wagon is so arranged that a portion of the energy can be utilised for the lighting of arc or incandescent lamps for fires occurring at night. The whole set of apparatus is finished with an electrical ladder. This consists of a low truck upon which the large ladder in use in the department is hoisted almost horizontally by means of an inclined plane and a windlass. The total weight of this apparatus, inclusive of its crew, is 9,150lb. It is the heaviest of the pieces of fire material to which mechanical propulsion has been applied. By reason of the peculiar difficulties presented by the manœuvring of it, it became necessary to assure the perfect stability of the vehicle, especially in turning corners, while running at considerable speed, and this has been done so successfully that the electric ladder truck is more stable than horse-drawn ones. The electric energy necessary for the operation of the various kinds of apparatus is furnished by batteries of accumulators made by the Société Bouquet-Garcin-Schrive, of Neuilly. The batteries are suspended beneath the vehicle in specially made cases. The capacity of the accumulators is sufficient to allow a vehicle to run 36 miles at 12 miles per hour without requiring recharging.

A New Electrolytic Meter.—A patent has recently been taken out in America by Mr. T. A. Edison, the invention being a new type of electrolytic meter. The instrument is claimed to be very accurate, easily read, and not liable to get out of order. The base of the invention is an improved electrolytic cell which is easily standardised, and which at a constant temperature will always maintain a constant resistance, so that the rate of deposition is uniform. The cell has two electrodes of pure zinc immersed in a solution of zinc sulphate. In order to prevent any evaporation of the solution or any tendency to creep, the solution is covered with oil. Having obtained this cell, two or three are then connected round a relatively low resistance, whereby a minute but constant ratio of the current will affect the cells. There is then produced by the

Digitized by Google

deposition from one electrode to the other, and by positive mechanical devices, an easily-read accurate registration of the total current. To this end the movable electrodes of two cells are hung on the two ends of a beam supported on knife-edges or other relatively frictionless support, the electrical connections being such that while the metal is being deposited upon the movable electrode of one cell it will be stripped off of the movable electrode of the other cell, whereby the scale beam will tend to move downward toward the heavier movable electrode. If desired, however, a single cell may be employed, connected to one extremity of the scale beam, a counterweight being connected to the other extremity of it. The beam is connected with a retarding device, which opposes the stress exerted by either of the movable electrodes of the two cells on which the deposit is taking place. In this way the scale beam, under the effect of the depositing and stripping of the metal, will acquire an extremely slow movement in one direction or the other, the extent of such movement being constant, but its relative slowness depending upon the current influencing the cells. The oscillations of the scale beam actuate an escapement controlling a registering train, which operates a suitable pointer or pointers of a dial or dials. The connection between the scale beam and escapement is of a novel character, and is such that friction is so infinitely small as to be negligible. The registering train is driven either by a weight or spring, and since the release of the escapement takes place very infrequently, even when currents of considerable volume are influencing the cell or cells, it will be possible to obtain a sufficient fall of the relatively light weight as to require winding only during long intervals of time. In order that the oscillations of the scale beam may be produced, the current through the cells requires to be reversed at each tripping of the escapement, and an improved reversing switch is employed wherein only a single movable contact is required, this reversing switch being operated directly by the register train, and imposing no stress upon the scale beam. The elements of the meter are carried on an insulated board within the meter box having a glass front, through which the dials may be observed. When used in localities where low temperatures may be expected, it is desirable to employ a heating device, probably an incandescent lamp, brought into circuit by means of a thermostat if the temperature falls near the freezing point of the liquid in the cell. In order that changes in temperature, which affect the resistance of the cells, may not result in incorrect registration, there is interposed in series with the cells an ordinary compensating coil, the resistance of which changes inversely with that of the cells, whereby the resistance of the shunt, including the cells and the compensator, will be always maintained constant irrespective of changes in temperature.

Electricity on the Rand.—We have just received the *Transactions* of the American Institution of Electrical Engineers published for August and September of this year. In it we find a most interesting contribution by Mr. A. W. K. Peirce on the use of electricity in South Africa. Mr. Peirce has been for some years the leading electrical engineer of the Consolidated Goldfields of South Africa, and his *résumé* of the electrical work actually carried out on the Rand is most interesting. He refers, for instance, to the largest distribution system established up to the present on the Wittewaterrand. This mining district occupies a stretch of country 25 miles long and a few thousand feet wide. At the one end of this there are some coal mines, which produce a fair quality of bituminous coal, which makes it, of course, very convenient. A project was started for establishing a power plant at one of these coal mines, using the waste coal as it came out and distributing the power at high tension along the reef, and that was done. There is a plant of about 2,500 kw. installed capacity and stepping up to 10,000 volts, transmitting over a pole-line about 25 miles long. All along the reef branch lines are taken off at intervals wherever required, and then, stepping down to suitable voltage, it is used for other purposes, usually for motors. The suburban district of Johannesburg is lighted largely from this plant. As regards the troubles experienced in this distribution, the insulators have been not the least important. This Mr. Peirce attributes to the fact that these are not high-tension insulators, such as are used in the States. The insulators are instead rather larger than the ordinary porcelain types, without the necessary provision for providing the high insulation required by such high voltages. It appears that these insulators explode at times, as fragments are frequently found up to 40ft. and 60ft. away from the poles. This the author thinks is due to the moisture in a crack in the insulator being converted into steam. Iron poles are used throughout, as wooden poles are attacked by ants. The maximum load on the supply station up to the beginning of this year was 1,800 kw., which occurred during lighting hours. The day load varies from 1,000 kw. to 1,200 kw. The next largest plant belongs to the Consolidated Goldfields Company, and is also worked at 10,000 volts. It is found that the electrical distribution gives the mines great assistance when unexpected amounts of water are met with in the workings, as an additional motor and pump can be laid down much more quickly than any other system of pumping. This company uses three-wire rubber-insulated, lead-covered, and iron-armoured cables for the distribution. Mr. Peirce then proceeds to state that the direct-current installations were not found to be as satisfactory as three-phase plants with induction motors. This he attributes to the fact that the motors are not well looked after, and that the dampness underground causes considerable trouble with the direct-current armatures. Also, attempts have been made to run the direct-current motors at high voltages, going up to nearly 1,000 volts. One of the most interesting problems yet to be solved, according to Mr. Peirce, is the haulage for the deep-level mines. These will have shafts extending down from 8,000ft. to 10,000ft. A single hoist from this depth up to the surface is a somewhat difficult problem on account of the necessary great weight and strength of the rope. In fact, in order that the rope may support itself and the cage at the bottom of the shaft, the size to be employed is almost prohibitive. One solution of the problem is to wind in stretches, and Mr. Peirce suggests that about 3,000ft. per stretch would be a reasonable lift. He is now looking into the question as to the best means by which this can be done electrically, as either electricity or compressed air would have to be used on the lower stages. He then calls the attention of his readers to the fact that no experimental apparatus ought to be sent out to the Rand, because the issues at stake were much too great for this. For instance, suppose a manufacturer does undertake to make good any defects which may arise, or supply new machinery if the first is not satisfactory, it takes six months at least to get plant out and erected, and when a mine is reckoning on a profit of £30,000 per month it will be seen that the failure of the plant is a most serious matter. In fact, the maker's risk in guaranteeing is infinitely small compared with the risk incurred by the mine owners. From figures given by the author we gather that a large amount of hoisting plant will be required, and it is a problem to which our electrical engineers could well devote considerable attention.

Digitized by Google

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Continued from page 585.)

Commutators and Commutation.

It was shown in the first article that if any wire be made to cut a magnetic field that an E.M.F. will be created in this wire, and that if this wire has a closed outer circuit that a current varying inversely as the resistance of the whole circuit, and directly as the E.M.F., will flow through this circuit; and, further, that the E.M.F. obtaining at any instant will depend upon the number of lines of force cut during that particular element of time, so that, in other words, it may be said that the amount of current will vary inversely as the resistance, and directly as the number of lines cut per unit time. It was also shown (Fig. 2) that the direction in which this current will flow depends upon the direction of the motion of the wire relatively to the field, and also upon the direction of the flow of the lines of force in a plane which is at right angles both to the direction of the motion of the wire and also to its length.

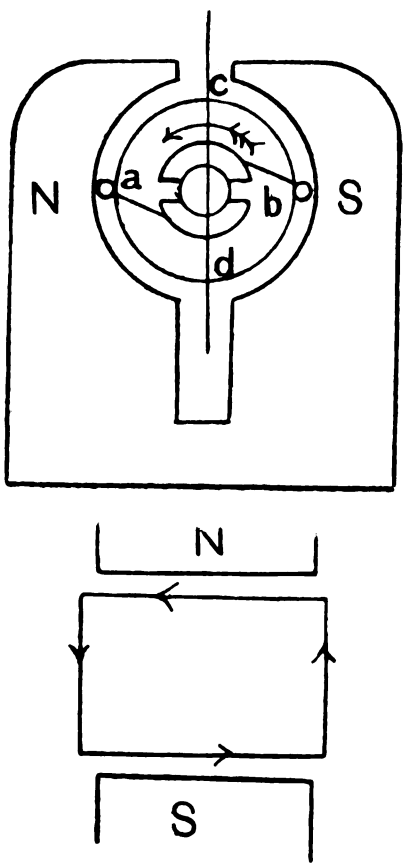


Fig. 10.

Fig. 10 represents a drum armature wound with a single complete coil, and it is assumed that each end of this coil is connected to a separate annular ring insulated from the other and also from the shaft upon which the two rings are mounted, and that the current is collected in any suitable manner from these rings. It will be seen from the plan that the two active lengths of the coil are in series with each other, the current flowing round the coil and through the outer circuit. If, now, a voltmeter were connected across these two rings, it would be seen that—assuming always a uniform speed—the maximum E.M.F. would be registered when the coil *a b* was in the position shown in the diagram, and that the E.M.F. gradually fell until the coil *a b* occupied the position *c d*, then gradually rose to its maximum when the coil had travelled through an angle of 180deg.—*i.e.*, when the positions of *a* and *b*, as shown in Fig. 10, were reversed—gradually falling again to zero, whilst the coil revolved through a further angle of 90deg, and rose once more to its maximum as it completed the full cycle, and reached its first position. If a current indicator had also been inserted, it would have been noted that while *a* travelled from *c* to *d* the current was flowing in one direction, but while it revolved from *d* to *c* the current was flowing in the opposite direction. This is only what would be anticipated from an application of the three fundamental principles. The lines of force flow—we may conveniently assume for the present—in straight lines across the armature core from one polar face to the other, and they have over all this area a uniform density—*i.e.*, in

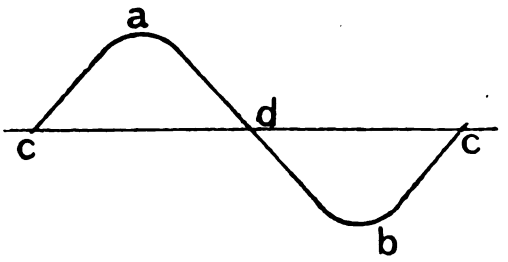


Fig. 11.

any square inch, or other unit area, taken in a plane normal to the flow, the number of lines passing is equal to that in any other square inch; and as the speed of revolution is uniform, the angle passed through in unit time by the coil is always the same, but the number of lines cut during this unit time will constantly vary, for while with the coil at *a* it is cutting straight across the magnetic lines, at *c* it is sliding, as it were, between them and not cutting any. If a large number of readings were taken and were marked on a chart, so as to show the E.M.F. produced at every instant, it would be found that the *locus* of these points would be a true sinusoidal curve as in Fig. 11, where the part of the curve above the line represents a current flowing in one direction, and the part below the line represents the current flowing in the opposite direction. It will be readily seen that this curve must be a true sine curve, for we have formerly stated that there will be uniform density of field in the plane *c d* (Fig. 10), which is parallel with the axis of the shaft, and at right angles to the direction of flow of the lines of force; and in order to cut a uniform number of lines per unit time it would, therefore, be necessary for the coil to travel a uniform length along *c d* per unit time, but since the coil travels through an equal angle per unit time, it is an easy mathematical proof to show that the distance traversed by the coil along *c d* is proportionate to the difference in the sines of the angles which lie between the lines, *c o*, *a o*, where *a* is the position which the revolving coil occupies at the end of equal intervals of unit time.

If the two annular rings be taken off and one ring be substituted, this ring being divided into halves along a plane parallel to the axis of the shaft, and if the two halves be insulated from each other and from the shaft we get an elementary commutator; if, then, the two ends of the coil be connected one to each of these commutator segments, and the brushes are so arranged that they pass from one section of the commutator to the other when the coil is in the position, *c d*, sliding through the lines, the current will in the outer circuit attain a maximum and minimum effect, but will always flow in the same direction,

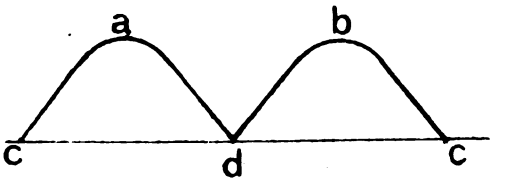


Fig. 12.

and it is then said to be commutated from an alternating to a direct current. It is worth noticing here that, with the single exception of homopolar dynamos, in all modern dynamos the current is generated as an alternating current, but in a direct-current dynamo it is rectified by the interaction of the commutator and the brushes before passing to the outer circuit. If, as before, periodical readings be taken of the E.M.F., and a curve representing this at any instant be drawn (Fig. 12), it will be found similar to the curve shown in Fig. 11, only

Digitized by Google

with the bottom part of the curve doubled over the datum line, showing that the current in the outer circuit flows always in the same direction, though the E.M.F. passes through a cycle of values.

If now, in place of a single coil being wound round the armature core, the coil be wrapped round twice before the two ends are connected to the commutator, it is evident that the four active lengths will all be in series with each other, and that if the speed be the same as before, the E.M.F. produced will be double that previously obtained; if, now, another voltmeter curve be obtained, the only difference will be that the length of the ordinates will be increased, the E.M.F. will still vary uniformly from zero to its maximum and back again to zero continuously.

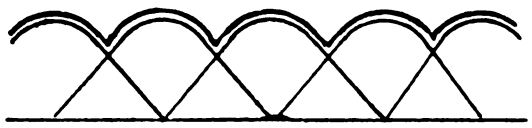


FIG. 13.

If, now, this extra coil be wound as a separate coil at right angles to the first, but in series with it, and a four-part commutator is made, each coil will only generate half the E.M.F. of the double coil, and as the coils are at right angles to each other, one coil will be cutting across the largest number of lines of force per unit time, while the other coil is cutting none; hence one will have its maximum value when the second has its zero value, and the first will gradually decrease to its zero value while the second is equally increasing to its maximum value, and we shall get two sine curves, one due to each coil, overlapping each other, as in Fig. 13, the resultant curve of the induced E.M.F. being shown for any instant by the heavy curve. It will be noticed that this resultant curve is very far from being a straight line, and that there will consequently be very great fluctuations in the induced E.M.F. In order to obtain a less fluctuating resultant E.M.F., the number of the coils and of the commutator segments must be increased, and these coils must be arranged symmetrically round the armature core, while the commutator segments must be equal in width and have a uniform pitch. It has been shown that with a two-coil armature wound at right angles, one coil must be passing through its position of zero value while the other is passing through its position of maximum value, and that hence the maximum E.M.F. will only be that which one coil would generate—although the amount of the fluctuations is halved. With an eight, sixteen, or other larger number of coils, more will lie in a strong field than in a neutral field, as the angle of embrace of the pole-pieces is usually larger than the angle of non-embrace. Consequently, not

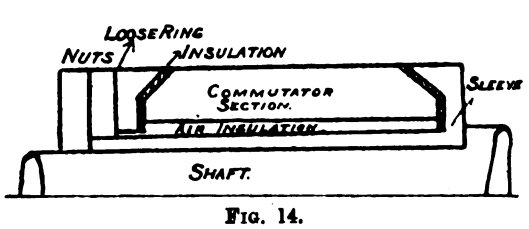


FIG. 14.

only will the amount of fluctuation with a large number of commutator segments and coils be considerably less, but the average E.M.F. will be higher. It has been found that for any number of coils above four, the average E.M.F. is about 0·63 of what the maximum E.M.F. would be were all the coils wound as one continuous coil and connected to a two-part commutator. The amount of fluctuation in the E.M.F. varies inversely as the number of commutator parts, but after a certain limit there is little advantage in further diminishing the fluctuations, as they are not appreciable whether the current be used for lighting or other purposes.

It has been pointed out that the various commutator segments must be insulated from each other, and also from the shaft, and although the mechanical construction of the commutator cannot be said to be in any way directly ruled by our fundamental principles, yet the difference in the running which a well-designed and well-built commutator makes to any dynamo is so great that it is most important that the student should have a sound knowledge not only of the function of the commutator, but also of the various stresses to which it is subjected. To begin with, we speak of the mechanical construction of the commutator, and yet at the same time, owing to its most unmechanical construction, it is generally the weakest part of any machine, while, in addition, the majority of the difficulties which arise in the design of a dynamo are those due to the requirements of either sparkless commutation, or fixity of lead—both commutator matters; and, further, after the machine is designed, built, and fixed, the commutator is the one part of the machine which receives the worst treatment: either the brushes are held down with too great a tension, or else, often, they are never readjusted, so that imperfect contact is made. Sometimes the commutator is left unlubricated and untouched; at other times, owing to the ignorance of the dynamo tender, it is so saturated with grease and oil that it collects all the dirt and filth of the engine-house, while often in private installations sparking is permitted to take place because the brush lead is not altered with the variations of load. So that we may sum up the question of the commutator thus: its mechanical construction is very weak and unsound at the best, it is concerned in the most difficult operation in the generation of a direct current—viz., the rectification of the current—and in actual work it too often receives only scant consideration and attention.

It has been shown that the various commutator segments must be efficiently insulated, not only from each other, but also from the shaft. In order to hold the commutator in position two end flanges are necessary, as shown in Fig. 14;

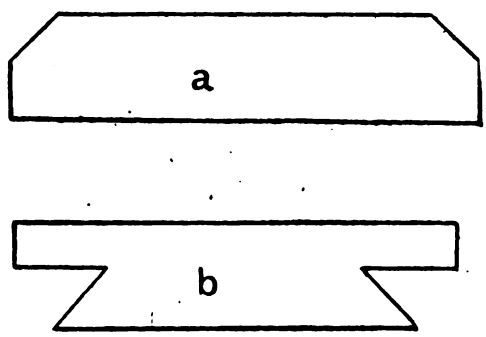


FIG. 15.

one of these is keyed tightly to the shaft, whilst the other is loose, and is forced into its position by means of a suitable nut, or bolt and nuts, tieing the two flanges together. In small machines it is usual to cast the fixed flange to a sleeve, which is keyed to the shaft, and which is screwed at the other end to receive the tightening nut holding the loose flange in position. Fig. 15 represents two sample types of commutator segments; *a* shows one in which the top corners are cut away to enable the end flanges to secure a good grip, while for the *b* type the end flanges are made with a horizontal V, which fits in a groove turned in the segments. No great difficulty would arise in building up a strong, sound commutator on such a principle, if it were possible to obtain a metal which was a good non-conductor of electricity, but as this is an impossibility, and it has been found impracticable to make a strong, substantial sleeve, with its necessary flanges, of any insulating substance, a loose sleeve or ring of some non-conducting material has to be inserted between the flange and the commutator, and this causes all the mechanical difficulty. The insulation of the various sections from each other is usually effected by means of thin slabs of pure mica, and that of the commutator from the sleeve or shaft by air only, the depth of the section being so designed as to leave such an air space between them and the shaft as shall prevent the current from arcing across in any way. The end insulation rings are now usually made of micanite, although other substances, such as red fibre, vulcanite, presspahn, have been and are still used. The peripheral speed of a modern commutator may be anything from 1,500ft. to 2,500ft. per minute, which is very high for such a loosely constructed article, and it is evident that the centrifugal force, especially as the mass is considerable, tending to cause the component parts of the

Digitized by Google

commutator to fly apart will assume a great magnitude. If, now, the commutator is in any way slack, or any one bar is not firmly gripped, this bar will fly outwards as far as possible, and as the whole commutator is held together by the wedging of the bars against each other, the shifting of one bar even to a slight extent will loosen the whole structure, and some bars will rise considerably higher than the others, and the necessary smooth and even surface of the commutator will be entirely destroyed. If, however, the commutator be well tightened up, it may be found that the bars have too small a cross-sectional area to carry the maximum current without heating considerably, or the friction of the brushes may cause undue heating, and this increase in temperature will cause the bars to expand, and so press more tightly into the insulating end rings, which, owing to their nature,

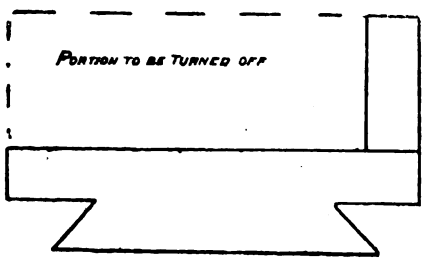


FIG. 16.

must have a yielding character. Upon cooling, the bars will contract and become slack, when the same result as that above described as due to a loosely-conducted commutator, will be obtained. The only method of securing a sound commutator is to arrange the cross-sectional area of such a size that, even allowing liberally for the heating due to friction, the rise in temperature of the whole commutator, after a prolonged run with full load, shall only be slight; a certain definite rise of temperature is often given in specifications for the armature, while no mention is made of any limiting value for the rise of the commutator—a matter which is of considerably more importance. After the cross-sectional area has been made large enough to fulfil the above requirements, the commutator should be built up and tightened in a lathe, and then, while being revolved, heated equally all over by means of a gas stove or other arrangement to some 10deg. or 15deg. F. higher than it is calculated the temperature will ever be in practice. It should then be allowed to cool to the temperature of the surrounding air, when it should

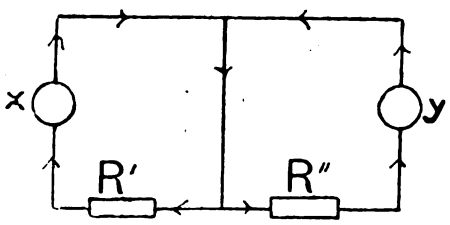


FIG. 17.

be again tightened up, and this process should be repeated three or four times. After being finally tightened up, the nut holding the loose flanges in position should be pinned or otherwise secured to the shaft to prevent it at any time working loose. If any type of section similar to *b* (Fig. 15) be employed, care must be taken to see that the sharp edges of the V's of all the flanges are cut away, otherwise there is a great possibility of these V's cutting through the insulation as the loose flange is tightened up; also great precaution must be taken to get rid of any dust in the commutator, which might cause a short-circuit between two bars.

The reason why such great care must be taken to prevent any bar from rising above its fellows is, that in order to obtain the best results the brushes are only held very lightly on the commutator, and with the high peripheral speed a risen bar would momentarily throw the brushes off the commutator, with consequent sparking. The section where the brushes were thrown off would become pitted and burnt, and the section upon which the brushes lighted again would also become worn away; flats would then be developed at these two points, and until these were turned out and the commutator tightened up, it would be quite impossible to run the machine without a great amount of disastrous sparking, which, if allowed to continue, would soon destroy the whole commutator. Flats will also be formed if any of the bars are softer than the others, and this prohibits the use of cast copper sections, as it is impossible, especially with copper, to guarantee that any two castings shall have the same degree of hardness; makers are therefore compelled to use either drop forged or rolled copper sections. The disadvantage of the latter is that usually it is necessary to have a lug of greater or less length attached to each section, and, as will be seen from Fig. 16, it would be a very costly matter if the bars were obtained of such a depth

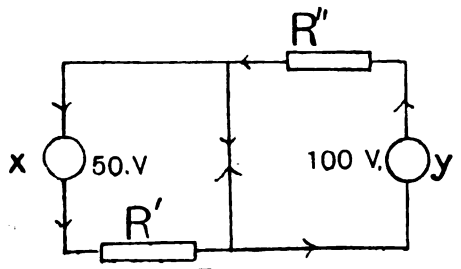


FIG. 18.

as would permit of their being turned down to leave a lug some 6in. or more long on each section, while the cost in labour of so turning them down would be very considerable. Hence the usual practice is to mill a slot in the end of each segment and let in a separate lug. This may be of cast or strip metal, according to the designer's fancy, but it must be firmly fixed. Preferably it should be brazed and riveted, as a loose or imperfect connection here or in any part of the armature will give rise to very heavy sparking when the machine is working.

The writer does not profess to have given every method which has been adopted for building up a commutator, but rather to have pointed out the main considerations which must be fulfilled in every design, whether for large or small dynamos, if successful running is anticipated. It is advisable to design the commutator to have such a length that the brushes may be staggered—*i.e.*, the positive and negative brushes should not trace out the same annular path, but rather overlap each other—so that should there be any tendency towards grooving, the

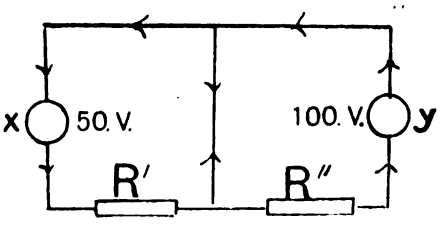


FIG. 19.

negative brushes may be so placed as to wear away the ridges which would be formed between the positive brushes, and *vice versâ*. It is also important that at least two brushes should be placed on each line of every machine, however small, so that, if necessary, one brush of any line may be removed or adjusted without interrupting the flow of the current while the machine is running. If sparking sets up at the brushes of a machine on which the commutator has just been turned true, in a very short time the surface of the commutator becomes badly worn, whereas if a machine runs for any length of time without sparking, a hard bronzy glaze is formed all over the commutator, which resists wearing away by sparking to a very great extent. The writer has found that if a machine be run with the brushes down on open circuit, but with the shunt excited from the armature, for two or three days when the machine is put down this glaze will be formed, and as any machine can be run without sparking on open load this glaze can always be produced. If, then, slight sparking does occur with full load, it will not be so injurious to the commutator as it would be were it not protected by this glaze.

Digitized by Google

Having dealt thus far with the construction and design of the commutator, we must now turn our attention to its function and to the theory of commutation. It was pointed out in the first article that an extension of Ohm's law, that $C = \frac{E}{R}$ was that if a current had several paths open for its flow it would be divided amongst them inversely as the resistance of the various paths, and it will be readily seen from Fig. 17 that if there are two different circuits having a common path during part of their circuits they will augment each other and flow down the same path together. It will also be seen from Fig. 18 that if the two currents oppose each other in this path, if they are equal in quantity, no current will flow down, but each will take up the work of the other. If the currents are not equal, only the amount of current equal to the difference in their values will flow along this path, and this will hold good whatever be the E.M.F.'s of the two currents, whether the same or not. For assume in Fig. 18 that x and y are two generators of electricity having no internal resistance, and that the external circuits apart from the resistances marked R′ and R″ have no resistance, that x generates a current at a pressure of 50 volts, and y a current at a pressure of 100 volts, and, further, that the directions

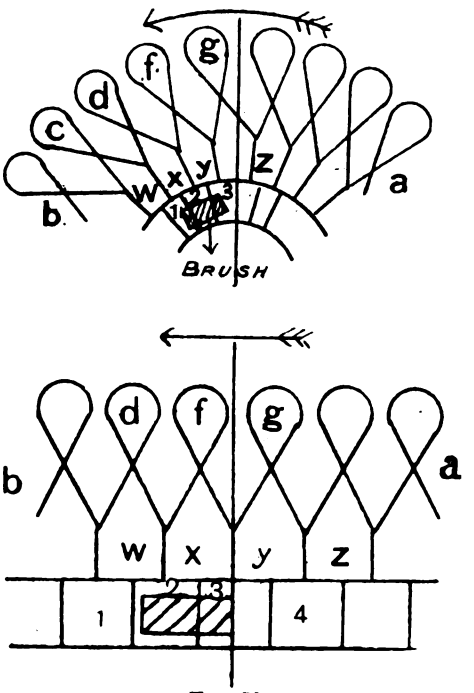


FIG. 20.

of flow in both circuits are those shown by the arrow heads. First, let us assume further that R′ = 10 and R″ = 20, then the current flowing round D C B A, if C F E B were taken away, would be five amperes, and that flowing round E B C F would also be five amperes were C D A B obliterated. At the positive side of x we have a pressure of 50 volts, which is maintained until the resistance R′ is reached; during the rest of the path the current is at zero potential. The same is the case with the current due to y. Now, if the path B C be removed there is a closed circuit still remaining—viz., E A D F—and the two generators are in series, and the conditions named above still hold good—viz., from R″ to x there is zero potential, and from R′ to y there is zero potential. There will, however, be a current flowing round the circuit, for considering the current to start at y, when it arrives with a zero potential at x its pressure will be raised to 50 volts to enable it to flow through R′ and thence into y. Hence, as in any case there will be zero potential at B C, the addition or omission of this path will make no difference, as no current will flow along it, and it may be said that x receives the current flowing from y, and y that flowing from x.

Let us now assume that R′ = 10 and R″ = 10. In this case we shall have a current of five amperes due to x and one of 10 amperes due to y. If B C is removed, we shall have at B zero potential of the current from y, and at C zero potential of the current from x. The y current upon reaching x will be boosted up to 50 volts, but since $C = \frac{E}{R''}$ and R′ = 10, only five amperes can pass through, and the other five will be blocked at x. If, however, the path B C be now inserted, these five amperes can flow down this path of no resistance to the negative side of y, and we shall have the whole of the x current flowing to y—half of the y current flowing to x to compensate for the x current which is flowing to y, while the other half of the y current will flow along the path B C.

If the two resistances be arranged as in Fig. 20, where x, y, R′, R″ have all the same values as before, we have a slightly different state of affairs. If B C be removed, there is a potential of 100 all the way from the positive of y to the negative of x, when the current is boosted up another 50 volts, and from the positive of x to R′ there is a potential of 150 volts. Now, the total resistance in the circuit is R′ + R″ = 10 + 10 = 20, which, since $C = \frac{E}{R'}$ will allow the passage of a current of 7·5 amperes. Hence, since E = C R, the fall of the potential due to R will be 10 × 7·5 = 75 volts, and we shall have a potential of 75 along the path between R′ and R″, and along the path from R′ to the negative of y a zero potential. If, now, the path B C be inserted, we shall still have a potential of 100 volts between y and x, and one of 150 between x and R′, and if 7·5 amperes flow through this resistance we should get a potential of 75 between R′ and C due to this current, but owing to the path B C having no resistance, there will be the same potential at C as at B—viz, 100 due to the y current. Hence along R′ C there will be a potential of 75 volts in a forward direction and of 100 in a backward direction, so that in addition to the resistance R′ there will be the extra resistance due to this back E.M.F. The condition which must be fulfilled is that the potential at C shall be equal for both the x and y currents—*i.e.*, the potential of the x current shall only fall 50 volts—and since E = C R′, we getting substituting known values, 10 C = 50, or C = 5. Consequently only five amperes can flow along the path B A D C, and we obtain the same result as before—viz., all the x current flows to y, half the y current flows into x to compensate for the x current flowing into y, and the other half flows down B C. It could be easily shown that the current would be similarly divided if it flowed the opposite way—*i.e.*, if the positive and negative sides of x and y were both reversed.

(To be continued.)

MISTAKES IN THE RATING OF INCANDESCENT LAMPS.*

BY ARTHUR J. ROWLAND, MEMBER.

(Concluded from page 564.)

It is interesting to notice, in these plots of illumination, that after the 45deg. ray is passed the value of all types of filaments is about the same; and it should be noted that the illumination procured is very small. An illumination of one-tenth of a candle-foot, for example, is that which one receives on a piece of paper held vertically more than 3ft. from an ordinary candle. Such light as passes out from a lamp in directions nearly horizontal or above the horizontal plane is useless except it is reflected back to the surfaces to be lighted or contributes to the general illumination by dispelling the gloom of the upper parts of a room and by giving a diffused character to the light. While it has such value, it is rarely that one can afford to use much light this way. If light is useful after reflection, it must travel in long paths, so that even if it reaches points where it is useful, so little illumination is produced that direct light is much the best. A very white surface will not reflect more than 85 per cent. of the light which strikes it, while dark walls and ceilings and hangings reflect almost no light at all. The item of reflected light is then one of very uncertain amount at most. Take a

* Paper read before the Franklin Institute.

Digitized by Google

room in which the ceiling is only 12ft. high, in which a 16-c.p. lamp hangs 4ft. from the ceiling, and one finds that no rays from any lamp now made, passing out to reach the ceiling or wall above the horizontal plane through the lamp, will give an illumination of as much as ·05 candle-foot on a surface 5ft. below the lamp, even on the assumption that the ceiling and wall are the best possible reflectors.

Influence of Filament Form on Candle-Power.—A number of interesting matters connected with the distribution of light from lamps having filaments of the different types are shown in Figs. 4 to 8, inclusive. Each figure gives the results from a test of one lamp—a lamp chosen to represent the type because it was truly representative mechanically, and by check against other lamps was found to be representative in light distribution. The rough sketch of the lamp on each figure shows very nearly the actual shape of the filament whose candle-power was measured. The left-hand sketch shows the lamp as it stood for measuring the horizontal candle-power at 0deg. and the right-hand figure at 90deg. In all the candle-power diagrams distance out radially from the centre of the diagram to the heavy curve giving the candle-power in that particular radial direction. Thus, in the curve of horizontal distribution, if the lamp stood with axis vertical and one went around the lamp taking candle-power of the light given in the direction toward him as he went on, these values of candle-power have been recorded and can be read off on the diagrams up to the heavy line. The same interpretation holds for the curves of vertical candle-power at the right of the figures.

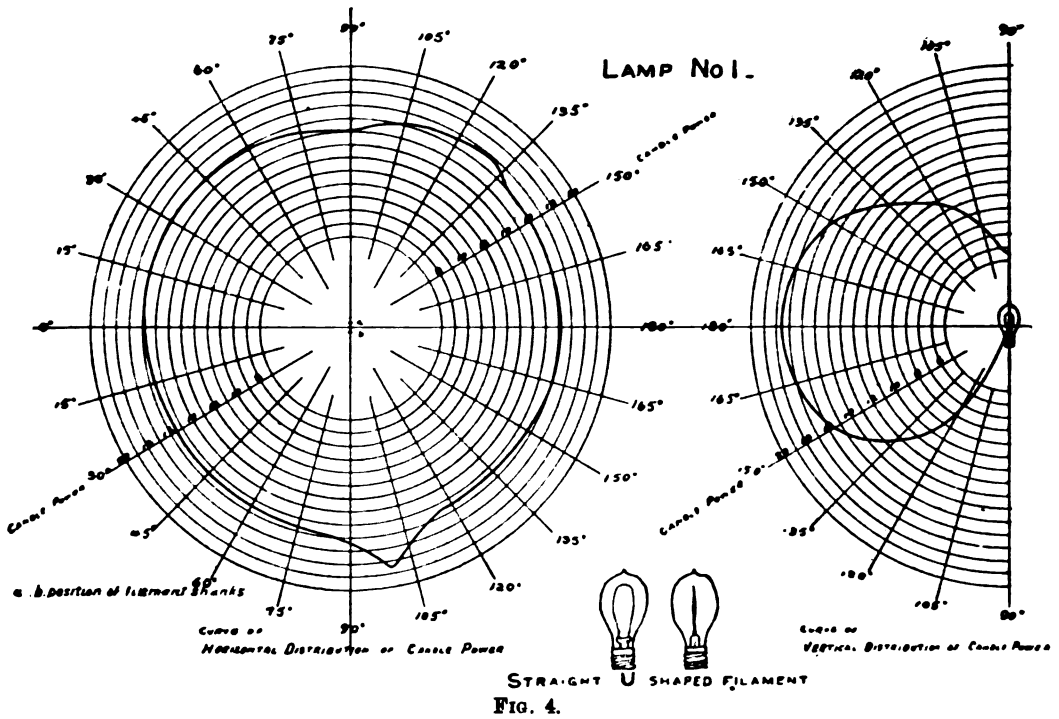


FIG. 4.

All the lamps were kept at the voltage at which they give 16 c.p. on the basis of the manufacturer's rating. In the curves of horizontal distribution we see that lamp No. 1 with the straight U-shaped filament is quite uniform in candle-power all around. The candle-power distribution of the long curl anchored filament (lamp No. 3) and the double filament (lamp No. 4) are somewhat similar. The irregularity of the curves for lamps Nos. 2 and 5, coil filament types, is great. This is always distinctive of lamps of the sort. The striking irregularity at one point of the curve for lamp No. 2 is not abnormal.

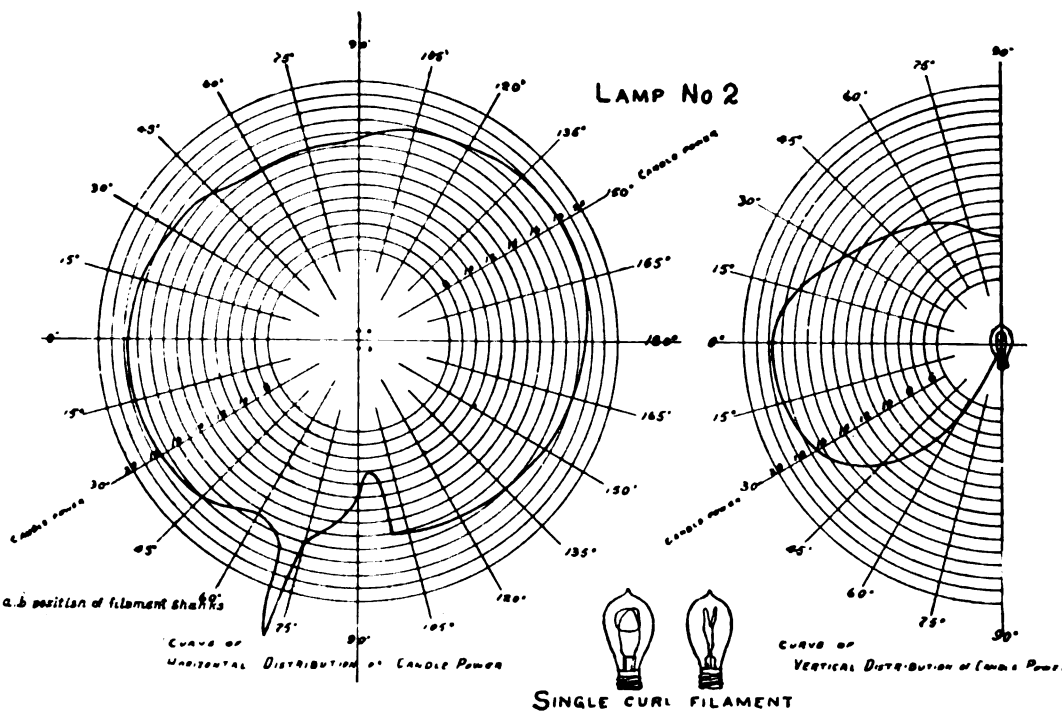


FIG. 5.

Digitized by Google

There are often two such breaks, one on each side of the lamp. The cause of this irregularity may be due to complex reflection and refraction of light due to varying thickness or curvature of the glass enclosure. It has not been investigated, I think. Since the manufacturer's rating is on the average or mean horizontal candle-power a lamp gives, the more uniform the candle-power curve of horizontal distribution the more nearly perfect a lamp might be considered, I suppose. At least, this seems to explain the design of the most recent filament forms. But by far the most important distribution is that in a vertical plane. Here the great differences in candle-power procured from various filament forms show best. Look at the curves.

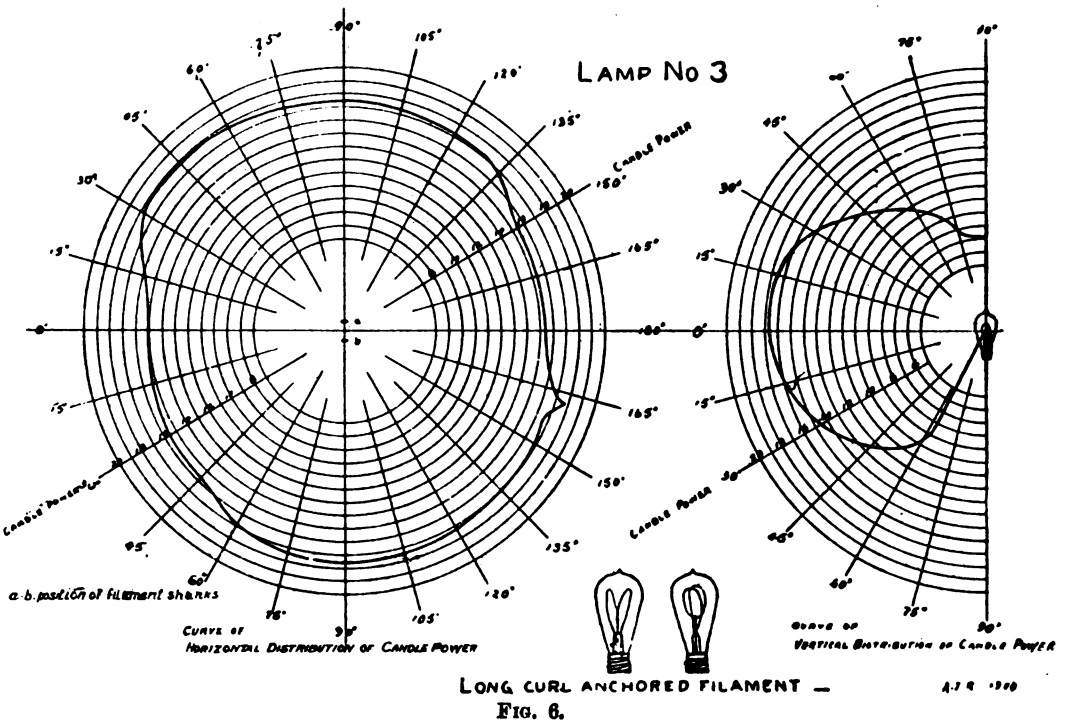


FIG. 6.

Lamps Nos. 1, 3, 4 are dreadfully deficient in light from the tipped end, and the candle-power of each falls off very rapidly as the 90deg. angle is approached.

How especially in this true of lamp No. 4, which, just as one comes to the direction from which the light is most important (between 75deg. and 90deg. at the tipped end), drops the candle-power down to less than five units. Most of the lamps, curiously enough, give most light in zones beyond the horizontal toward the base, where its usefulness is very problematical. This is true, too, of lamp No. 5, which maintains the candle-power it gives so well out toward the tipped end. It sends a good deal of light toward the base, but if we have a good light where it is useful, we must not criticise too severely the delivery of light where it has no especial value. The effect of the omission of the sealed-off tip on this lamp in helping up the candle-power at the end is well shown in the curve of vertical distribution for lamp No. 5, where from 75deg. to 90deg. the candle-power keeps up. This is due partly to the way the loops of the filament are spread, and partly to the omission of the tip.

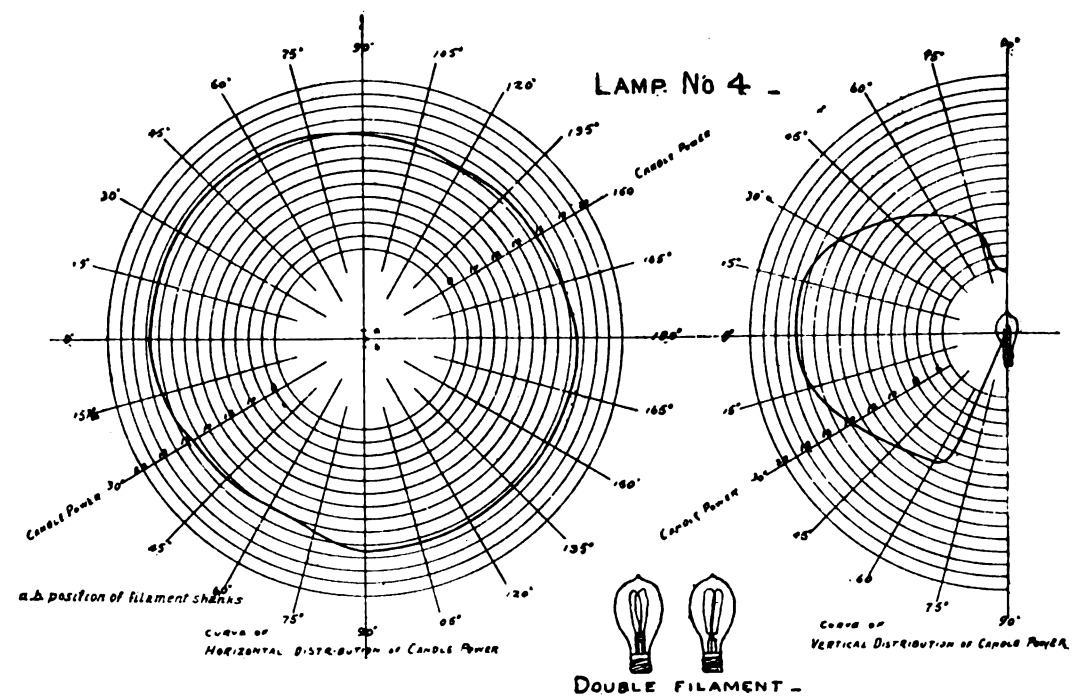


FIG. 7.

What is a 16-c.p. Incandescent Lamp?—It does not take much consideration of these curves to satisfy one that a 16-c.p. lamp is not necessarily one which gives 16 c.p. where this much light is wanted. The candle-power of incandescent lamps is determined really in a very empirical and arbitrary fashion. Most people seem to think it is as surely known as the watts used, and is as readily measured. But really it is about as vague and elusive a value as the

Digitized by Google

candle-power of an arc lamp, for which it has facetiously been said that it gives 2,000 c.p. because at any street corner it delivers 500 c.p. in each of the four directions. The common method of measuring candle-power in use by the manufacturers of incandescent lamps is to spin them at 180 revolutions per minute on a vertical axis and measure the average horizontal candle-power by a single reading. How this comes to be accepted as satisfactory, and what the status of candle-power measurement of incandescent lamps is, will be worth a little consideration right here.

When incandescent lamps first became commercial, they were put into competition with gas lights, and were made so they would measure 16 c.p. when placed in a photometer, precisely as gas lights had to be placed—base down, and the old U-shaped filament with a plane through the shanks of the U perpendicular to the photometer bar. Indeed, since photometers (except for purely scientific investigations) were used only for measuring the candle-power of illuminating gas, these very photometers were used for the incandescent lamps; and methods for gas photometry were adopted as far as possible into their candle-power measurement. It was soon clear that some more complete sort of measurement ought to be made, and in 1885, in connection with important tests of incandescent lamps for their economic value, probably the most elaborate tests ever made, the Franklin Institute adopted a method of measuring the mean spherical candle-power which was really an empirical or arbitrary one, but gave as a result a candle-power value quite nearly the true average of all measurements when the lamp was viewed from all possible directions.*

The measurement of the mean spherical candle-power by the Franklin Institute method requires that at least between 40 and 50 measurements on the photometer be made, and the average of 38 determinations is taken to get the result. About two hours' time for two operators with a well-equipped photometer laboratory is required for the measurement of one incandescent lamp, while the apparatus required, as supplied by instrument makers, is defective, in that it does not enable satisfactory measurements of the light radiated in directions near the lamp base to be made. While, then, this method came near giving the real average candle-power of a lamp, it could not well be used by lamp manufacturers in rating their product, nor was it. Most of them rated their lamps by the candle-power measured when the lamp stands vertically with base downwards and the bar of the photometer points to some selected side of the lamp. Some attempts were made to use a constant number, by which this reading of candle-power might be multiplied to give the mean spherical candle-power for a given type of lamp, but without success in commercial usage.

In recent years lamps have been measured by their mean horizontal candle-power and so rated. To save time, the manufacturer has lamps standing in the position already described, but has them rotating when the candle-power is measured; 180 revolutions per minute is a common speed, and the voltage marked on the label is that required to give 16 c.p. when the lamp is so rotating. The user who checks the manufacturer's product as it is delivered to him must perforce use the same method.

The National Electric Light Convention, not satisfied with the uncertainty of the methods in use, and in order to procure uniformity of standards and practice in rating lamps, appointed a committee, who made a report at the convention in June, 1897, in which they say that the mean spherical candle-power is the only proper and fair value to consider in comparing lamps. The practical measurement of this is so difficult, however, that a simpler method was recommended whereby the average luminous output of the lamp might be measured. The proposed measurement was to be taken "in the direction inclined 45deg. to the axis of the lamp, while the lamp is revolving upon its axis, the distance of the lamp from the photometric screen to be regarded as the distance between the centre of the axis of its bulb and the screen. This will furnish a fair approximation to the mean spherical candle-power, and reduce the amount of labour in measurement to the minimum." Two revolutions per second or 120 revolutions per minute was recommended as a speed of rotation.

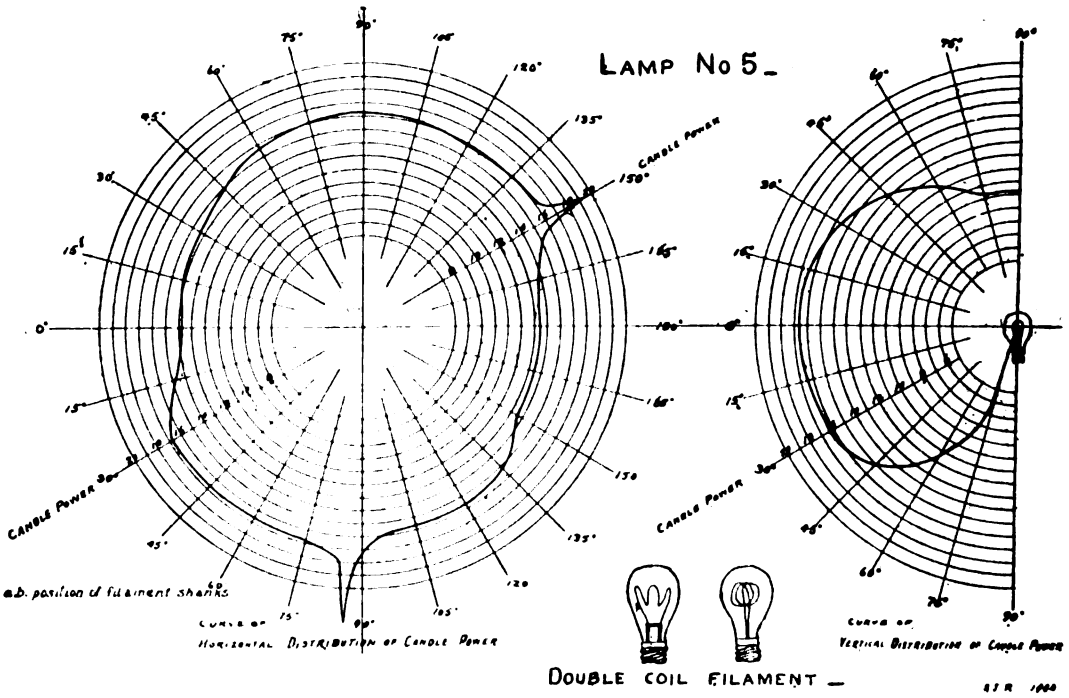


FIG. 8.

A year later, in June, 1898, the same committee made a further report telling of tests made, confirming the committee's suggestion of measurement at 45deg. of inclination, and making the proper speed 200 to 250 revolutions per minute. The committee was continued and made another report at the last meeting of the convention, but altogether on other phases of the subject—photometers, standards of candle-power, etc. Here the matter rests. In spite of the official adoption of the report by the convention, manufacturers continue to rate their lamps by a measurement of mean horizontal candle-power with the lamps in rotation at 180 revolutions per minute. There is no photometric apparatus made which can be satisfactorily and continuously used for the measurement adopted by the National Electric Light Association, and if there were, the indefiniteness of the conclusions reached leaves much to be desired.

* The influence of candle-power measurements of gas upon similar measurements of incandescent lamps is well shown by the fact that the photometer expert of the Franklin Institute committee was Dr. Ward, the Philadelphia gaslight photometric expert.

Digitized by Google

TABLE A.—Candle-Power of Lamps with Different Forms of Filaments.

Candle-power taken.	Candle-power. Single U shaped filament	Single curl filament	Long curl anchored filament	Double filament	Double-coil filament
(a) At 180 revs. with axis vertical	16	16	16	16	16
(b) Mean horizontal (standard method)	15·8	16·2	16 6	16 0	15 72
(c) Mean horizontal (from plotted values)	16·0	16·7	16·7	16 1	15·6
(d) Mean spherical (standard method)	12·7	13·5	13·75	13·2	13·8
(e) Mean with axis at 45deg.	10·5	12 0	11·7	12 0	14·0
(f) Mean hemispherical	14·3	14 5	14·6	14·0	14·5
(g) Mean within 30deg. from tip	8·7	10·3	8·7	7·9	10·9
(h) From the tip	5·7	8·35	7 05	4·8	10·1

In Table A, I have set down a number of candle-power values for each of the five lamps of which some data was given in Figs. 4 to 8 inclusive. Each of these gives a value of candle-power by which the lamp might be called. The values were procured as follows: A lamp was set at 16 c.p. when rotating at 180 revolutions per minute with the lamp axis vertical, in the common arbitrary method, and for all measurements involved in the other tabulated values was held at that voltage. Values in line *b* were determined by taking the average of 12 readings as the lamp is turned, beginning with its standard position and at every succeeding 30deg. Values in line *c* are computed from the curves in Figs. 4 to 8 which take account of all horizontal candle-power variations. The line of mean spherical candle-powers is computed by the Franklin Institute method. Notice how much less the real average is than the rated candle-power in each case, and how this average compares with the rated value for each type of filament. Line *e* gives the candle-power these lamps should have been marked if rated by the National Electric Light Association's standard. The readings are not by a rotating socket, but averaged from readings made individually from the lamps tilted at the right angle. It will be noted that this agrees poorly with the value of mean spherical candle-power, and bears no easy numerical relation to it. Line *f* of the mean hemispherical candle-power is to be compared with the spherical candle-power values, and this in turn with the line *g*, in which average candle-power is included every ray of really useful light. Line *h* is set down for comparison and to mention later. With such an array of candle-power values for each lamp, what is its candle-power?

What should a 16 c.p. Lamp be?—Earlier it has been pretty thoroughly explained that the only sensible candle-power by which to call an incandescent lamp, is that which is useful in producing illumination at desired points. Such a method has never been used in marking incandescent lamps for sale. It is strange how precedent binds us in everything we do. Here in the matter of incandescent lamp candle-power we are all tied to methods of designation which look back to photometric methods used for gas-burners. True mean spherical candle-power and rotation methods are distinctively electrical, but they first came to be of importance because incandescent lamps are so commonly placed in positions impossible to gas-burners, and the rotation methods are used simply to save time in measurement, one reading taking the place of a dozen. It has already been explained that mean spherical candle-power is an impossible measurement for commercial purposes. Rotation methods are poor, too. Not only does the speed of rotation affect the result procured, but some of the best modern lamps produce such a flicker at the car of the photometer when rotated at standard speed (180 revolutions) that not only is the making of an observation most trying to the eyes, but the observer can only make a rough guess for the position of his screen when a balance is obtained. A recent suggestion to choose such a speed for each lamp as just removes the flicker is impracticable also, for not only does it require an adjustment of speed with different lamps, but with many filaments high speed of rotation distorts the filament or even throws it against the glass, due to centrifugal forces brought into operation by the high speed.

What more rational, then, than to measure the lamp's candle-power looking in at the end? It is the light coming from the end which we make use of—which we are interested in. Then this is the light to measure, and that by which the lamp should be rated. Lamps measured thus are as comparable with each other as lamps measured any other way. The apparatus required to make the measurement would be very simple, for no rotating device would be required, and the lamp need only be inserted in the socket without any care as to which side comes uppermost when its candle-power is determined, since the candle-power must always be read the same. Thus, readings of different observers would agree without respect to anything involved in the measurement, except the standards used and the personal element, which never can be eliminated. Such a radical change of method, however sensible the change, could not be made without the sanction and support of some of the large associations of electrical engineers. In the meantime, however, for eventually this method must certainly come to be used, all lamp users, should in addition to a measurement of candle power in the conventional way to check up the lamps purchased, take a reading of the useful light out from the tip.

A 16-c.p. lamp should be one giving 16 c p. from the tipped end. The horizontal candle-power might be considerably less and be irregular in different directions without altering the real value of the lamp. An ideal 16-c.p. lamp would perhaps be one which measures 16 c.p. from the tipped end, had 16 c.p. as the mean horizontal candle-power, and was of nearly 16 c.p. mean spherical. Such a lamp could be turned into any position in an electrolier and still give an illumination equally as good as before and as well distributed.

In most lighting, also, the end of the lamp which has been called the tipped end all along should be tipless. Hold a piece of white paper below an ordinary tipped lamp hung with the tip down, as it commonly is, and the reason is unnecessary to state. Variations in thickness of glass and shadow cast by the tip make lines of light and shade that spoil all real value of light procured.

Since the making of such lamps as these is doubtless but a choice of filament form and arrangement, let us hope it will not be long until there are some ideal lamps available commercially.

TABLE B.—Watts per Candle-Power of 16-c.p. Incandescent Lamps on Basis of Different Candle-Power Ratings.

Watts based on candle-power as stated.	Watts per candle-power. Single U shaped filament	Single curl filament	Long curl anchored filament	Double filament	Double-coil filament
(k) At 180 revs. with axis vertical	3·5	3·5	3 5	3 5	3 5
(l) Mean horizontal (standard method)	3·54	3·45	3 37	3·50	3 56
(m) Mean with axis at 45deg.	5 33	4 66	4·79	4 66	4 00
(n) Mean spherical	4·40	4·15	4·07	4 23	4·07
(o) Mean hemispherical	3·92	3·86	3 83	4·00	3·86
(p) Mean within 30deg. of tip	6·44	5 44	6·44	7 09	5·14
(q) From the tip	9 82	6 71	7 95	11 70	5·54

What is a 3·5-watt Lamp?—So far no word as to the efficiency of lamps has been said. It does not directly affect the candle-power nor distribution of candle-power. All the lamps mentioned above, for instance, were 3 5-watt 16-c.p. lamps. But why are they 3·5 watts per candle-power? Each lamp used burned with a consumption of 56 watts. The efficiency or watts per candle-power is strikingly varied by the candle-power to which reference is made. In Table B are set down the efficiencies of each lamp of the five types, calculated on the basis of the candle-power values in Table A. A 3 5-watt lamp turns out to be

Digitized by Google

one which uses this much electric power per candle-power if this is reckoned at its highest value the mean horizontal. What a terrible inefficiency these lamps have if we calculate the watts per candle-power from the useful light or the light from their tips!

Lines *p* and *q* of Table B give this. Lamps 2 and 5 are the only ones whose efficiency reckoned in a rational way is at all reasonable. The lamps of Table B all were supposed to have the same average life and would not be very far different in maintenance of candle-power during life. If a lamp can be made which gives 16 c.p. out from the tip and burns at five watts per candle-power, we will have a lamp which is better than any now made. If its life is as good as the present 3·5-watt lamps, it would be a much better lamp than any we have now for all commercial usage. Keeping, however, to lamps now made, Table C. gives the relative cost of current per 16 c p. of useful light (light from the end) from each of the five different filament types now made. The computation is on the basis of 12 cents per kilowatt-hour for electrical energy, and the cost is per 500 hours of burning (the average life of a lamp).

TABLE C.

Type of filament.	Cost of current per 16 c p. of useful light and per 500 hours' service.
Single U-shaped	$9 43
Single curl	6 44
Long curl, anchored	7·62
Double	11 20
Double coil, tipless	5·32
Double coil (10-c.p. mean horizontal)	$4·10

Since we only use electric current in incandescent lamps for the light we get, and since it is the cost of the light which is the vital commercial problem, the table needs no comments to show which filament types are best—that is, which ones are most economical to use. I have put lowest in the table the cost of current per 16 c.p. of useful light from a standard 10-c.p. (mean horizontal) double-coil filament lamp. This lamp gives 8·2 c.p. out from the tip. It is worth noticing that a 10-c.p. lamp (so called), with this type of filament, gives as much candle-power out from the tip as any one of the other types which are rated at 16 c.p. Hence, such a lamp using only 35 watts gives as much useful light as any of the other four types, which require 56 watts.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address.

BY PROF. JOHN PERRY, M E, D SC., F R S, PRESIDENT.

I do not intend to make this in any sense a report of the progress of our Institution during the last or any number of years. I shall not, therefore, give any account of the exceedingly good work done by Colonel Crompton and the active service corps of our Electrical Engineer Volunteers in South Africa. I shall not describe how we fêted our American cousins in England and France, nor how they fêted us; nor what a wonderful success accompanied all that was attempted by us or by them or by M. Mascart and our French colleagues, although I cannot refrain from bearing my testimony to the great kindness of the Prince of Wales and the British Commission in so generously lending us the British Pavilion for our great reception and giving us the use of one of its rooms for our office all the time of our visit to Paris. My brother has tried to get me to introduce to your notice some novel ideas which have come to us during the last 10 years in our business of lighting the city of Galway from a fairly constant water power using accumulators with a gas plant stand-by. It has almost come to be a practical idea to produce carbide of calcium in wet seasons and utilise it through the gas-engine in dry seasons. I was also tempted to discuss the use of large gas-engine plant at central stations; and another of several subjects in which I have been recently engaged has been the magnetic effect produced by systems of electric traction. But I have resisted temptation, and have chosen a subject which seems to me much more important.

Your president's address is followed by no discussion. He is, therefore, privileged, but his very privileges cause him to address you with a greater sense of responsibility; he may say what he pleases, but he must be very sure that he has the best interests of the Institution at heart—the interests of the Institution as a whole, not the interests merely of a few members, and least of all ought he to think of his own interests. Nevertheless, your president speaks not as an omniscient judge, but rather as a very fallible, very prejudiced, one-sided man, who, because he has devoted himself to one part of the work of this Institution, is certain to be unfair in his comments upon other parts of the work. Your past presidents represent in this way all classes of members of this Institution. You have had scientific men, given some of them to calculation, and some to experiment, and some to both; men who have advanced the study of pure science. You have had practical telegraph men, civil and military, men cunning in land and deep-sea telegraphy and telephony; men cunning in railway signalling. You have had electrical chemists. You have had manufacturers and users of all kinds of electrical appliances. You have had men who devote themselves to the teaching of electrical engineers and who fully appreciate the fact that no good teacher ought to be out of practical touch with the profession. And nearly all of your past presidents have invented things which are now in practical use. As each of these men has given you at least one address written from his own peculiar point of view, his prejudices are not likely to have done any harm to members who read the other addresses. I know, therefore, that you are good-naturedly prepared to give me plenty of rope. I can predict the twinkle of amusement in the faces of some of my friends when they learn that I am about to take up a subject on which we have had many debates.

In this address I mean to put before you this simple question: Is electrical engineering to remain a profession or is to become a trade? Is this Institution to continue to be a society for the advancement of knowledge in the applications of scientific principles to electrical industries, or is it to become a mere trades union? Of course, at the present time the outside public are willing to regard membership of this Institution as a symbol of something more than the membership of a mere trades union. During the early growth of any trade, even such a trade as that of the plumber, it was really a profession. And a common trade may suddenly become a profession, if it suddenly begins to develop, as, for example, stonemasonry of a hundred years ago suddenly developed into civil engineering. Electrical engineering has been developed rapidly, so that in the past it has certainly been a profesion and not a trade. Again, we are an institution of engineers, and the general public are willing to class us with other engineering institutions—for example, the Institution of Civil Engineers. Now the title M.I C.E. is a professional distinction which represents in civil engineering what F.R.C.S. does in surgery, or M R C.P. in medicine. We owe a great deal to our association with, and recognition by, the Institution of Civil Engineers: our meetings are held in its rooms; many of our members are also its members; our proceedings are modelled on its proceedings.

Now this older institution, governed by the best thoughts of the best British engineers, has laid it down that its associate members, that important class from which the higher class is mainly fed, shall have passed certain specified examinations in pure and applied science. I am not now suggesting that we ought to adopt this science examination method of admitting any kind of members to our Institution. I do not believe in the wholesale adoption of methods of working from another society. I am asking you early in my address to remember that this greatest of all professional engineering institutions, governed by practical men full of common sense, knowing the wants of their profession well, insists upon a knowledge of science in its new members. If this recognition of science did not exist anywhere else in the whole world, I say that its recognition by such a thoroughly good professional society as that of the Civil Engineers ought to recommend it to all professional societies. In Germany an enormous stride has recently been made in the raising of

Digitized by Google

engineering degrees to rank with the highest university honours. There is hardly one engineer of eminence in Switzerland, France, or Germany who has not passed with honour through the classes of one of their great science universities.* In Great Britain within the last 15 years not only have great engineering schools been established in all the manufacturing towns, but even in Cambridge University there is one of the best schools of civil, mechanical, and electrical engineering of which I know anything.

Before we think of imitating the Institution of Civil Engineers, we ought to reflect on certain fundamental distinctions between that institution and our own which at first sight seem to make us less professional. There is a well-known unwritten rule of the Civil Engineers to which there are only a few exceptions, that no contracting railway or harbour engineer can acquire the title of M.I.C.E. I think myself that it is a pity to draw a hard-and-fast line between consulting engineers and contractors. No doubt it simplifies the labour of the council in its selection of candidates, but it gives rise to anomalies. A man who was once a civil engineer because he served a pupilage under his clever father, and who now is nominally at the head of his father's large practice, the real engineering work being done by many clever employés, this man may be a member. A contracting engineer who shows marvellous ability not only in rectifying the mistakes of the designer of a large bridge or tunnel or reservoir embankment, but shows the power of Lord Kitchener in directing the work of thousands of men so that no man need be idle, and the whole contract goes on like clockwork, and is finished well in the minimum of time, this man is ineligible. Now in our Institution it has been recognised from the very first that manufacturers and contractors and their employés may belong to the very highest ranks of their profession. Of course, I do not mean men who simply receive the profits of businesses, or even men who merely work to obtain orders for themselves. I mean men who are not merely formally, but in reality manufacturing or contracting engineers. I mean men who, in dealing with standardised things, design new methods for quick, good, cheap production of such things. I mean men who improve old forms of such things, possibly through their paid subordinates. I mean by a manufacturer fit to be a M.I.E.E. a man who might act as his own manager, and who perhaps, has a wider outlook than on mere managerial duties. So long as a contractor or manufacturer is really an engineer, we know that we add to our strength with the addition of every such member. But consider a contractor who only uses ordinary types of machines or electrical plant in well-known ways, surely he can hardly be said to be in the profession at all. Surely the one thing that differentiates us from mere tradesmen is that we do not follow mere rule-of-thumb methods; we think for ourselves, we weigh advantages and disadvantages. If every new installation required the same treatment as existing ones, the engineer would degenerate into a tradesman, and it seems to me that the electrical engineer ought to have a special fear of such degeneration. In railway and harbour and river and sanitary engineering, in every new job, there are new difficulties to be dealt with. An engineer who designs many undertakings and sees them carried out must be a thoughtful man. He cannot help keeping himself acquainted with engineering principles, and so he is a professional man. So an architect finds that each new job requires all his experience. Every case that comes before a real physician or surgeon requires a somewhat different treatment from any old case. Every case brought before a barrister requires the exercise of all his past experience. In every case a *profession* implies the necessity for the exercise of all one's past experience, because the work one has to do is never the same as any work one has ever done before; and when I say past experience, I really mean certain general principles which one has always in one's mind, principles derived from all that one has done, or seen, or read about.

Electrical engineering is in a curious position. It owes its being altogether to scientific men, to the laboratory and desk work of a long line of experimenters and philosophers. Even now the work going on in a laboratory to-day becomes the much larger work of the engineer to-morrow. When at length the laboratory experiment is utilised in engineering, we see that there is no other kind of engineering which so lends itself to mathematical treatment and exact measurement. Most of the phenomena dealt with by the electrical engineer lend themselves to exact mathematical calculation, and after calculations are made exact measurements may be made to test the accuracy of our theory. For a completed machine or any of its parts can be submitted to the most searching electrical and magnetic tests, since these tests, unlike those applied by the mechanical engineer, do not destroy the body tested. Contrast this with the calculations it is possible to make in other kinds of engineering. The pressure of earth against a revetement wall is possibly 200 or 300 per cent. greater, or 50 to 70 per cent. less, than what we imagine it to be in what some limited men call theory. We use factors of safety 5 or 10 or more on all kinds of iron structure calculations, because we are aware of our ignorance of a correct method of dealing with the problems. The civil engineer never has exactly the same problem as has already been solved. In tunnelling, earthwork, building, etc., in making railways and canals, he is supremely dependent on the natural conditions provided for him: the configuration of the surface of the ground, the geological formation, the structural materials available in the neighbourhood. The story of how the engineer has to study the endlessly different ways of interaction of water and sand and gravel is told by the troublesome bars at the mouths of rivers all over the world, by the difficulties of coast and river-bank protection, by the failure of sea-walls and piers. But why should I make a catalogue of the different kinds of work done by civil engineers? Every one of them needs the exercise of general scientific principles due to much experience.

Now of all such natural difficulties the consulting or contracting electrical engineer is greatly independent. Give him a source of power and tell him what is to be done; whether he is to light a town or a building, whether with arc or incandescent lights; whether he drives a stamp mill near a mine or a pump, or a machine tool, or a spinning frame, the electrical part of the work is carried out in much the same way. Natural conditions affect him mainly in the cost of transport of his materials and the cost of labour. He can make in an easy way the most careful calculations as to the best arrangement of his conductors and machines to give maximum economy, and except for this easy calculation his work is that of a mere tradesman. He is practically independent even of the weather. There are, indeed, some of us who grumble that this easy calculation is not made easier still, who prefer to make arithmetical guesses rather than exact calculation, because, perhaps, we like to see a little uncertainty introduced into the problem to make it more like a problem in civil engineering. I want members to see clearly that as time goes on, as our electrical engineering work gets more and more cut and dried, the man who loses the power to calculate, who loses his grip of the simple theory underlying our work, must sink more and more into the position of a mere tradesman who has no longer the right to call himself an engineer. An electrical engineer must have such a good mental grasp of the general scientific principles underlying his work that he is able to improve existing things and ways of using these things. It has become the custom to call this *theory*, and I suppose I must follow the custom. I should prefer to call it *science** or *knowledge* Do you remember

* I understand also that the great unions of manufacturers in *Germany* are about to make facilities for giving a year of real factory work to the polytechnic students, thus perfecting the German system. In Japan we found great success in requiring students to spend their summer in real shops, their winters at college. In England it may be that we shall prefer to let apprentices have shorter factory hours than workmen, their masters being responsible for instruction being given in theory.

* What Falstaff said of the word "occupy" we have to say of the word "science." It is used by many people out of its proper meaning and then condemned, so that one is getting afraid to use it. In Prof. Fitzgerald's splendid inaugural address to the Dublin Section of this Institution he says: "As has recently been pointed out to me by Dr. Trouton, it would be impossible to say the same contemptuous things of *knowledge* as are said of *science*. In Germany the word used, "Wissenschaft," is the one corresponding to our word 'knowledge,' and there nobody of any sense could say

Digitized by Google

Huxley's definition of science? "Science," he said, "is organised common sense," and this is really what I mean. Well, calling it *theory*, the man who is permeated by theory, whose theory is so much a part of his mental machinery that it is always ready for practical application to any problem, he is the real engineer. But you must not mistake me in this matter. Eighty per cent. of the men who pass examinations in mathematics, mechanics, and electricity have very little of this theory. Fifty per cent. of the writers of letters in the engineering journals in which mathematical expressions occur have almost nothing of this theory in their possession. It is unknown to foolish men. Books alone, lectures alone, experiments alone, workshop experience alone cannot teach this theory. The acumen of a Q.C. may actually prevent a man from acquiring it. A man may have much of this theory, although he may never have listened to lectures, although he may dislike the sight of a mathematical expression. I have known men who might be called illiterate to possess much theory. I have known many men who might be called good *electricians* who are almost wanting in the theory necessary for the electrical engineer. I am speaking only of theory. Of the other qualifications for an engineer I need not here speak; they are present to the minds of all of us. A man may have any amount of knowledge; he may know how to apply his knowledge, and yet he may not be able to apply the knowledge from a want of engineering *character*. The engineer must be a real man; he must possess individuality, the power to think for himself. He must not be like a sheep, knowing only enough to follow the bell-wether. Over and over again in the last 30 years have some of us given our students much the same sort of advice that Baden-Powell gives to scouts in that excellent little book of his. If any of you have not read that book you ought to buy it at once, and you will there find that if a man is to think for himself he must possess all kinds of knowledge, he must be constantly picking up new kinds of knowledge.

Nobody can limit the value of any kind of knowledge, but still one may say that certain things are probably more important than others. To gain what we call "theory" a good general education is most helpful—mathematical knowledge is very helpful; laboratory and workshop experience are extremely helpful. There is one qualification which the electrical engineer must have and without which all other qualifications are useless, and if a man has it no other qualification is supremely important, and this absolutely indispensable qualification is that a man shall love to think about and work with electrical things. He must like these not because of the money he can make through electrical contrivances, nor even, I think, because of the name he may make before the world—this would be mere liking or cupboard love, which has no lasting quality. So long as we have men in this country who have the true love for scientific work of which I speak, so long shall we have a real profession of electrical engineering, for such men are always scheming new contrivances and improving old ones and utilising the services of all helpful people, and especially of capitalists. When we have reached a state in which nobody schemes new things because the existing things are perfect there will no longer be a profession of electrical engineering. Of all ideas surely that of having reached *perfection* is most hateful: the idea of exact knowledge, that nothing is unknown, that there is no need for thought and therefore that to think for oneself is a sin. And so, although we are all agreed that much standardisation in our contrivances and methods is absolutely necessary for our competition with other nations, we must follow the Americans in this matter and take care that it does not destroy invention. Of course when things are really standardised, when we have our perfect Mauser rifle or dynamo or locomotive or traction engine or electrically-driven stamp mill, a Boer can buy or even manufacture them if he has money, and he can use them as well as, or possibly better than, we can. But he is not an engineer. He uses things after the engineer has done his work upon them. A stoker, a common engine-driver, the guard of a train, these are not engineers. You must have noticed that the American engineers, who surely deserve the character of being practical idealists above all other engineers, are the men who are most imbued with notions of standardisation which lead to cheapness of manufacture, and they are also the men most alive to the necessity for occasional extensive scrapping of types of machinery when they become even a little antiquated. Our chiefs—the men who run us all, our real men at this Institution—may be called practical idealists. They have imagination and judgment and individuality. They have the imagination and enthusiasm of inventors, and yet they are more than inventors, for they can estimate the worth of their own inventions and control their imaginations. They are ready to receive all new ideas, they welcome all new things, and yet they are not carried away. They are radicals, and yet they are conservatives. They have what Mrs. Beecher Stowe called *faculty*. A strong imagination well under control, surely it is the greatest of mental gifts. I look round me and wonder how many of us really have it, and how many of us are only dull music-hall loving men, who scorn novels and poetry, who live utilitarian, material lives, whose aim is merely to make money through electricity, who love it not for its own self, who cherish their "tuppeny-ha'penny-worth" of theory because it is sufficient for their immediate wants. Why, even the writers of leading articles in the daily papers can talk of the wonders of electricity, and what may yet come to pass, and yet we who make machines and use them, and switch the marvellous thing on and off, and take all sorts of liberties with it—we are like Calibans, oblivious of the wonders of the fairy isle—like soulless priests, making a living in the temple of Isis—like Aladdins, who rub our lamp only to get the necessaries of life.

Twenty years ago some of us were laughed at for our optimism, and yet everything that we declared then to be do-able has now actually been done by engineers, except the thing which was then and is now declared to be the supremely important thing—namely, the electric consumption of coal. We say now, as we said then, "The applied science of the future lies invisible and small in the operations of the men who work at pure chemistry and physics.' And think of the wonderfully rapid rate at which the laboratory discoveries have been made in the last 11 years, and how, as the years go on, they become more and more numerous, and yet many of us plod along with our work seeing no farther than our noses. A year is now more pregnant with discovery than a hundred years used to be, and yet the protective stolidity of our ancestors is upon us, and we think of the latest discovery as if it were really the very last that can be made. A thousand men are measuring and trying new things in laboratories all over the world. Some of them plodding and soulless; others of them with imagination and clearness of vision. Do you think that nothing is to come from all that work? And is not one of the most important functions of the engineer to do as Mr. Marconi has done—to convince capitalists ignorant of science that if the successful laboratory experiment is tried on the large scale it must also be successful? And are we going to leave all this pioneering work, with all its possibilities of great gain, albeit with possible loss, to foreign engineers, when in most cases the scientific discovery has been made in England? Are we so lacking in the hope and faith which are born of imagination and science? And must we in the future, as in the past, have to rely upon the influx of the clever foreigner like Sir William Siemens? Must we, Boer like, always depend upon our Uitlander population—Fleming and German, Hollander, Huguenot, and Hebrew—for the development of our natural resources?

Some of the best engineers I know are so exceptional that one must class them with geniuses; they have faculty and character, and so they have become engineers even under the most unfavourable circumstances. They have passed through ordinary schools and yet developed common-sense. They were pitchforked into practical work, and their liking for the work, as well as some curious kind of instinct, led them to pick up all sorts of knowledge which have become part of their mental machinery. They continue to pick up new kinds of knowledge when these become necessary for their pro-

that 'knowledge is all humbug,' as is here often said, and still oftener thought, of 'science.'"

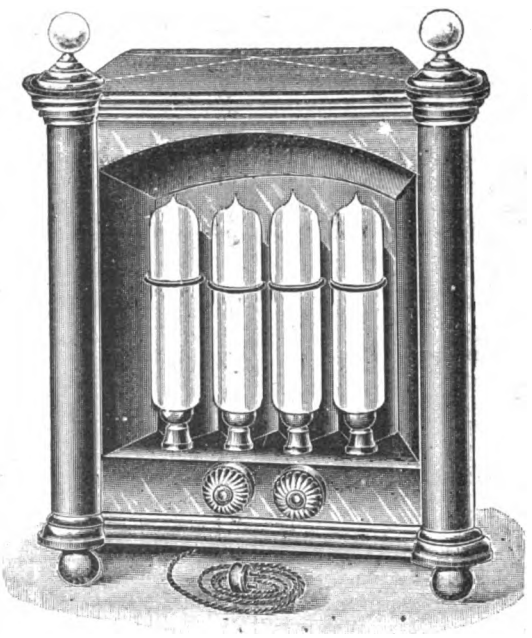
Digitized by Google

fessional work. Unfortunately these men do not realise how exceptional they are, and they advise boys to go direct from school into works. They forget that the other 99 per cent. of men treated in the same way as themselves can only become the hewers of wood and drawers of water to real engineers. Treated in this way, average boys are just like so many sheep: they learn just what seems absolutely necessary and no more; their acquaintance with the scientific principles underlying their trade is a hand-to-mouth knowledge which becomes useless when their trade undergoes development. In 1867 I was an apprentice, and when in the drawing office and pattern shop I remember well how I was chaffed for studying such a non-paying, non-practical subject as electricity. When I published my first electrical paper in 1874 before the Royal Society, and even for some years afterwards, the real students of electricity in England could be counted on the fingers of one's hands. Many of us remember the first Gramme magneto machine that came to this country, a scientific toy, in 1874. How many engineers dreamt that a great new branch of engineering had been started Even in 1878 engineers were, as a rule, quite ignorant of electricity, and since then every year, although newspaper writers have talked largely of the age of electricity, the men actually engaged in electrical industries have acted as if the greatest of changes were not perpetually going on in it. To be left behind, or to become camp followers, children of Gibeon, this is the usual fate of the men who scorn theory. In 1882-4 we used to have to pay men £200 or £300 a year because they had a slight knowledge of electrical matters. In 1884 6 these very men were not worth 20s. a week; they were weeded out of the profession, and their places were taken by men of better knowledge. Two or three years after, these better men were again found to have been weeded out, because men of still better knowledge were available. And so it has gone on ever since. Men learn just enough to get posts; they settle down in these posts and scorn theory. They actually forget what little theory they once did possess They know a great deal about existing machines, but presently they discover that improvements have been going on, and that they no longer have a right to say that they belong to the engineering profession. In every year one has told men, "You will be left behind. See A and B and C. I told them three years ago, when their names were in everybody's mouth, that they would be left behind like their predecessors, and they laughed. Now I tell you and you laugh, and you also will be left behind. Yes, I know that you get a good salary or large fees, and your head touches the sky. Nevertheless, because you neglect theory and the simple mathematics by means of which theory is made available in practical problems, you will have to take a back seat presently, for our profession is in its early youth and is growing rapidly." Remember that I do not now refer to the few exceptional heaven-born engineers who, in spite of bad training, do manage somehow to pick up the necessary knowledge. I speak of the average men, many of whom are now living in the same old fool's paradise. They know enough for present needs; they scorn the simple principles which underlie all our work; they scorn the easy mathematics by which these principles are most readily employed in practical problems; they will have their reward.

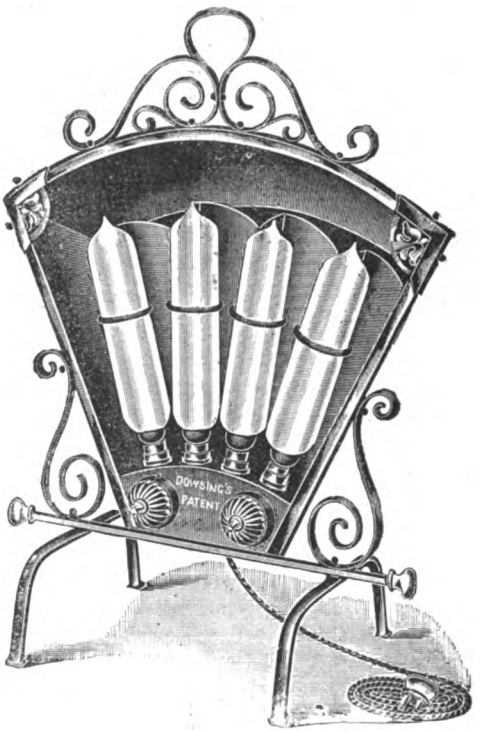
(To be continued.)

THE DOWSING ELECTRIC RADIATORS.

We have before now referred to the luminous electric radiators designed by Mr. H. J. Dowsing, but this week we were invited by that gentleman to inspect his new types, which, he rightly claims, are more serviceable than the older ones. In the illustrations herewith we show two of these new types, of which a description will be interesting. The so-called heat lamps employed are placed inside a radiator, the surfaces of which are, as a rule, highly polished, so that the heat may be reflected. As, however, the best of reflectors do absorb a certain amount of heat, Mr. Dowsing has arranged the forms of his reflectors so that there are vertical air passages behind them. Up these a draught is created on the well-known chimney principle, because the air becomes heated while in contact with the rear surfaces of the heat reflectors. The upper ends of these air tubes can be seen in the illustrations just above the ends of the heat lamps. The lower ends of these tubes are at the back of the radiator. The action then tends to circulate the air in the room, the cold air being taken up from the floor level. It then passes up through the radiator



and becomes heated. One result of this combination is that the radiators are more serviceable than those of the earlier type. With the ordinary type of radiator with heat lamps the consumption of electricity is one unit per hour. It must be remembered that central-station engineers are quite prepared to give special rates for electrical energy to be consumed for heating purposes; in fact, in many towns these radiators would be supplied at



1d. per unit, or, say, 8d. per day of eight hours. There are a number of rooms in every house in which it is difficult to know when fires will be required, and for these the electric radiators have special advantages. What, however, remains one of the greatest advantages of the Dowsing type of radiator is that they are exceedingly pleasant to look upon. They also give off heat immediately they are turned on, so that they are most serviceable in emergency.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:
139-140, SALISBURY COURT, FLEET STREET,
LONDON, E.C.

CONTENTS.

Notes	649	The Big Searchlights at the Paris Exhibition	669
The Philosophy of Dynamo Design	654	The Factors which Determine the Design of Monophase and Polyphase Generators	670
Mistakes in the Rating of Incandescent Lamps	657	Manchester Electricity Committee	671
Institution of Electrical Engineers: Inaugural Address	662	Legal Intelligence	672
The Dowsing Electric Radiators	665	Forthcoming Events	672
The Use of Mathematics	666	Questions and Answers	673
The Manchester Council	666	Companies' Meetings and Reports	676
Correspondence	667	Contracts for Electrical Supplies	677
Public Opening of the Borough Electricity Works, Bury St. Edmunds	668	Traction Notes	678
The Newcastle Local Centre of the Institution of Electrical Engineers	669	Lighting Notes	680
Ottawa and Its Water Power	669	Provisional Patents	683
Light Railways	670	Specifications Accepted	684
		Traffic Returns	684
		Companies' Stock and Share List	684

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

THE USE OF MATHEMATICS.

The President of the Institution of Electrical Engineers must not be classed with those prophets who prophesy smooth things. His address, delivered to the Institution last night, has many healthy criticisms both of the individual members of the electrical profession and also of the profession as a whole, in that it has allowed the electrical industry in this country to lag behind that in the States and on the Continent. With the fact that in certain respects Dr. Perry's charge is only too true we have to agree, and we have from time to time during the past few years commented on the indifference of electrical manufacturers in this country to improvements in types of machines and systems of supply which it was absolutely necessary they should adopt in order to retain control of the Colonial markets. It will, of course, be open to question as to whether Dr. Perry's solution of the chief cause of our backward position is a correct one. Personally, we believe that Dr. Perry is quite right in laying the great stress he does on the advantages of a working knowledge of the higher branches of pure mathematics, but there are many other causes at work, and we doubt if a knowledge of higher mathematics by certain members of the staff of a manufacturing firm will enable that firm to obtain the capital required to extend their works. The lack of capital easily obtainable for electrical ventures is a very serious drawback in England. Referring more, however, to the personal element, as Prof. Perry has done, our rising engineers must learn that pure mathematics applied without reason to engineering problems leads to disaster. We can point to numerous general solutions in mathematical form of particular electrical phenomena which are absolutely valueless save as a mathematical exercise, because they assume that certain constants exist and are obtainable when such is not the case. As a rule, however, a good knowledge of mathematics increases the aptitude of the student and the observation of physical facts, and the two in combination will be found a most valuable aid in professional life. We only wish that Dr. Perry's address was open for discussion.

THE MANCHESTER COUNCIL

The outcome of the enquiry undertaken by the special committee of the Manchester City Council into the charges brought by Mr. Norbury Williams against Mr. Alderman Lloyd Higginbottom has been the resignation of that latter gentleman from his position as alderman of the city, and consequently of the chairmanship of the Electricity Committee. Enquiry was made into the nine clauses in Mr. Williams's address which were directed solely against Mr. Higginbottom. Out of these eight were found to be without serious foundation, and the ninth was considered to be proved. This conclusion confirms what we stated in our leader last week, that the only objection which could be brought against Mr. Higginbottom was on the question of the supply of cranes. Evidence was obtained to the fact that out of six contracts for cranes Mr. Higgin-

Digitized by Google

bottom's firm had received, as sub-contractors, the major portion of the contract sums. If the engineers of the Gas and Electricity Committees had seen to the fulfilment of the common clause existing, we believe, in all engineering specifications on the question of sub-contractors, the so-called scandal in the present instance would have been avoided, as the name of the firm of Higginbottom and Mannock would then have had to come before the committees for approval. Still, Mr. Higginbottom has sinned against the law, and has suffered the extreme penalty of dissociation from the enterprise he has so ably controlled for many years. It has not, however, been proved against him that the contractors to whom his firm supplied goods for the Corporation did not in each case send in the lowest tender, or that they received any preferential treatment from the two committees or their engineers. It is, however, necessary that the Lord Mayor of Manchester shall be above suspicion, and we concur, therefore, in the course taken by the committee. Mr. Norbury Williams, as can be seen from the Manchester papers, is pleased with the success of his address, and in the pride of his success took it upon him to insult the Council as a whole. Thus in an address to the Manchester reporters immediately after the meeting on Monday, he had the impudence to wish the re-elected Lord Mayor "a happy and blameless year of office." We are also informed by the *Manchester Evening Chronicle* that "considerable further action against other members of the Council is most probable." The points arise out of the position of certain members of the Council on limited liability companies trading in that city. Such companies are not debarred by law from doing work for the Council, in spite of the fact that some shareholders may be either councillors or aldermen. The above paper states that, "unfortunately for the position of the members of the City Council, Mr. Norbury Williams is not satisfied with the law." When one considers the logical outcome of the position disclosed in our above-named contemporary, one is driven to the conclusion that the so-called reform party in Manchester will not be satisfied until all the members of the City Council are men absolutely without interests in undertakings in the city which may either directly or indirectly do business with the Corporation as contractors, or who may have to undertake negotiations with the Corporation. Such a restriction would prevent the best class of inhabitants from having any part in the government of their city. It is commonly stated that the man who successfully conducts his own business, making it a credit to the town he lives in, is the best qualified to assist in the ruling of that town. The Manchester reformers take the opposite view, which will only logically be fulfilled when the Manchester Council is elected from inhabitants of such far-away places as Lands End and John O'Groats.

New Canadian Cable.—It is reported that the Canadian Government intend having a short cable from Belleisle, Newfoundland, to Scotland, *vid* the North of Ireland. Canada's share of the cost would not be over £200,000, and the cost of cable messages would be reduced 6d.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RATING OF INCANDESCENT LAMPS.

SIR,—You reproduce in your issue of the 19th ult. the first portion of a very interesting paper read before the Franklin Institute by Mr. Arthur J. Rowland. The paper deals with a matter to which my attention has for some time been directed, and which, so far as I am aware, has never, in view of its importance, been adequately studied (even admitting that it has been studied at all) by electrical engineers, either in this country or abroad.

The paper is entitled "Mistakes in the Rating of Incandescent Lamps," and it is, if I correctly appreciate it, designed to bring home to the public the erroneous conclusions which they come to in regard to the efficiency of electric incandescent lamps based on their arbitrarily marked candle-power.

Taking, by way of illustration, a 16-c.p. lamp, which is the one most commonly used, the author deals clearly and methodically with the questions of economy and efficiency, commencing with a statement as to what a lamp ought to be, then drawing attention to the importance of the light from the tipped end of the lamp, and describing the types of filament in use by the various manufacturers of lamps.

It seems incredible, after the lapse of so many years since the electric lamp became a commercial article, that so few attempts should have been made to utilise the rays of light emitted from the lamp in a plane at right angles to the filament, or, in other words, that makers of lamps should have practically ignored the fact that the length of the filament is a factor which determines the efficiency or candle-power of a lamp, and that any rating which disregards this is grossly erroneous. Lamps, however, have hitherto been rated according to their spherical candle-power, without regard to the fact that the light emitted from the end of the lamp is of prime importance, for the reason that the greatest number, probably 99 per cent. of the lamps in use, are suspended so that what may be termed the "side light" of the lamp is only partly utilised, and generally serves for the illumination of space, and is consequently often practically lost. In some installations, it is true, lamps are placed horizontally and reflectors are placed above them in order to obtain the benefit of this side light, but the arrangement is of such rare occurrence that it may be disregarded.

The diagrams appended to Mr. Rowland's paper and the description of the various forms of filaments which may be used with a view of giving the maximum efficiency at the tipped end of a lamp are most interesting, and shed a flood of light on the theories which the author enunciates. But as regards the filament, it seems clear that no form can be given to it which will render the light emitted at the end of the lamp equal, or nearly equal, to the side light. Hence, it behoves electrical engineers to endeavour to obtain some device which will intercept the side rays and divert them into the required direction *without diminution*, so as to obtain the maximum useful effect for a given consumption of current.

Mr. Rowland refers to the holophanes, which are no doubt useful devices, but which do not meet requirements, as they are expensive adjuncts, while their use is often precluded by reason of the cost of the installation, and they are apt to accumulate dirt. The use of a reflector, again, for the purpose of increasing the light below the lamp, is a crude attempt to solve the difficulty, for, apart from expense, a reflector, as the author remarks, cuts the light off absolutely in some directions, and so diverts it in others as to produce sharp shadows and brilliant lighting contrasts. Moreover, a reflector intensifies the light and thus increases the distress to the eyesight caused by the glaring filament, often necessitating the adoption of a ground glass or semi-opaque bulb to modify the light, so that while on the one hand some of the rays are refracted and diverted into the required direction, on the other hand the efficiency of the lamp is diminished. In other words, the account shows no balance to credit, the dividend earned being expended uselessly. The best type of what may be

Digitized by Google

termed a reflector lamp is that known as the improved glow lamp or Edison and Swan's "Queen" lamp, which is of flattened form and has a mirror-like backing, so that the light is powerfully projected downwardly when the lamp is hung from overhead.

What is required is a device which will both divert the side rays gradually and imperceptibly—*i.e.*, without any hard shadows or line of demarcation—and at same time screen the filament, that will be cheap, that will form a part and parcel of the lamp, and (which is of no less consequence) will be applicable to the lamps of all makers.

If the improved glow lamps were provided with a shade or screen which would conceal the filament while permitting the light to pass without undue diminution, it would be an excellent lamp, while the lamps of other makers would also be practically perfect if they were provided with a similar adjunct.

The nearest approach to what is needed seems to me to be the spiral globe, in which the bulb is enveloped by a spirally-coiled glass rod. This I have found a most excellent arrangement, as it does divert the side rays, and actually doubles the efficiency at the top or end of the lamp, as I have proved by the photometer. But the lamp is somewhat heavy and expensive, and does not suit all installations. But if someone could produce a screen partaking of the character of the spiral globe which could be applied to all kinds of lamps indifferently, he would earn the thanks of not only the public, but the makers of lamps also, as the serious objections raised to ordinary lamps would be got rid of, and consequently an increased sale of lamps would be the result.

I throw out the above suggestion, and trust that it will be carefully considered.—Yours, etc., H. A. HOBSON.

45, Lombard-street, E.C.

BURY ST. EDMUND'S.

SIR,—Referring to your notice of the Bury St. Edmund's plant, I have this morning received a sample from Mr. Roe, respecting which he writes that it was delivered by my heater detartariser at "top load." I have tested this sample, and find it to contain 2deg. of hardness. A sample of the main water which I tested in June last for the purpose of determining whether the use of soda would be necessary, showed the water to contain 19deg. of hardness, of which 3·5 consisted of sulphates and 15·5 of carbonates.—Yours, etc., WILLIAM BOBY.

London, Nov. 2, 1900.

ADVERTISEMENTS FOR TENDERS.

SIR,—In the interest of electrical agents, permit me to make some slight protest against the manner in which advertisements inviting tenders are too frequently worded. Often, for example, among the contracts advertised we find something of this kind: "The Corporation of —— invite tenders for the supply and erection of engines and dynamos. Specifications and forms of tender may be obtained on payment of a fee of three guineas, on application to," etc., no information being given about the type or size of engine and dynamo required.

An agent's profits are not so great that he can afford to risk many guineas on such indefinite grounds, with the probability that the specification will stipulate for one particular type of engine and some special features in the design of the dynamo which may prevent him tendering for those he represents, while an application to the consulting engineers for more definite information, before sending the prescribed fee, as often as not remains unanswered.

The objects in advertising for tenders are, presumably, to obtain the best possible machine for the required purposes and to encourage competition. These objects would, I think, be more readily attained were the advertisements to state clearly the required voltage and output of the dynamo, the type of engine, and whether the design of these is left open to the maker or is restricted by the terms of the specification. An agent or manufacturer could then tell at once if his machines were eligible for competition, and be saved the useless expense of applying for a copy of the specification, only to find himself unable to quote; while the advertisers would be more sure of obtaining tenders for those best suited to their requirements.—Yours, etc., W. H. MERRIMAN.

London, Nov. 7, 1900.

[N.B.—Mr. Merriman will find that in most cases such specification can, as is stated in the advertisements, be inspected at the offices of the consulting engineers. Such an inspection will enable manufacturers to determine, before expending the three guineas, whether or no they should be able to tender to the specification.—ED. *E. E.*]

PUBLIC OPENING OF THE BOROUGH ELECTRICITY WORKS, BURY ST. EDMUNDS.

The formal opening of the new electricity works at Bury St. Edmunds, fully described and illustrated in our issue of last week, took place on Tuesday, Nov. 6, when the Mayoress (Mrs. T. Shillitoe), in the presence of an interested assemblage of ladies and gentlemen, switched on the supply of current to the distributing mains. The MAYOR, in starting the first engine, alluded to the extreme pleasure which it gave him to be able to perform the ceremony during his year of office. He looked upon that day as a red-letter day in the history of Bury St. Edmunds, since it saw the completion of the long labours of the Electricity Committee which had been entailed in promoting the scheme. In this latter respect he could bear testimony as to the able manner in which Mr. Charles Oliver had discharged the arduous duties of chairman of the committee. The Mayor then called upon Mr. Oliver to start the second engine, which having been duly accomplished the Mayoress switched on the current, the supply thereupon being formally inaugurated. The subsequent inspection of the works revealed their very ship-shape order. A substantial job has been made of the battery-room, which was not quite fully equipped at the time of our previous visit to the works. The accumulators are arranged in three tiers with supports of cast iron. The connections from the battery are also very neatly disposed of.

After the inspection, a move was made to the Guildhall, where, in commemoration of the opening which had just taken place, a large number of guests were entertained by the Mayor and Mayoress to an excellent champagne luncheon.

In proposing the toast of "Prosperity to the Bury St. Edmund's Electricity Works," Mr. CHAS. OLIVER gave an outlined history of his association with the Electricity Committee as chairman, and commented upon the severe opposition with which the undertaking had had to contend with. But, notwithstanding the opposition, they were now in possession, he was pleased to say, of electricity works worthy of the town. He saw no reason why gas and electricity should be looked upon as directly antagonistic to each other; he felt sure there would be demands for both. Personally, he had come to the conclusion, after having put down for his own purposes the first private electric lighting plant in Bury St. Edmund's, that the new light was both economical and otherwise desirable as an artificial illuminant. For many years he had been a strong advocate of the electric light. With regard to their electricity works, there was only one fault concerning them which he had to find, and that was with the battery-room, which he considered should have been on the ground floor. He would couple with the toast the name of Mr. A. H. Roe, their resident electrical engineer, who was so ably promoting the interests of the undertaking.

Mr. ROE, in responding, expressed his regret at the opposition offered to the original scheme, but for which the town would have on that day been in the possession of an installation of public electric street-lighting in addition to the supply inaugurated. With regard to the popular idea that electrical energy was expensive as compared with gas, he would point out that electricity at 6d. per unit compared very favourably with gas at 4s. per 1,000 cubic feet. Electricity also facilitated further economy by the ease with which a lamp could

Digitized by Google

be switched off when not immediately required. He had great hopes of the future success of the undertaking.

The MAYOR, in very appreciative terms, then proposed the health of Mr. F. Hastings Medhurst, the consulting electrical engineer to the Corporation.

In returning thanks for the hearty manner in which the toast had been responded to, Mr. MEDHURST reviewed the difficulties which had been successfully encountered in connection with the scheme. With regard to the suggestion made by Mr. Oliver concerning the position of the battery-room at the works, he thought it strange that the criticism should not have been made when the designs were originally submitted for approval. In preparing those designs he had gone upon the same lines as he would have done had the moneys for their execution been coming from his own pocket. He had restricted expenditure so far as possible to immediate requirements, and this policy had been the ruling factor throughout. Provision had, however, been made to facilitate future extensions, and in this manner expenditure had been avoided for which there could have been no immediate return.

Alderman JOHN G. OLIVER proposed the health of the contractors. Messrs. F. J. ANSON and P. T. MOORE responded for Messrs. Fowler and Co., and Mr. POCKLINGTON for Messrs. Callender and Co.

The concluding toast—"Long life, health, and happiness to the Mayor and Mayoress"—was very heartily responded to, and this terminated a very enjoyable afternoon.

THE NEWCASTLE LOCAL CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Newcastle-on-Tyne is noted for the forwardness of its inhabitants, and in this respect the local centre of the Institution of Electrical Engineers is not behind. Thus, of all the local centres recently formed, it is the first to hold an annual dinner. This first annual dinner of the Newcastle centre was held on Wednesday last, when Mr. A. W. Heaviside, the president of the section, took the chair. Amongst those present were the Mayor of Newcastle (Sir Riley Lord); Prof. J. Perry, F.R.S., D.Sc., president of the Institution of Electrical Engineers; Mr. W. G. McMillan; the Rev. Principal Gurney; Mr. S. G. Weeks, president of the Institute of Mining Engineers; Mr. John H. Holmes, president of the Newcastle Association of Students of the Institute of Civil Engineers; Mr. J. M. Moncrieff, M.I.C.E., president-elect of the Newcastle Students C.E.; Mr. John Hay; Mr. C. L. Andrews; Dr. Stroud, and others.

After a well-served dinner, the usual loyal toasts were honoured, and Mr. J. F. C. SNELL then proposed "The Corporation and City of Newcastle-on-Tyne," to which the MAYOR responded.

The next toast was that of "The Learned Societies," and we may presume that the usual form of the toast was not adopted in order to cut away from under the feet of the proposer the usual jocular distinctions between the learned and scientific societies.

Prof. GURNEY, in reply lamented that this country had not taken the prominent lead it should have done in electrical engineering. He proceeded to review the remarkable developments of electrical engineering, and prophesied a most brilliant future for the profession. He even went so far as to say that the science was, "of course, still in its infancy."

It then fell to the lot of Prof. JOHN PERRY, F.R.S., D.Sc., to propose "The Newcastle Local Centre." He referred to the widespread influence which the Institution was exerting on the English-speaking world. Although London was the heart of their Institution, they knew that the heart was not really more important than the limbs, and he trusted that the particular limb of Newcastle would become of enormous importance, and vie with the centres in other large manufacturing districts. He proceeded to refer to the need of every exertion being made by the members to keep their industry well to the front.

The CHAIRMAN (Mr. A. W. Heaviside) replied on behalf of the section, pointing out that though they had a membership of 100, there was ample scope for a much larger support in the district which the section covered. He then referred to the development of the industry in the district.

A musical programme was interspersed with the various speeches.

OTTAWA AND ITS WATER POWER.

We have received from the Board of Trade of the city of Ottawa a copy of a most interesting book published by the Ottawa Free Press this year. In this volume illustrations are given of all the principal buildings in the town, and also of the health resorts near it. The various industries which are represented in the city and districts are also described, with numerous illustrations to exemplify the prominence to which these industries have been brought. The section of the volume most interesting to electrical engineers, however, is that which deals with the great water powers of the province. In connection with these a well-prepared map is given, to which we referred briefly a month ago. In this map the various rivers and lakes are shown, and the height and horse-power of the different falls are marked in red. In this way one can easily gather a good idea of the enormous water powers available, and also of their minimum and maximum values. For instance, with the Chats Falls, near Fitzroy Harbour, a 40ft. head is easily obtainable, while the horse-power would vary between 140,000 to 600,000. Another fall at Bryson has a 56ft. head, the horse-power available varying from 186,000 to 780,000. It would appear from this map that both of these falls are conveniently situated as regards water transit. Of the whole water power available, which comes out at about 1,000,000 h.p, over one-fifth is situated within eight miles of the city of Ottawa itself. These powers are in certain cases being utilised, and before long manufacturers in the province will have the full benefit of cheap electrical power. The advantage of this cannot be over-estimated, and when considered in connection with the natural advantages of the district, one cannot but predict a good future for the industries in question. What, however, is of more importance, is that these waterfalls offer such great opportunities for the establishment of new industries, such as the various electro-chemical manufactures in which electricity plays a prominent part. We think that every credit is due to the originator of the map in which so much information is given, and whom we understand to be Mr. Andrews Holland, a member of the council of the Ottawa Board of Trade. The illustrations of these various waterfalls in the volume are most interesting.

THE BIG SEARCHLIGHTS AT THE PARIS EXHIBITION.

We have received the following information about the searchlight on the tower of the German navigation section at the Paris Exhibition. This searchlight was quite a notable feature amongst the evening displays at the Exhibition, and it was available as an attraction when all the galleries of the Exhibition were closed. The searchlight in question was manufactured by the Schuckert Company, of Nuremberg, and is an outcome of the extensive experience which that firm has had in the manufacture of such apparatus It is now about 15 years since Mr. Sigmund Schuckert first succeeded in polishing glass mirrors into a true parabolic form. In devising the machine for this object he had the co-operation of Prof. Munker. The early machine for this purpose having proved successful, the firm commenced to turn out these mirrors in considerable quantities, and their great experience has enabled them to attain quite unprecedented accuracy even in large sizes. Thus the reflector of the large searchlight on the tower of the German navigation section has a diameter of 59in. The convex back of this glass mirror is covered by electrolytic means with pure silver. The arc lamp used in

Digitized by Google

connection with the same takes 150 amperes, and the crater of the arc is placed in the focus of the parabola. In the information before us an attempt is made to estimate the intensity of the beam of light produced by this searchlight, which is stated to be 180,000,000 c.p., but such comparison does not really hold, as one is comparing the light of a beam with that of a candle giving light in all directions. The dimensions of this searchlight are not extraordinary at the present time, as the same company exhibited a reflector of that size in Frankfort in 1891, and again in the International Exhibition at Chicago. It may be mentioned, however, that at Chicago the projector was placed at a considerable height, and that its beam was clearly visible at a distance of 170 miles. This projector was bought by the Government of the United States, and it is now in regular use in the Sandy Hook Lighthouse.

The Schuckert Company have, however, a much larger projector in the Paris Exhibition, in which a mirror no less than 79in. in diameter is used. In this case the electric lamp is constructed for a current of 200 amperes. The beam of light on the above-mentioned rating comes out at 300,000,000 c.p. The apparatus is heavy, as it weighs nearly five tons. In consequence of this, the friction had to be kept down in all the leading parts, and this was done by means of ball bearings. The carbons employed in the arc lamp are 49mm. and 35mm. diameter respectively. The mirror has a focal length of 34in. In addition to this, the searchlight has an arrangement for darkening purposes, constructed on the same principle as the Iris shutter used in photographic apparatus, and thus enables the light from the searchlight to be completely shut off. This arrangement is operated by means of a motor, and can be actuated from a distance. A hand-wheel also allows of the operation of this mechanism by hand. This searchlight is at present the largest in the world, and the accuracy of the polishing of the mirror is such that all the rays of a beam of light falling on the mirror in a direction parallel to its axis are united at the focus in a spherical space of not quite 2mm. diameter.

LIGHT RAILWAYS.

The enquiry into the Swansea light railway, which was adjourned from Swansea for counsel's speeches, was resumed at 54, Parliament-street, London, on Monday, before Mr. S. G. Fitzgerald. At the conclusion of the sitting, the Chairman said they would recommend the granting of the order of the scheme, subject to the introduction of clauses to carry into effect the undertaking given with respect to the reduction of speed and diminution of the other inconveniences mentioned when passing Mr. Harris's church, and subject also to the condition that if the Rhondda and Swansea Bay Railway Company pull down the Bridge Inn, so as to effect a public improvement, the Corporation shall pay the Rhondda Company £100.

It is announced that the Commissioners are prepared to sanction line No. 1 of the Rhondda Valley scheme, subject to a number of conditions which will be specified in writing to the promoters and to the various opponents.

The Santiago electric tramways, superseding horse traction, were inaugurated with much ceremony on Sept. 8. Over £600,000 will be required to complete the system.

It is stated that an application will shortly be made to the Commissioners on behalf of the London and South-Western Railway Company for permission to abandon part of the light railway they are authorised to construct from Grateley Station and Shrewton. If the application is granted the line will stop at Ratfin-road, Amesbury.

The Gloucestershire County Council will contribute £15,000 towards the Witney Burford and Andoversford light railway.

The Staines and Egham Tramways Company have decided to abandon their agreement with the Middlesex County Council to construct 31½ miles of light railways in Middlesex at a cost of £550,000.

The Middlesex County Council have finally approved an agreement between the North Metropolitan Tramway Company, the County Council, and the Metropolitan Tramways and Omnibus Company in relation to the working, purchase, etc., of the light railways under the county of Middlesex light railways joint order (northern lines), the important alteration being if the Council take over the Enfield and Waltham Cross lines it shall also purchase all the Council's lines in Middlesex and lease the whole of them. The Council also intend to apply for parliamentary powers.

THE FACTORS WHICH DETERMINE THE DESIGN OF MONOPHASE AND POLYPHASE GENERATORS.*

BY B A BEHREND.

(Continued from page 599)

In order to determine the dynamic characteristic from the static and short-circuit characteristics, which we assume to be known or predetermined (how this can be done will be shown in the third section of this article), we can proceed in the following manner:

If we assume that the armature reaction and armature leakage within the alternator have the same effect as an induction coil placed outside the machine, then the E M.F. which is to overcome the reactance of this coil must be in quadrature with the current, and as we take from the generator a wattless current, the E M.F. of self-induction is in an exactly opposite phase to the impressed E.M F. of the generator. Hence, in order to get a point of the dynamic characteristic, we should simply have to deduct the E M.F. consumed in the induction coil from the impressed E.M.F. of the alternator. If we take an ordinate of the static characteristic, and divide it by the short-circuit current belonging to the same excitation, we immediately get the reactance of the induction coil; or, as we assumed this reactance to be equal to the combined effect of armature reaction and armature leakage, this quotient gives us the apparent reactance of the armature. I say apparent reactance, as the real reactance may have a different value.

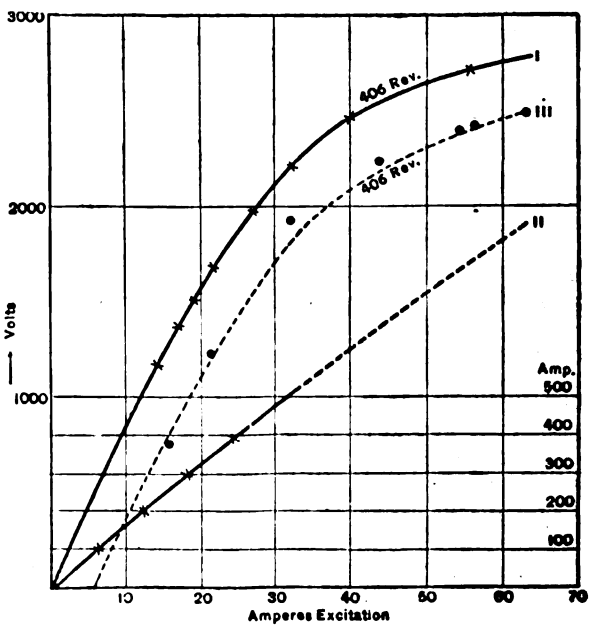


FIG 3.—Characteristics of Three-Phase Inductor Generator.

Mr. C. P. Steinmetz, in his admirable work "Alternating-Current Phenomena," first edition, p. 238, introduces for the combined effect of armature reaction and armature self-inductance (this term is here open to criticism, as the inductance is caused by the leakage lines of the armature current), the name synchronous reactance. The apparent reactance need not be equal to the synchronous reactance, though this is generally the case. We must bear in mind that the apparent reactance is a calculated value; hence these two quantities will be equal only if the method employed is correct. If we attempt to use the apparent reactance in the vector diagram for the determination of the power consumed by the circuit on which the generator works, we may be led into serious blunders. See for such an attempt Dr. Bohn-Eschenburg, *L'Industrie Electrique*, Aug 25, 1895. The E.M F. in the vector diagram is considerably greater than the real E M F. within the generator, on account of the armature reaction; besides, it is very doubtful whether we may rely on this method for power factors near unity. In this case the relative position of the armature with respect to the field is different from that at short-circuit, causing an increased self-inductance of the armature. If the iron in the armature

* From *Electrical World and Engineer* (New York).

Digitized by Google

between the slots is highly saturated, the distortion of the field caused by the armature currents will produce an additional drop just as in direct-current machines.

Let us now see whether this method yields results in conformity with fact and observation.

In Fig. 3 the Curve I. is the static characteristic of a 500-h.p. three-phase inductor generator for 2,000 volts between the lines. The speed is 406 revolutions per minute, the frequency 54. Curve II. represents the short-circuit characteristic. The generator was working on induction motors running light; the current was therefore practically in quadrature with the voltage at the terminals. The points marked represent an inductive load of 96 amperes. This current could not be taken out at voltages below 2,000 volts, as the magnetising current of the motors decreases with the lower voltage. It has therefore been necessary, in order to construct a curve for constant current, to make allowance for this difference. As the drop may, for low saturations, be set proportional to the current by which it is caused, the drop as represented by the points of Curve III. is obtained by multiplying the observed drop by the ratio 96 ÷ observed current. The broken line, Curve III., represents the drop calculated in the following manner:

For 62 amperes excitation the generator produces on open circuit 2,760 volts. The short-circuit current is 920 amperes. The apparent reactance of the generator for this excitation is given by the ratio 2,760 + 920 equal to 3·00. Hence the inductive drop for a current of 96 amperes is equal to 5 × 96 = 288 volts. This deducted from 2,760 volts gives 2,472 volts at the terminals.

TABLE I.

i.	I.	II.	*Et*	III.
62	2 760	920	2,470	2 472
56	2 710	840	2,410	2 400
54	2 690	815	2,390	2,373
44	2 550	680	2 230	2,190
32	2,220	510	1,900	1,802
31	1,650	340	1,230	1,184
15·5	1,270	255	747	792

Table I. is calculated in this manner. The first column contains the exciting current *i*. The second column, marked I., contains the volts on open circuit, interpolated from Curve I., in Fig. 3. The third column, marked II., contains the values of the short-circuit current, also interpolated from Fig. 3 The fourth column, marked *Et*, represents the volts at the terminals of the generator when working on the inductive load of 96 amperes. The fifth column, marked III., represents the calculated values of the terminal volts, as represented by Curve III. in Fig. 3. With the exception of the fifth series of observations, the agreement of calculation and experiment may fairly be called perfect. I am inclined to think that the disagreement in this one case is due to an inaccuracy in the measurement of either the voltage or the speed.

(To be continued.)

MANCHESTER ELECTRICITY COMMITTEE

The special committee appointed by the City Council of Manchester to enquire into the charges brought by Mr. S. Norbury Williams against Mr. Alderman Lloyd Higginbottom duly reported to the special meeting of the Council held on Monday last. As an outcome of this report, the meeting had also to receive a letter announcing the resignation of that gentleman.

The following is the full text of the report:

CITY OF MANCHESTER.

The special committee appointed by the City Council on Oct. 31, 1900, presents the following report, in pursuance of the instructions received by them—viz.:

"Resolved that this meeting at the close of its ordinary business be adjourned to Monday next, Nov. 5, for consideration of the allegations made by Mr. Norbury Williams against Alderman Higginbottom, and the statement of Alderman Higginbottom made this morning, and that in the meantime a special committee be appointed (for the purpose of considering the charges and reporting to such adjourned meeting of the Council), consisting of the Lord Mayor, Aldermen M'Dougall and Copeland, Councillors Edwin Holt, Shann, Plummer, and Vaudrey."

We met immediately after the close of the Council, and instructed the officials of the gas and electricity departments to be in attendance, with all books and documents, on the following morning. We also sent the following communications:

"Town Hall, Manchester, Oct. 31, 1900.

"Dear Sir,—I am desired by the special committee appointed by the City Council at their meeting held to-day to request your attendance at the Lord Mayor's office to-morrow (Thursday), at 10.30 o'clock a.m., in reference to the resolution copied on the other side.—I am, etc., THOMAS BRIGGS, Lord Mayor.

"S. Norbury Williams, Esq., Citizens' Auditor.

"P.S.—A similar communication has been sent to Alderman Higginbottom."

"Town Hall, Manchester, Oct. 31, 1900.

"Dear Alderman Lloyd Higginbottom,—I am desired by the special committee appointed by the City Council at their meeting held to-day to request your attendance at the Lord Mayor's office to-morrow (Thursday), at 10.30 o'clock a.m., in reference to the resolution copied on the other side.—I am, etc. THOMAS BRIGGS, Lord Mayor.

"Alderman Lloyd Higginbottom.

"P.S.—A similar communication has been sent to S. Norbury Williams, Esq."

We commenced our enquiry in the presence of Mr. S. Norbury Williams and Alderman Higginbottom on Thursday, Nov. 1, and continued it until after 6 p.m. on Friday, Nov. 2. Mr. Norbury Williams and Alderman Higginbottom attended throughout these proceedings, and addressed us from time to time. Several witnesses also attended before us, and have answered the questions put by the two above-named gentlemen and ourselves, and every opportunity has been afforded for the fullest explanation. At the commencement of the proceedings it was arranged, with the entire concurrence of Mr. Norbury Williams, that our enquiry should be confined to the items numbered 14 to 23 of his letter to the *City News*, and a print of those paragraphs, together with Alderman Higginbottom's speech in the Council on the 31st ult., is appended hereto.

Since the conclusion of the enquiry we have devoted several hours to the careful consideration of the evidence and statements placed before us by Mr. Norbury Williams and Alderman Higginbottom, and also of the information obtained by ourselves by means of documents called for or questions put by us during the enquiry. We propose to deal with the several items in Mr. Norbury Williams's letter *seriatim*.

Item 14. Having examined into the circumstances connected with item No. 14, referring to S. Z. de Ferranti, Limited, we find that this item has no bearing upon the subject of our enquiry.

Item 15. The British Insulated Wire Company, Limited.—We have enquired into this matter, and are satisfied that Alderman Higginbottom is not interested in this company.

Items 16, 17, 18, and 19.—After considerable investigation we find that neither the action of the British Electric Works Company, Limited, nor of Alderman Higginbottom as its chairman, has been such as to give rise to any substantial cause of complaint. One tender was sent in by this company without the knowledge of Alderman Higginbottom, who, on discovering it, instructed the chief engineer that it must not be considered, but it does not appear that this instruction was heard by the members of the committee present on the occasion.

Item 20. Purchase of scrap metal by the West Gorton Foundry Company, Limited.—As the company's tender was the highest, the Corporation suffered no loss by its acceptance, and we find that Alderman Higginbottom requested that it might be withdrawn, but the committee insisted on its being accepted. Alderman Higginbottom admitted the undesirability of this company sending in tenders to the Corporation.

Item 21. The scale of charges for supply of electric power, to which exception is taken in this paragraph, is purely a question of the policy of the Electricity Committee itself. This scale was fixed by the Electricity Committee on the recommendation of the chief engineer, and is very similar to that adopted in some other large towns. The imputation that Alderman Higginbottom was instrumental in reducing the price of supply for motors in order to promote his own business interests we find to be absolutely without foundation.

Item 22. Cranes at Corporation Gasworks.—We have carefully considered this matter, and have referred to the minutes and documents in the gas department. We find that, although Messrs. Frank Pearn and Co., Limited, took the contracts for doing the work, they sublet in some cases the whole and in other cases portions thereof to Messrs. Higginbottom and Mannock.

Item 23. Cranes at Electricity Works.—We find that Messrs. Higginbottom and Mannock have acted and are acting as subcontractors in reference to the manufacture and fixing of cranes in connection with the electricity works of the Corporation.

Digitized by Google

We find that the transactions have been as follows (the amounts of the sub-contracts given below were stated by Alderman Higginbottom in his evidence before us):

(*a*) That on March 14, 1892, a tender was accepted from Messrs. H. and J. Ellis amounting to £446 for work for the electricity department of the Corporation, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract.

(*b*) That on Sept. 23, 1892, a tender was accepted from Messrs. Mather and Platt, Limited, amounting to £230 for work for the electricity department of the Corporation, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract to the amount of £150.

(*c*) That on Jan. 26, 1898, a tender was accepted from Messrs. Thomas Parker, Limited, amounting to £528 for work for the electricity department of the Corporation, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract to the amount of £307.

(*d*) That on June 7, 1898, a tender was accepted from Messrs. Thomas Parker, Limited, amounting to £1,545 for work for the electricity department of the Corporation, and that Messrs. Higginbottom and Mannock were sub-contractors in this contract to the amount of £950.

(*e*) That on Feb. 14, 1900, a tender was accepted from Messrs. P. R. Jackson and Co., Limited, amounting to £1,808 for work for the electricity department of the Corporation, and that Messrs. Higginbottom and Mannock are sub-contractors in this contract to the amount of £1,440. [This contract is still in course of execution.]

(*f*) That on May 12, 1900, a tender was accepted from Messrs. the British Schuckert Electric Company, Limited, amounting to £1,750, for work for the electricity department of the Corporation, and that Messrs. Higginbottom and Mannock are sub-contractors in this contract to the amount of £1,382. [This contract is still in course of execution.]

In conclusion, we are of opinion that the action of Alderman Higginbottom with respect to these sub-contracts, as well as to those referred to in item No. 22 of this report, has been altogether improper, and such as the committee cannot justify, having regard to his position upon the Electricity Committee and the Gas Committee.

THOMAS BRIGGS,	W. H. VAUDREY.
Lord Mayor, Chairman.	HENRY PLUMMER.
ALEX. M'DOUGALL.	EDWYN HOLT.
A. G. COPELAND.	T. THORNHILL SHANN.

Town Hall, Manchester, Nov. 3, 1900.

After the meeting, Mr. Norbury Williams made a statement to the Press to the effect that he was not to blame as to the time selected by him to publish his address. This he had done as soon as he had acquired the information in question, and he professed that six weeks ago he did not know of the irregularities he afterwards complained of. Mr. Williams proceeded to hint at further revelations being likely as regards the Electricity Committee, and concluded his statement by wishing the re-elected Mayor a happy and blameless year of office.

LEGAL INTELLIGENCE.

WOLVERHAMPTON CORPORATION v. BRITISH ELECTRIC TRACTION COMPANY.

In the Chancery Division, before Mr. Justice Joyce, Mr. Thompson on Nov. 2 made an application for the defendant company. He said the action was one for the specific performance of an agreement for the sale of certain tramways, and the substantial question in dispute was whether under certain Acts and provisional orders the defendant company were entitled to have running powers over certain of the Wolverhampton tramways. The defendants had retained Mr. Cripps, Q.C., but yesterday they heard that he had decided to go abroad, and would be unable to take up any case for three weeks. He now asked that the case should stand over for that period.

Mr. Hughes, Q.C., for the other side, opposed. He said the question affected the whole matter of the Wolverhampton trams, and the Corporation were very anxious to have it settled.

Finally, it was decided that the case should be taken on Thursday next, subject to any part-heard case.

CLAIM BY THE NATIONAL ELECTRIC WIRING COMPANY.

In the Westminster County Court, on Friday, before his Honour Judge Lumley Smith, Q.C., the case of the National Electric Wiring Company *v.* Jones was tried. It was an action by the plaintiffs, who carry on business at Charing Cross-road, to recover the sum of £61 in respect of electric wiring and fittings supplied to the order of the defendant, who carries on the business of an hotel keeper in the Strand. The defendant did not dispute having given the order for the wiring and fittings, but set up a counter-claim in the way of damages on the ground that the installation was badly done.

Mr. Jenkinson was called, and said that at the time the work was carried out he was general manager of the plaintiff company, and it was within his knowledge that everything was done to make the work complete. It was passed by the inspector of the company who supplied the light, and that was a guarantee that it was efficiently done.

After hearing the evidence of the defendant and his witnesses as to certain defects in the work, his Honour gave judgment for the plaintiff company for the amount claimed (£61), and judgment for the defendant on the counter claim.

BIRD v. THE DUBLIN UNITED TRAMWAY COMPANY.

On Monday at the City Sessions, before the Recorder, the case of John Bird, of 32½, Dawson-street against the Dublin United Tramways Company to recover damages for personal injuries received by the complainant on Sept. 24 by being knocked down in Dawson-street by an electric tram, which was opened on Saturday, was resumed.

Captain Greeley, examined by Mr. Brady, solicitor for the plaintiff, stated that, in his opinion, the tram conductor was in fault.

Mr. Kelly, examined, stated the plaintiff was hunting a collie dog, and suddenly turned on to the tramline. The tram conductor could not have pulled up in time to save him.

The Plaintiff said he was not getting justice in that court as a working man. There were witnesses for him that were not called.

Mr. Brady said they could not be found.

The Recorder said that if the plaintiff thought he was not getting justice there he would give him an opportunity of having the case heard elsewhere, and would dismiss it on the merits. He had three witnesses to one, and adjourned the case in order to give the plaintiff an opportunity of examining more witnesses. If people went hunting collie dogs in the street they must be careful. He dismissed the case on the merits, with costs.

FORTHCOMING EVENTS.

FRIDAY, NOV. 9.

Faradian Club.—At 8 p.m., at St. James's Restaurant, club smoking concert.

Physical Society.—At 5 p.m., ordinary meeting. Papers on "Electromotive Force and Osmotic Pressure," by Dr. R. A. Lehfeldt; "On Astigmatic Lenses," by Mr. R. J. Sowter; "On a Phase-turning Apparatus for use with Electrostatic Voltmeters," "On a Method of Measuring Power in Alternate-Current Circuits," and a "Note on obtaining Alternating Currents and Voltages in the same Phase for Fictitious Loads," by Mr. A. Campbell, B.A; and "On the Refraction of Sound by Wind," by Dr. E. H. Barton.

SATURDAY, NOV. 10.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., at Glasgow, adjourned discussion of a paper on "Slow-Speed Engine Design," by Mr. A. M. Downie.

MONDAY, NOV. 12.

Institution of Electrical Engineers (Newcastle Section).—Opening meeting.

TUESDAY, NOV. 13.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "The Metropolitan Terminus of the Great Central Railway," by Messrs. G. A. Hobson and E. Wragge.

Institution of Electrical Engineers (Manchester Section).—Opening meeting.

WEDNESDAY, NOV. 14.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., opening meeting. Paper on "Electrical Supply," by Mr. W. A. Chamen.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting. Paper on "Overhead Line Material," by Mr. A. J. Le Hurst.

THURSDAY, NOV. 15.

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, NOV. 16.

Institution of Mechanical Engineers.—At 8 p.m., ordinary general meeting. Paper on "Capacity of Railway Wagons as affecting Cost of Transport," by Mr. J. D. Twinberrow.

Electro-Harmonic Society.—At 8 p.m., at St. James's Hall Restaurant, evening concert (ladies' night), Major Crompton presiding.

North-East Coast Institution of Engineers and Shipbuilders.—At Sunderland, ordinary meeting.

SATURDAY, NOV. 17.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "Some Notes on the Organisation of a Workshop," by Mr. H. D. Jackson.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle, graduates' meeting. Paper on "Comparison between British and American Locomotive Practice," by Mr. H. J. Potts.

Digitized by Google

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

323. In alternating-current supplies with networks of concentric cables, in switching on and off there is a danger of breakdown in the insulation between the outer main and the lead covering. What is the best way to prevent this defect?—K.

324. Compare the cost of lighting by direct and alternating current arc lamps respectively.—K.

ANSWERS.

Question No. 317.—Describe and sketch the cheapest form of main and distribution switchboard suitable for a small private station of two 65-kw. steam dynamos at 100 volts; first, with the necessary switching arrangements for accumulator charge and discharging; and, second, without same.

Best Answer to No. 317 *(awarded* 10*s.)*.—Two 65-kw. sets do not form a very small private station, and with plant of this capacity it would be foolish to go in for some cheap pattern of switchboard, but it should be of substantial design, and the writer suggests the one according to sketch to be used with a storage battery. The current from the dynamos is controlled by two main switches capable of carrying 600 amperes without heating, in connection with which is the main fuse; two dynamo ammeters reading to 600 amperes; bars arranged with plugs so that any combination may be obtained in working (two of these bars on each pole could be placed at the back of the board, which would diminish the cost, as they could be finished rough); six-way charge and discharge battery switch, the contacts of which consist of two separate bars, which are connected together through a resistance coil, which prevents the short-circuiting of a cell when passing from one contact to another; accomplishing the regulation without breaking the circuit, these switches to carry about 200 amperes; capacity of cells taken at 200 amperes for five hours. A magnetic cut-in and cut-out is very useful in charging accumulators, as it automatically cuts in or out if from any cause the E.M.F. of the dynamo falls below the required standard. A combined charge and discharge ammeter reading to 300 amperes, which also records at a glance whether battery is charging or discharging. A voltmeter reading to 150 volts with a five-way double-pole voltmeter switch, which is connected to different parts of the board as required (connections to voltmeter switch are not shown to avoid complication).

The distribution part of the board has been allowed for 10 100-ampere circuits, which is provided on one side with a two-way throw-over switch so constructed that the connection is made on one side before the other side is broken (see elevation at A) By this means the current on any circuit can be measured independently by means of ammeter 300 amperes. This switch will also act as a duplex fuse in case of emergency. On the other pole the circuits are taken through lever bar switch cut-outs (see elevation at B).

The price of this board with moulded teak frame on enamelled slate would be about £110; this could be reduced to £95 by having a simpler charge and discharge switch, and instruments with 7in. dials; by doing away with the accumulator portion the cost would be about £86.—W. A. J.

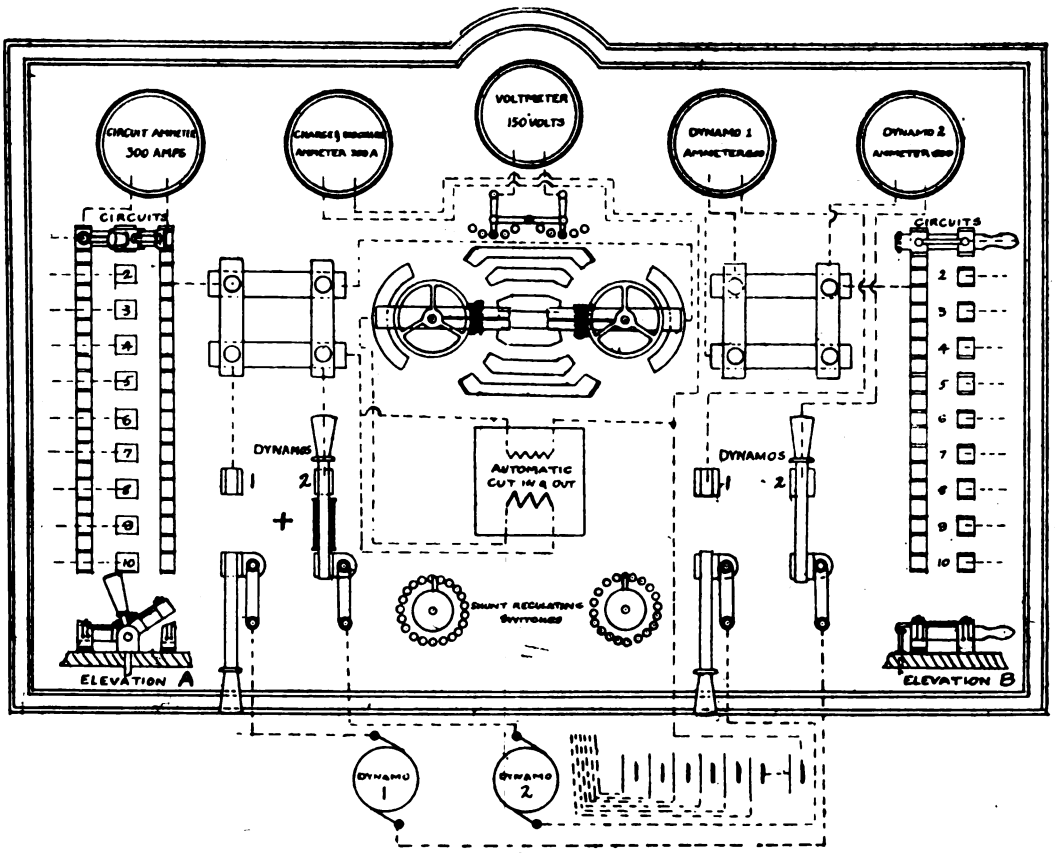


Diagram of Connections.—W. A. J.

Answer to No. 317 (*awarded* 5*s.*).—The question before us is one of interest, especially to the installation contractor, for there is at present a demand for "a good job at a low price." Having to comply with this request, contractors are anxious to obtain inexpensive material, which at the same time is of the best and thoroughly reliable; also to do away with those accessories which are not essential, and yet to have the job in every sense complete.

The particular case before us—viz., switchboards—is one in which great care should be taken, as unsuitable switching arrangements often lead to trouble, and prevents the plant from being run in the most economical manner; at the same time the board should not be designed with instruments, switches, fuses, etc., that are unnecessary.

Digitized by Google

The accompanying diagrammatic sketches show two boards, the connections of which will explain themselves. The writer has assumed the two dynamos are to work separately or in parallel, also that there are six main distributing circuits, as would be the case in a building with six floors, these circuits being taken to smaller distributing boards on their respective floors. Each machine gives 65 kw. at 100 volts = 65,000 watts at 100 volts = 650 amperes at 100 volts.

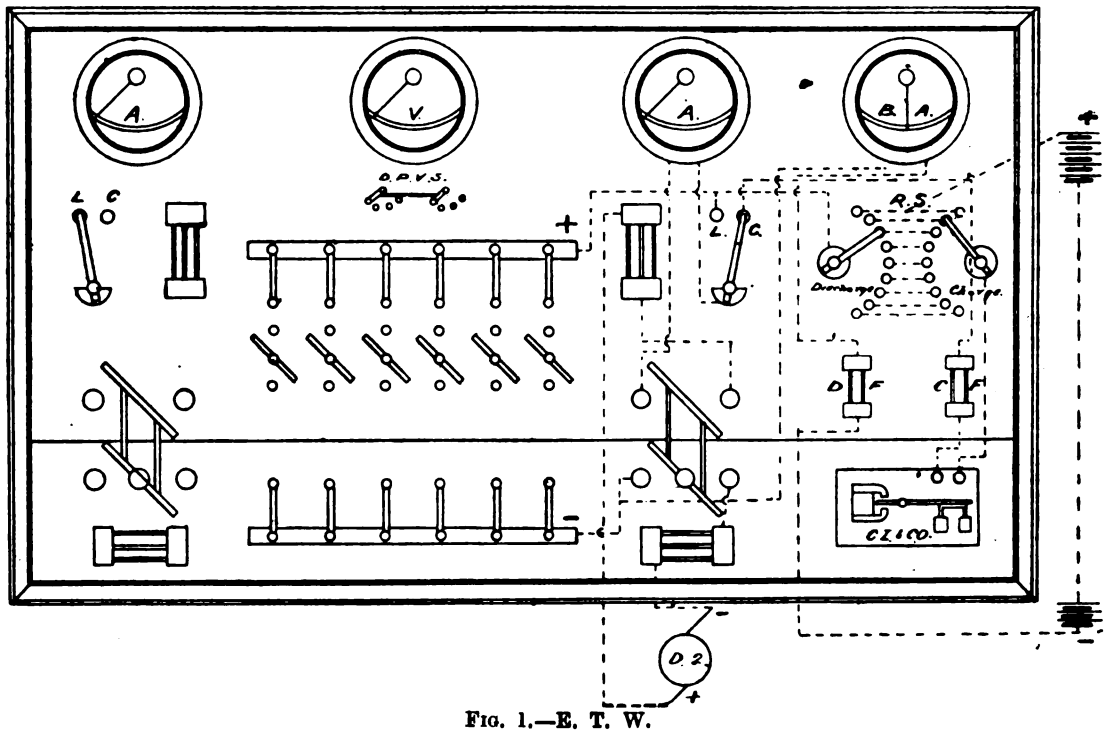


FIG. 1.—E. T. W.

Taking, firstly, the second board, the one without the accumulator charging devices, it will be seen that it contains the following instruments, switches, etc.: two ammeters reading up to, say, 800 amperes; one voltmeter reading up to, say, 150 volts; two double-pole, double-break main switches to carry 650 amperes; four main fuses to carry, say, 800 amperes; six branch double-break switches to carry, say, 150 amperes; 12 branch fuses to blow off at, say, 200 amperes; one three-way double-pole voltmeter switch. The board is made up of two enamelled slates, and fixed in a hardwood frame. The working of this board will be obvious, therefore further comment is needless.

The first diagram shows the arrangement for charging and discharging accumulators. In addition to the instruments, etc., enumerated for the second board, there are the following: two two-way main divisional switches, marked L C; one battery ammeter to read the charging or discharging current on either side of the zero; one battery-regulating switch for charging and discharging; two fuses, D F and C F; one automatic cut-in and cut-out switch; one four-way double-pole voltmeter switch in place of three-way ditto before mentioned. An inspection of the diagram and connections will show the method of working the board to be: for charging divisional switch, L C is turned on to C, contact. The current passes from here to fuse C F, which should be regulated to blow at 50 per cent. above the maximum charging current. The current next passes through the automatic cut-in and cut-out. The function of this instrument is, when the dynamo voltage is slightly in excess of the battery voltage, to cut in the battery-charging switch. If from any cause the battery voltage rises above that of the dynamo, the charging switch is cut out, thus disconnecting one side of the dynamo from the battery and preventing the possibility of reversing the machine. *For running direct* on to the main circuits, the divisional switch is turned over on to contact marked L. When in this position the battery is in parallel with the dynamo through the discharge regulating switch. In this manner any fluctuation of voltage is taken up by the battery, thus insuring steadiness to the lights. *For discharging* from the battery alone, it will be seen that the current passes from the battery through the discharge regulating switch on to the positive 'bus bar, returning from the negative 'bus bar through the battery ammeter and the fuse, D F, to the negative side of the battery. The function of the fuse, D F, is to prevent too great a current being taken from the battery, and ought to be rated at 50 per cent. above the battery maximum discharge current. It will further be seen that one dynamo can be run direct on to the load while the other is charging; also that one machine can be charging and supplying current for a load simultaneously.

For the sake of clearness a number of the connections have been omitted, but this should cause no difficulty. By using a voltmeter switch, one voltmeter is used to read the voltages on the respective dynamos and the battery. It will be noticed that, though the dynamos are intended to work in parallel, no minimum cut-outs have been provided.

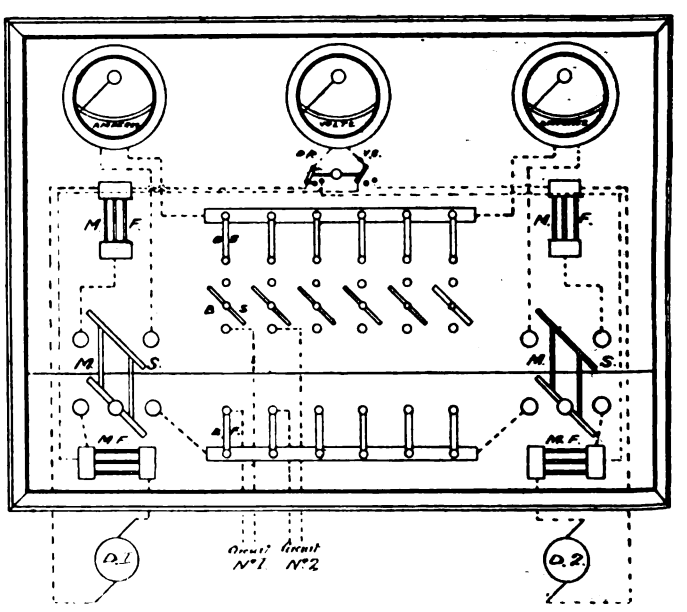


FIG. 2.—E. T. W.

Further, that there are no shunt-regulating switches for the dynamos. The writer thinks these to be hardly necessary; there are many similar private stations working efficiently without them.

The price of these boards may be greatly reduced by (1) working in with the makers' standard designs as far as possible; (2) having no bright metal work except the

Digitized by Google

rubbing contacts; (3) by working the metal parts at 25 per cent. greater density than the standard. The standard densities for the highest-grade boards are: copper, 1,000 amperes per square inch; gunmetal, 640 amperes per square inch; brass, 300 amperes per square inch. This increasing the density is a usual method adopted by some of the best makers for their second-grade boards.—E. T. W.

Answer to No. 317 *(awarded* 5*s.).*—The conditions laid down in the question are somewhat exacting and, indeed, impossible were they to be taken literally. One cannot have both the best and the cheapest of everything, although your client or customer almost invariably asks for it. What they get is a fair compromise between the two, and the extent to which one has to give way to the other almost entirely depends on how much money your customer has to spend and how far he will go in sacrificing convenience of running the plant to a low first cost.

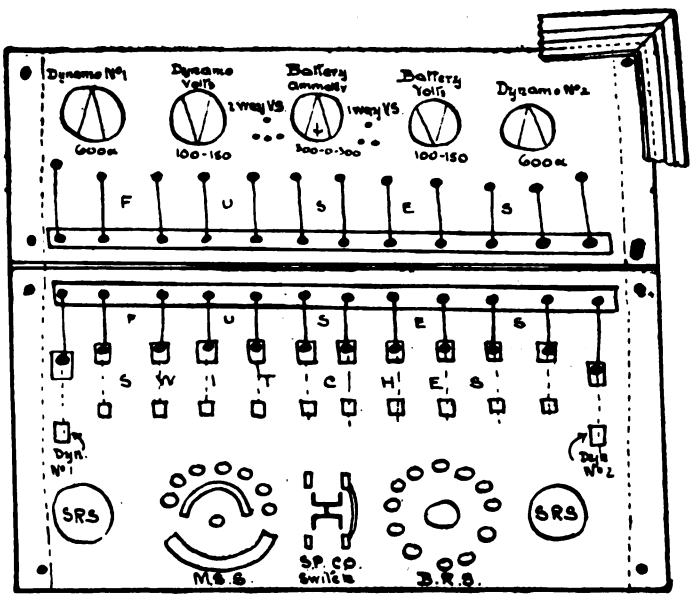


FIG. 1.

The switchboard shown in Fig. 1, the connections of which are given in Fig. 2, is of a type which obtains fairly often in installations of this kind. The arrangements are not elaborate, but will enable the plant to perform the work quite satisfactorily. The two generators are each provided with an ammeter, a single-pole switch, and double-pole fuse connected on to the + and − 'bus bars. The shunt-regulating switches, S R S, are shown on the lower panel and should each have about 15 stops. In the diagram (Fig. 2) it will be seen that the shunts are excited

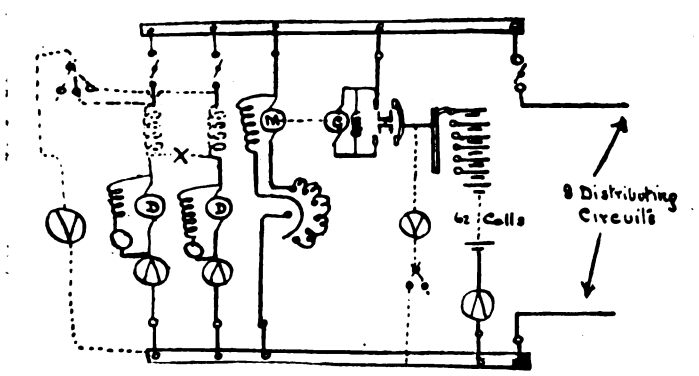


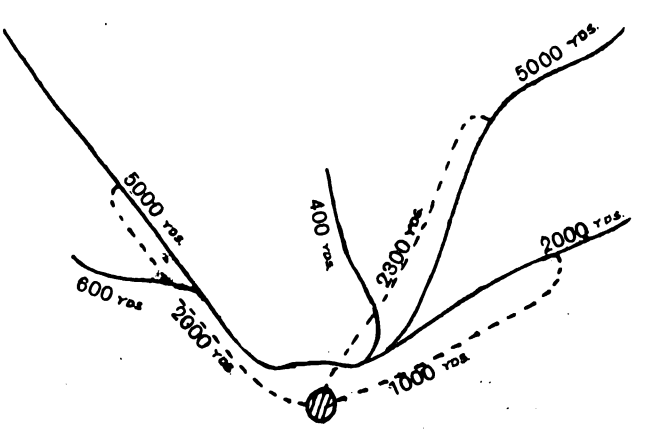
FIG. 2.

off the generator terminals instead of the 'bus bars, thus dispensing with shunt-breaking switches. The board is arranged for shunt-wound dynamos, but for compound-wound dynamos an additional switch has to be provided, shown at X in the diagram. This puts the series windings in parallel.

The writer considers that in connection with such large generators (for a private plant) it is the better plan to use a "booster" for charging purposes instead of the usual charge and discharge switch. The latter arrangement would involve sending very large currents through the regulating cells when maintaining a large load and charging the battery at the same time; also the first arrangement admits of great flexibility of manipulation, although more costly. We have a 15-way battery-regulating switch, B R S, the centre contact of which is joined to a two-way or change-over switch, which includes the generator of the booster set in the battery circuit or not according as the position of the change-over switch is up or down. This generator is driven by a motor connected across the 'bus bars, and its speed is varied, and consequently the generator volts, by means of the motor starting and regulating switch, M S S. When the battery is being charged all the regulating cells are cut in, and the booster set started, the voltage of which can be varied in order to keep the charging current at its proper value. In practice the booster in this case should be capable of generating about 40 volts at the charging current. There are shown eight 150-200-ampere single-pole switches and double-pole fuses attached to the 'bus bars for distributing purposes. The number and size of these, however, will be determined by the actual requirements of the plant. The remaining apparatus on the board are: an ammeter for the battery circuit; a dynamo voltmeter, with a two-way and off single-pole switch and a battery voltmeter; and one-way and off single-pole switch. The instruments may be of the ordinary type, with soft-iron attraction, of which there are plenty of makes at moderate prices. The fuses should be composed of tin strip secured to the 'bus bar by a stem and a nut or terminal head. On the lower panel these fuse terminals are attached to the top contact of a single-pole switch, which may be of the knife pattern. The change-over switch is shown as a chopper-type switch for the sake of clearness. The battery-regulating switch may be of the circular pattern with sector-shaped contacts, and the arm provided with a non-short-circuiting device. The contacts of the motor-starting switch may be similar to the above-mentioned, and provided with a shunt ring, which can be arranged to break a little after the armature circuit, and fitted with a non-inductive resistance. Cable connections should be made at the back by means of cable sockets attached to copper or gunmetal stems coming through the board from the various switches, etc.

The apparatus may be mounted on enamelled slate or marble, metal work of opposite polarity being on separate slabs as shown. The panels are supported on angle-iron uprights by means of bolts at the corners, the holes being bushed with ebonite for insulating purposes. The whole may be surmounted by a neat teak moulding to give the board a good appearance if desired. The board can be supported away from the wall by means of tiebars grouted into the wall. The angle-iron uprights may terminate in cast-iron feet fixed in concrete floor, and the board placed at such a height that the switches can be operated easily and the instrument readings taken from any part of the room. For an installation without battery the arrangement of switchboard would be the same with the exception that the change-over switch, motor-starting switch, and the battery-regulating switch would be left out.—E. J. EVANS.

Question No. 318.—In a traction scheme, as per appended sketch, would it not be advisable to feed the trolley wires

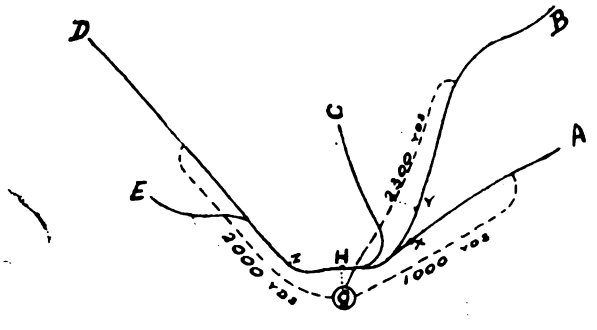


at the station in addition to the feeders, or would it be best to transmit all the energy through the feeders and not tap on to trolley wires at station?

Digitized by Google

Best Answer to No. 318 (*awarded* 10*s.*).—From the sketch I should gather that the whole system of trolley wires are electrically connected together independently of the feeders, and although such a system has the disadvantage that no one feeder circuit breaker will deaden a section of the line on which a serious short has occurred, leaving the remainder of the system in working order, we will deal with the question as it stands.

Referring to figure, to take a tapping from the trolley wire at a point adjacent to the station, G, may be done in two ways. One would be to run a short cable from the + station 'bus bar direct to H. This would necessitate another circuit breaker and feeder switch on the switchboard, and also arrangements (such as a street switch pillar) for making connection with the trolley wire. The other way would be tap from either of the feeders leading to A and B, and so make use of their circuit breakers and switching arrangements, but in this case also we should require a switch box to be built in the street. If all the feeders are taken from a common 'bus bar, the point H will be, owing to its relative shorter distance from G, of a higher voltage than either of the other feeding points, and as all the trolley wires are connected, feeding will take place from this point in each direction up to such points, that the drop in voltage from G, *viâ* H, to these points is equal to the drop *viâ* the original feeder in each section. These points will be continually shifting, their exact locality depending upon spacing of the load on each line at a particular instant, and upon the resistance of the feeders; but for the purposes of the question we may take it that, as an average, the current required for the whole of C, together with about 1,200 yards of B and 600 yards of A, will be passing through H to the right and, perhaps, the whole of E + 1,200 yards of D to the left. From this it will be seen that if method *b* has been adopted in making the tapping, the circuit breaker on the feeder from which the tapping has been taken will have to be of largely increased capacity; and if this is installed, the current flowing between the tapping and G along the feeder will be enormously in excess of its original value, and if the size of the feeder were just sufficient in the first instance, it will be very largely and dangerously overloaded at its station end as a consequence of the new feeding point. This practically disposes of *b*, and leaves *a* only to be dealt with. The section of the trolley wire between H and the junctions of C, B, and A, will now be carrying a large current, and although it is impossible to speak definitely without particulars of the traffic, it is not unlikely that it may be seriously overloaded—at least, at times when heavy loads coincide at the station ends of A, B, and C. From the information at hand, therefore, I should say that it would be unwise to make a feeding point of H by itself, especially when taking into consideration the alterations necessary on the switchboard and the switching arrangements outside; but if such a tapping is taken I would suggest inserting a section insulator between B and A as a means of reducing the current flowing through the short stretch of trolley wire above referred to, should it prove too great.



A better, and perhaps less expensive, way of dealing with the matter would, I think, be as follows: The Board of Trade in Rule 9 state that the line must be divided into sections not exceeding half a mile in length, with arrangements provided for isolating the sections for testing purposes. This is generally complied with by bringing the adjacent ends of two trolley wire sections down to a switch box at the most convenient points, and although the Board of Trade do not stipulate it, the feeders often pass through the boxes, and are themselves provided with arrangements for isolating sections. The advantage of this mode of procedure, apart from convenience of localising a fault, is that there is no need then for more than one section of the line to be dead in the event of a short or open circuit on the line, and if the track be double, this gap caused by the dead section may be bridged over by running the car trolley pole upon the other wire, removing it, of course, when an opposing car is met with. A faulty section of the feeder also may be made dead, and the current fed along the line up to the next switch box. Now, if in the system in question section switch boxes exist, a tapping might be taken from at least one such point to each feeder (provided that the feeder follows the course of the track), the position of these points being taken as nearly as possible to correspond with X, Y, and Z in the figure. The balance of the system will now remain almost undisturbed. There will be no alteration necessary on the switchboard, as approximately the same current will return by each feeder as formerly; there will be no need for a new switch box, as existing ones may be made use of; and, finally, no section of the trolley wire will be more overloaded than in the original case.—W. G. M.

COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The ordinary general meeting of this Company was held on Wednesday at Winchester House.

Sir J. Wolfe Barry, who presided, stated that during the half-year under review the unissued balance of 50,000 shares of the Company's share capital was issued to the shareholders at a premium of £3 per share, or £13 each, and an official quotation on the Stock Exchange had since been obtained. The desire of the directors, was, if possible, to reduce the cost per word by this Company's system from 4*s.* 9*d.* to a minimum of 2*s.* 6*d.* The first step—viz., a reduction from 4*s.* 9*d.* to 4*s.*—was already accomplished, and the revenue up to now had been maintained at the reduced rate. It was intended, if the standard was maintained, to make successive reductions to 3*s.* 6*d.* 3*s.*, and finally in 1903 to 2*s.* 6*d.* per word, which would be 6*d.* per word less than the minimum sum proposed to be charged by the Pacific Company. The 2*s.* 6*d.* was not fixed on in any spirit of competition, but the decision was arrived at before the Pacific Company arranged that their charge should be 3*s.* per word.

The **Marquis of Tweedale** seconded the adoption of the report and accounts (noted in our last issue), which were carried.

BRITISH ELECTRIC TRACTION.

Directors: Sir Charles Rivers Wilson, G.C.M.G., C.B. (chairman); the Right Hon. Lord Rathmore; the Hon. Sir Charles William Fremantle, K.C.B.; John Smith Raworth, M.I.C.E.; Charles S. Drummond; C. Shirreff B. Hilton; Emile Garcke, M.I.E.E. (managing director).

The interim report of the directors, dated November, 1900, states that the directors have decided to pay an interim dividend on the ordinary shares on Dec. 22 next (being six months after the last payment of dividend) at the rate of 6 per cent. per annum for the half-year ended Sept. 30 on account of the dividend for the financial year ending March 31, 1901, which is at the same rate per cent. per annum as the interim dividend paid last year. Satisfactory progress continues to be made by the Company and its associated companies, and the aggregate traffic receipts on the various lines in operation show a considerable increase. The tramways (5¼ miles) owned by the Swansea Improvements and Tramways Company were opened for traffic by electric traction on June 30, 1900, and are working satisfactorily. The receipts have increased by about 60 per cent., while the expenses of working have been relatively reduced. The Potteries Electric Traction Company, Limited, is now working 24½ miles by electric traction, and a further 4¼ miles are ready for working. The traffic receipts on all the lines are satisfactory. Since the date of the last report 3½ miles of lines of the Dudley, Stourbridge, and District Electric Traction Company, Limited, have been opened for traffic by electric traction, and a further five miles will be opened as soon as the Board of Trade have given their certificate. The traffic receipts are satisfactory. The section of the Dudley and Wolverhampton tramways from Dudley to Sedgley (2½ miles) has been reconstructed, and was opened for traffic by electric traction on Oct. 3, 1900. The electric lighting supply under the order transferred from the Kidderminster Corporation to the Kidderminster and District Electric Lighting and Traction Company, Limited, was commenced in August. The lines (four miles) owned by the Tynemouth Electric

Digitized by Google

Traction Company are practically completed, and will be opened for traffic as soon as the Corporation are ready to supply the current. Additional powers have been obtained under light railway orders granted subject to the approval of the Board of Trade as follows: Durham and Brandon, 2¾ miles; Jarrow and South Shields, 3½ miles; Morley and district, 7 miles; Spen Valley (extensions), 9 miles; Barnsley (extensions), 4½ miles. The two light railway orders for South Staffordshire granted by the Light Railway Commissioners (seven miles) have been confirmed by the Board of Trade. An Act of Parliament has been obtained for the construction and working of tramroads in the Wellingborough district (19 miles). The Peterborough order granted by the Light Railway Commissioners (5½ miles) has been confirmed by the Board of Trade. The Poole and District Electric Traction Company, Limited, has obtained an Act of Parliament for the construction and working of tramways (3¾ miles) in Christchurch and Bournemouth subject to the provision that if within a certain period the Corporation of Bournemouth under powers granted them construct that portion of the line within their borough, the Company's power to construct it shall cease, but they shall be entitled to running powers. The Kidderminster and District Electric Lighting and Traction Company has been granted a light railway order for an extension to Bewdley (4½ miles), subject to the approval of the Board of Trade. The light railway order for the Gateshead Tramways Company (2½ miles) granted by the Light Railway Commissioners has been confirmed by the Board of Trade. The application for a light railway order for extensions by the Wigan Tramways Company, Limited, has been granted in part (four miles) by the Light Railway Commissioners, subject to the approval of the Board of Trade. The South Staffordshire Tramways (Lessee) Company, Limited, has obtained a lease of the whole of the lines of the South Staffordshire Tramways Company as from Feb. 1, 1900. The provisional order granted by the Board of Trade authorising the reconstruction of the lines of the Rothesay Tramways Company, Limited for electric traction and extension of tenure has been confirmed by Parliament. The provisional order authorising tramways (3½ miles) granted by the Board of Trade to the Weston-super-Mare and District Electric Supply Company, Limited, has been confirmed by Parliament The provisional order granted by the Board of Trade authorising (*inter alia*) the reconstruction by the Leamington and Warwick Tramways and Omnibus Company, Limited, of the company's tramways within the borough of Warwick has been confirmed by Parliament. The Bills promoted in the last session of Parliament by the Electrical Power Distribution Company, Limited, for the supply of electric energy in bulk in the county of Durham and North Metropolitan areas have both been passed, and the Acts of Parliament have received the Royal assent. The Board of Trade have approved the transfer to the Company of the following electric lighting orders from the authorities who obtained them: Hertford Local Authority, Lewes Local Authority. The following electric lighting provisional orders granted by the Board of Trade have been confirmed by Parliament: Banbury, Jarrow, Sevenoaks, Sheerness, Staines, Egham, and Chertsey, Wallington, Wellingborough. The applications for light railway orders at Blyth and Windermere have been withdrawn for the time being. The Light Railway Commissioners declined to grant the order applied for in respect of Kingston and Surbiton.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN

Salford.—Tenders for the electric lighting of the town hall, Pendleton, will be called for shortly.

Kendal.—The Corporation invite tenders for the supply and erection of various plant. Tenders by Dec. 1. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for electric travelling crane and condensing plant. Tenders by Nov. 22. Details in our advertisement columns.

Farnworth.—The Urban District Council invite tenders for the wiring of premises on a deferred payment system. Tenders by Nov. 12. Details in our advertisement columns.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for arc lamp cables, telephone and pilot wires. Tenders by Nov. 21. Details in our advertisement columns.

Newcastle-upon-Tyne.—The New Tramways Committee of the Corporation invite tenders for arc lamps and accessories. Tenders by 21st inst. Details in our advertisement columns.

Belfast.—The Gas and Electric Committee invite tenders for switchboard extensions. Specifications, etc., may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer. Tenders by Nov. 23.

Nottingham.—Tenders are invited for the installation of an electric lighting plant at the new workhouse. Specifications may be obtained from Mr. G. Muncaster Howard, clerk, Poor-Law Offices, Nottingham.

West Bromwich.—The Corporation invite tenders for the supply of wiring materials, motors, and labour in wiring for lighting and power installations. Tenders by Nov. 17. Details in our advertisement columns.

Wolverhampton.—The Tramways Committee invite tenders for erection of car depôt, paint and repair shops, etc., at Cleveland-road. Plans, etc., may be seen at the office of Mr. J. W. Bradley, C.E., M.I.M.E., borough engineer, Wolverhampton. Tenders by Nov. 19.

Cardiff.—The Corporation invite tenders for the following: (Section 4) 75-kw. motor-generator and Tudor storage battery; (5) lead-covered cables; (6) 20-ton travelling crane. Tenders by Nov. 28. Details in our advertisement columns.

Watford.—The Urban District Council invite tenders for materials for and the construction of a boiler setting at their electric lighting station. Specification, etc., may be seen at the offices of Mr. D. Waterhouse, 14, High-street, Watford. Tenders by Nov. 15.

Greenwich.—The Guardians invite tenders for proposed electric lighting installation at the new workhouse, Grove Park, S.E., now in course of erection. Specification, etc., may be obtained and plans seen at the Greenwich offices of the architect, Mr. Thomas Dinwiddy, F.R.I.B.A. Tenders by Nov. 22.

Walker (Northumberland).—The Urban District Council invite tenders for the erection, complete, exclusive of buildings, of a two-unit dust destructor of the Meldrum type, etc. Specifications can be obtained from the engineers, Messrs. Handcock and Dykes, 1, Victoria street, Westminster, London, S.W. Tenders by Nov. 13.

London (City).—The Streets Committee of the Corporation invite tenders for the hiring of a mechanically-driven dust-cart for collecting and removing the dust, trade refuse, and street sweepings from the City to the Corporation's depôt at Lett's Wharf, Commercial-road, Lambeth, S.E. Tenders by Nov. 10. Details in our advertisement columns.

Shoreditch.—The Vestry invite tenders for the supply of various plant for the new generating station at Whiston-street, including direct-connected direct-current generators of an output of about 800 kw. each set. Specifications, etc., may be obtained at the office of the Vestry's electrical engineer, Mr. C. Newton Russell, Electric Light Station, Coronet-street, Hoxton, N. Tenders by Nov. 20.

Stockport.—The Tramways Committee invite tenders for the overhead equipment and supply of rail bonds for six sections of their electric tramways, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Specifications, etc., may be obtained from Mr. A. J. H. Carter, electrical engineer, or Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Stockport.—The Tramways Committee invite tenders for the laying of the permanent way of their electric tramways, including concrete foundation, but excluding bonding and paving, in six sections, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Plans, etc., may be obtained on application to Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

London, S.W.—The London County Council invite tenders for the supply, within 10 weeks of the order being given, of about 150 arc lamps, required in connection with the electric light installation for the Victoria-embankment and Westminster Bridge. Approximately, 80 of the lamps will be for current of 10 to 12 amperes, and 70 for current of 5 to 6 amperes. The lamps will be run in both cases 10 in series, and the supply will be from one or more dynamos, the pressure available being from 460 to 480 volts. Each person tendering will be required to submit a drawing of the kind of lamp which he proposes to supply, showing details of construction, and the materials to be used. Specifications, etc., may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W., upon payment of £1. Tenders by Nov. 13.

RESULTS OF TENDERS:

Limerick.—The tender of Mr. Bourke, Carr-street, has been accepted for erecting at the gasworks a generating station for electric lighting, at £2,680.

Middleton (Lancs.).—The Corporation have accepted the tender of Messrs. Partington and Sons, Middleton, at £5,950, for the erection of electricity buildings.

London County Council.—The Council have accepted the tender of Messrs. Barlow Bros. and Co., at £260, for the wiring and fittings required at the fire station in course of erection at Shepherd's Bush.

Whitby.—The Urban District Council have accepted the tender of the Callender's Cable and Construction Company, Limited, for the supply, delivery, and fixing of conduits, cables, boxes, lamps, and posts, at £5,327. 5s. 8d.

Sheffield.—The tender of the Electrical Construction Company, Limited, of Wolverhampton, for the two new two-phase alternators and engines for the sum of £13,840, and for the alteration of the existing single-phase plant at schedule prices, has been accepted.

London, S.E.—The Strand District Board of Works have accepted the tender of the Alliance Electrical Company, Limited, London, at £540, for the construction, delivery, and fixing of an engine and dynamo, switchboard, etc., for their destructor works, Shot Tower Wharf, Commercial-road, Lambeth.

Digitized by Google

Beetle.—The following contracts have been entered into by the Corporation for electric traction purposes in Knowsley-road: R. W. Blackwell and Co., £1,100; Callender's Cable and Construction Company, £210; Leeds Steelworks, together with cost incurred by the Corporation in laying rails, £2,924.

Warrington.—The Electric Lighting Committee have accepted the following tenders: Venner and Co., 200 meters to be delivered within 12 months from acceptance of tender, according to schedule prices; the Reason Manufacturing Company, Limited, 200 demand indicators; the Warrington and District Electric Light and Power Company, Limited, installation of electric light mains and fittings at the generating station and central sanitary depôt, at £354. 2s.

Salford.—The following tenders have been accepted: Cables—(Section 1) Western Electric Company, (2) British Insulated Wire Company, (3) Western Electric Company, (4) St. Helens Cable Company, (4, part) W. T. Glover and Co., (5) St. Helens Cable Company, (6) W. T. Glover and Co.; rubber solution and strip, Baxendale and Co.; black tape and binding wire, St. Helens Cable Company; fine solder, jointers' metal, etc., British Insulated Wire Company; cast-iron boxes and brass fittings, Lancaster and Tonge; wrought-iron pipes and bends, Clydeside Tube Company.

Cardiff.—The following tenders have been received by the Tramways Department of the Corporation:

Section No. 1.—Engines (the guaranteed efficiency per cent. is given in parentheses).

Ashton-Frost (91)	£10,324	0	0
R. W. Blackwell (92 without pumps)	18 205	6	0
Cole, Marchant, and Morley (90)	12,408	0	0
V. Coates (88)	12,400	0	0
Caledon Shipbuilding Company (88)	15,137	0	0
Dutilh-Smith and Co. (90)	12 900	0	0
Ferranti (91)	15 191	5	0
Galloway and Co. (88)	12,754	0	0
Hick, Hargreaves, and Co. (90)	16,178	0	0
Metcalf and Co. (90)	11,205	0	0
Musgrave and Co. (91) (accepted)	14,508	0	0
Nell and Co. (91)	20,984	0	0
Pollitt and Wigzell (90)	15,906	0	0
Stewart and Co. (88)	14,786	0	0
British Schuckert Company (93)	12,018	0	0
Thomson-Houston Company (92)	13,303	10	0
Yates and Thom (92)	12,670	0	0
Robey and Co. (90)	13,682	0	0

Section No. 2.—Generators.

Anchor Electric Company (93)	6 400	0	0
Ashton-Frost (93·5)	6 799	0	0
Bergtheil and Young (94)	7,315	10	0
Brush Electrical Engineering Company (94)	8 208	0	0
Crompton and Co. (92)	9,015	0	0
Dick, Kerr and Co. (94)	7,600	0	0
Dutilh-Smith (94)	6,810	0	0
Electric Construction Company (93)	8,810	0	0
Jackson and Co.	9 914	0	0
Lancashire Dynamo Company	7,663	0	0
Mather and Platt (93)	8,715	0	0
British Schuckert Company (92)	7 242	0	0
Siemens Bros. (91)	10,213	0	0
F. Suter and Co. (93)	6,378	12	0
Sunderland Forge (90)	12,458	0	0
Thomson-Houston Company (93)	8,568	16	0
Thames Ironworks (93·5)	8,874	0	0
Witting Bros. (91)	6,300	0	0
Westinghouse Company (93) (accepted)	7,467	10	0
Bruce Peebles and Co. (93)	7,627	10	0

Section No. 3.—Boilers, etc.

V. Coates—boilers, £3,700; Vicars stokers, £730; Bennis stokers, £650; conveyor, £170; elevator, £160; bunkers, £800; economisers, £530; superheaters, £440; water-tank, £500; pumps, £390.

Evans—boilers, £2,900; Vicars stokers, £750; Bennis stokers, £625; conveyor, £180; elevator, £150; bunkers, £800; economisers, £510; superheaters, £585; water-tank, £525; pumps, £350.

Galloways—boilers, £3,040; Vicars stokers, £720; Bennis stokers, £628; conveyor, V. £168, B. £288; elevator, V. £138; bunkers, V. £966, B. £804; economisers, £530; superheaters, £620; water-tank, £560; pumps, £370.

Meldrum—boilers, own make; Bennis stokers, £705.

Musgrave—boilers, £2,952 (accepted); Vicars stokers, £685; Bennis stokers, £595; conveyor, V. £159. 10s., B. £280; elevator, V. £131. 10s.; bunkers, V. £917, B. £762; economisers, £512 (accepted); superheaters, £558 (accepted); water-tank, £698 (accepted); pumps, £395 (accepted).

Tinkers—boilers, £2,940; Vicars stokers, £725; elevator, £138; bunkers, £965; economisers, £550; superheaters, £590; water-tank, £720; pumps, £380

Yates and Thom—boilers, £2,877; Vicars stokers, £753; Bennis stokers, £605; conveyor, V. £305, B. £288; bunkers, V. £958, B. £800; economisers, £530; superheaters, £566; water-tank, £581; pumps, £378.

Danks and Co.—boilers, £2,767. 10s.; Bennis stokers, £623. 14s.; conveyor, B. £286; bunkers, B. £798. 1s.; economisers, £530; superheaters, £450; water-tank, £495; pumps, £371.

Vicars (direct)—stokers, £684. 19s. (accepted); conveyor, £159. 10s. (accepted); elevator, £131 (accepted); bunkers, £917 (accepted).

Messrs. Tinkers's tender reduced £965 if Bennis stokers are used.

Perth.—The Commissioners have received the following tenders for supply of electric cut-outs: Hands, Limited, 21, Garlick-hill, Cannon-street, London, E.C., cut-outs, two-wire, 0 to 10 amperes carrying capacity, 8s. each, 10 to 25 amperes 11s., 25 to 50 amperes 12s. 6d., 50 to 75 amperes 15s., 75 to 100 amperes 18s. (accepted).

London County Council.—The Council have received the following tenders with regard to the wiring and fittings required in connection with the electric lighting of the fire station in course of erection at Redcross-street, City:

Barlow Bros. and Co. (accepted)	£270	0	0
Electric Lighting Corporation, Limited	305	0	0
G. E. Taylor and Co.	320	0	0
F. A. Glover and Co.	321	0	0
Tamplin and Makovski, Limited	375	0	0
E. S. B. Harrison and Co.	440	1	0

BUSINESS NOTES.

TRACTION.

Buxton.—The rent for meters has been reduced to 2s. 6d. per quarter.

Perth.—The tramway company have refused the offer of the Town Council to purchase the tramways.

London County Council.—The Fire Brigades Committee are considering the advisability of employing motors instead of horses.

Warrington.—Application is to be made to the Board of Trade by the Town Council for permission to construct certain tramways in the town.

Bolton.—The electric tramways, which are worked by the Corporation, have made a profit of £12,151. 11s. 6d. upon the last six months' working.

Erdington.—A committee is to be appointed with the power to obtain expert advice and to consider and report upon the best system of tramways to be constructed, and the roads along which they should be laid.

Folkestone.—At a public meeting on Friday the subject of the proposed tramways (details of which appeared in our last issue) was discussed, and a resolution passed in favour of the scheme. A poll was demanded.

Audenshaw.—Notice is to be served upon the Manchester Carriage and Tramways Company for the purchase, under the Suburban Tramways Act, 1879, of so much of their undertaking, including material and plant, as goes through the township of Audenshaw.

Huyton.—At the last meeting of the District Council the proposed branch of the South Lancashire tramways through Roby and Huyton was again discussed, and it was decided that the scheme be opposed until the line along the Liverpool-road had been constructed.

Brighton.—At the clearing-up meeting of the Town Council last week a motion to amalgamate the Electric Lighting and Tramways Committees was moved, but was withdrawn on the balance of opinion appearing to favour the keeping of the two committees separate.

Cheap Tramcars.—When the Sheffield Tramways Committee sold six of their old vehicles last week, one in fairly good condition fetched 25s, another £2. The best realised only £4. 2s. 6d., although it had cost originally about £100. These prices were exclusive of under-carriage and wheels.

Birstall.—A letter from the British Electric Traction Company suggesting that the District Council should purchase the portion of the Dewsbury, Batley, and Birstall tramway within its district, and lease the same to the traction company for 28 years, will come before the next meeting of the District Council.

Glasgow.—The Tramways Committee of the Corporation have agreed that additional borrowing powers should be obtained for £1,250,000 to cover the cost of constructing and equipping the authorised and proposed tramway lines, and also of completing the conversion of the existing lines, including cars, power stations, etc.

Paisley.—Polling took place on Saturday on the question whether the Corporation should promote a Tramways Bill or support private enterprise in carrying out a tramways undertaking for the town and district. The result was announced as follows: private enterprise, 3 616; Corporation Bill, 2,022—majority, 1,594.

Aberdeen.—The Tramways Committee of the Town Council have decided to allow a section of line to be laid down on the surface contact system as an experiment. The length of the experimental track will be about 600 yards, and Messrs. M'Elroy and Grunow, if the line is successful, are to sell it to the Town Council for £1,400.

Wrexham.—Mr. Trentham has been in communication with the National Electric Traction Company, Limited, 66, Victoria-street, London, as promoters of the tramways, and he is of opinion that a traction feeder, at the cost of the tramway company, would have to be laid to Ruabon-road by way of Madeira-hill and Poplar-road.

Lytham.—Negotiations are proceeding between the Blackpool Corporation and the Blackpool, Lytham, and St. Annes Tramway Company for the purchase of the latter's undertaking, and it is

Digitized by Google

stated that there is not a very great difference between the respective amount the Council is prepared to give and the company to accept for the concern.

Wolverhampton.—At a special meeting of the Town Council last week a report from the Tramways Committee containing recommendations as to the lines of route which should be first taken in hand for construction for the future working of the tramways on the electric traction system in place of the present horse traction, was adopted.

Burton.—The sub-committee of the Town Council appointed to deal with the proposed tramways for Burton have adopted the reports of the borough surveyor and Mr. J. E. Waller. The scheme includes the laying of tramways in six different directions in the town. As to the motive power to be used the committee leave the Town Council to decide.

Turton.—The Bolton Corporation Tramways Committee not being prepared to make any offer with regard to any tramways proposed to be constructed in Turton, the clerk is consulting Mr. Ball the Urban District Council's parliamentary agent, as to the proposals of the South Lancashire Tramways Company with regard to tramways and light railways in Turton.

King's Norton.—The Urban District Council have proposed to promote a Bill in Parliament or apply for a provisional order to authorise the Council to construct and work and to lease or sell certain tramways and light railways along the Bristol-road, Pershore-road, and other roads, and for granting other powers in relation to tramways within the district of the Council.

Kent.—The authorities of the districts from Plumstead to Dartford have agreed to ask for powers for an electric tramway. The proposed line will run from the existing metropolitan system at Plumstead through East Wickham, Welling, Bexley Heath, Crayford, and Dartford. Both the Dartford and Bexley urban authorities have the electric supply in their own hands.

Fulham.—At the final meeting of the members constituting the Vestry, a communication was received from the London County Council notifying their intention to introduce a Bill in the next session of Parliament for powers to construct tramways along the King's-road, Fulham, to and over Putney Bridge. The Vestry sanctioned the affixing of the usual notices to the lamp-posts.

Hull.—Lieutenant Colonel Von Donop, R.E., has made an inspection of the Spring-bank route of the Hull Corporation's system of tramways. The city engineer (Mr. White) has been instructed to lay the rails for electric cars along the Hedon-road, and to repave the road with wood as far as the sanatorium. The plant at the station is to be increased by additional engine, boilers, and dynamo.

Bristol.—A number of new electric lines are shortly to be placed at the service of the public in Bristol. Many lines have recently been converted from horse to electric traction, and some are of entirely new construction. Some 250 new cars have been built for this service, and the cars are to run from about 5 a.m. to 12 midnight. It is proposed to use the tram horses for omnibuses which are to run to and from the various electric tramways.

Llanelly.—The Light Railway Commissioners last week held an enquiry into the scheme formulated by the Llanelly and District Electric Lighting and Traction Company, which was approved of by the Borough Council and all other local public bodies. The Chairman, at the close of the enquiry, remarked that the scheme appeared to be an excellent one, and that the Commissioners would have great pleasure in recommending it to the Board of Trade.

Reading.—Notice to purchase has been served on the tramways company, and has been acknowledged by them. The Corporation have made a formal offer of £10,105, and have informed the company that in the event of the offer not being accepted within a month from the date of making the same, the offer will be regarded as declined, and an application will thereupon be made by the Corporation to the Board of Trade to appoint a referee pursuant to Section 43 of the Tramways Act, 1870.

West Bromwich.—At Wednesday's meeting of the Town Council the General Purposes Committee reported that they had now arranged terms by which the tramways when acquired should be leased to the South Staffordshire Company for a term of 21 years (to be extended to 30 years if the authority of Parliament be obtained) upon satisfactory terms under which the Corporation would reconstruct the tramways and equip them electrically with overhead traction, the company taking from the Corporation the supply of electrical energy required.

Birmingham.—The accounts of the tramway department for the half year ending Sept. 26 show a surplus between income and expenditure of £12,151. 4s. 6d. The expenditure includes a sum of £6,385. 6s. 6d. for interest and sinking fund, and £3,610. 4s. 9d. for repairs of all kinds. Thus in the general statement the income is £35,762, and the expenditure £23,610. The details of the working expenses are for management £807, for traffic £10,988, and for rent, rates, and taxes £1,677. The repairs and maintenance expenses include: rolling stock £2 567, electrical equipment £230, permanent way £813, and miscellaneous expenses £143—making a total for works expenses of £17 225.

New Issue.—The London United Tramways Company, Limited, are issuing £550,000 4 per cent. first mortgage debenture stock, of which £34 125 is reserved for allotment to the holders of existing terminable debentures, and the remaining £315,875 is offered for public subscription at par. The company was incorporated in 1894 with a capital of £600,000, £350 of which has been called up, and they have powers for the construction of electric tramways in the western districts of London. The first portion of the scheme to be carried out comprises 16 miles of route, of which 11 miles have already been completed and are about to put into operation electrically; the remaining five miles are in course of construction.

Manchester.—A special meeting of the City Council will be held on Dec. 5 to consider and decide "whether the Council shall exercise its right, under the powers conferred by Section 43 of the Tramways Act, 1870, to require the Manchester Carriage and Tramways Company to sell to the Corporation so much of the undertaking authorised by Part II. of the Manchester Carriage and Tramways Company Act, 1880, as the Lord Mayor, aldermen, and citizens of the city of Manchester are under the said 43rd section entitled to purchase"; and to consider an agreement to be produced at the meeting made under the provisions of the Manchester Corporation Tramways Act, 1900, fixing a date for the accruer of the right of purchase, also to adopt, if so decided, a resolution by which the sale will be required after the approval of the Board of Trade has been obtained.

William Griffiths and Co., Limited.—This Company has been formed, with a capital of £200,000, to acquire and carry on the well-known business of William Griffiths, stone and granite merchant, contractor for paving works in stone, wood, and asphalte, tramway construction, municipal works, and other works of a similar nature, carried on at Hamilton House, Bishopsgate-street (London), Hoxton, Islington, Bethnal Green, and elsewhere, and the business of William Stranger, quarry owner, Guernsey, which has been worked in connection therewith. The business of William Griffiths has been established for upwards of 70 years, and amongst its more important customers are H.M. Government, the Corporation of the City of London and other corporations, the London County Council and other county councils, and municipal authorities, also railway, gas, water, tramway, electric lighting, and other public companies.

Normanton.—Some time ago the Urban District Council decided to oppose the application of the North British and Northern Counties Electric Supply Companies for a provisional order to supply the town with electric light by making application for an order themselves. Since then the Council met a deputation from the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, of Westminster, who have a scheme in hand for connecting Normanton, Castleford, Pontefract, and Knottingley with electric tramways and electric light, and the proposed area will include Altofts, Whitwood, Fryston, Featherstone, Sharlston, Streethouse, Snydale, and Warmfield. It is intended to form a sub-company, to be named the West Riding Company, and the offices will be at Leeds. The maximum rate for the tramways will be 1d. per mile for ordinary passengers and ½d. per mile for workmen's cars, and the maximum price for lighting is to be 4d. for public and 6d. for private use per unit. The syndicate will also undertake the conveyance of goods by night. The Council favour this scheme on condition that Altofts was connected instead of Featherstone, and on the consent of the other authorities being obtained, the work will be proceeded with on license pending the granting of the provisional order.

Bradford.—Lieut.-Colonel Von Donop last week inspected the two new tram routes belonging to the Corporation, which are now ready for operation. The first of these, known as the Whetley Hill tramway, extends from Godwin-street, in Westgate, to Duckworth-lane, and is 1 mile 922 yards long. The other line runs from Thornbury to the Leeds city boundary at Stanningley. On the new Whetley Hill section during Friday, Saturday, and Sunday, traffic on the first named day not being begun until half an hour after noon, and with five cars only at disposal on the route at present, a distance run of 762 miles produced receipts of £80. 1s. 4d., or 25 21d. per mile. The returns of the working of the other Bradford electric tramways for the week ended Nov. 4 show that on the Bolton section 3,099 miles have been run, and that the receipts amount to £136. 16s. 1d., which is equal to 10 59d. per car mile. The workmen's cheques issued numbered 1,490, and 1 498 were returned. The total receipts since April 1 amount to £4,716 7s. 5d., or 11·38d. per car mile. On the Horton section during the past week 6,309 miles were run, and the receipts were £285. 6s. 5d., equal to 10·85d. per car mile. The workmen's checks issued numbered 1,764, and 1,793 were returned. The total receipts since April 1 amount to £10,205 6s. 6d., or 12 09d. per car mile. On the Lidget Green section 2,720 miles were run during the past week, and the receipts were £128. 14s. 4d., equal to 11·35d. per car mile. The total receipts up to date have been £1,266. 17s. 8d., equal to 11 65d. per car mile.

Sheffield.—The Heeley route has been opened for traffic. The minutes to be presented at the Council meeting to-day include those of a joint meeting of the Finance and Consultation Sub-Committee of the Improvement Committee, the Audit Sub-Committee of the Highway Committee, and a sub-committee of the Tramways Committee, which has been held to consider the cost of street widenings and works necessitated through tramways construction. The Joint Sub Committee recommend that the following principles of adjustment be adopted between the Tramways and Improvement Committees as to purchases of properties for tramway construction and street improvements: (1) In case of street widening entirely and solely for tramway construction, which otherwise would not be done, the Tramways Committee to bear a proportionate share of the cost; the amount to be adjusted by the two committees. (2) In case of street widening where it is partly required for street improvement and partly for tramway construction, the Tramways Committee to bear a proportionate share of the cost; the amount to be adjusted between the two committees. (3) In case of street widening where it is entirely and solely for street improvement, irrespective of any contemplated tramway con-

Digitized by Google

struction which may hereafter be carried out, the Tramway Committee not to bear any proportion of cost of such widening. The Tramways Committee recommends increases of wages of the staff at the power station; also that the general manager and the city surveyor report on the facilities of the Fitzalan Market as a central tramway station, and that power be obtained to take over the whole of the Fitzalan Market for use as a central station, and that the Finance Committee be asked as to the amount required to buy the same. At a recent meeting of the Tramways Committee the city surveyor reported that the following routes are now in hand, being part of the work ordered for the year 1900-1: Hillsborough route (*via* Nursery-street) to Hillsborough-park; Western Bank to Crookes (*via* Whitham-road); Darnall route (Staniforth-road and Pinfold-lane). The city surveyor also reported that the following is a list of the routes (not yet started) to complete work ordered for year 1900 1: Broomhill to Nether Green *via* Fulwood-road; Shalesmoor to Hillfoot Bridge *via* Penistone-road; Intake route extension (cemetery to Intake). The sub-committee recommend that the following routes be put in hand as soon as the work already agreed to be done is completed: Page Hall-road and Upwell-street; Newhall-road; Rustlings-road, Hunter's Bar to Nether Green; Carlisle-street to Grimesthorpe; junction of Glossop-road and Hounsfield-road along Clarkehouse-road and Brocco-bank to connect with Ecclesall-road; Ecclesall-road, Hunter's Bar to Ecclesall Church; Cemetery-road to Ecclesall Church *via* Cemetery-road and Psalter lane. That the route from Nether Edge terminus along Sheldon-road, to connect with Abbeydale-road, be commenced as soon as the road is properly constructed. That the portion of the road from the bottom of Crookes-road to Broomhill (bottom of Manchester-road) be electrically equipped, so as to commence running cars to Broomhill as soon as the route is ready for running.

LIGHTING AND GENERAL.

Gibraltar.—Wireless telegraph stations are to be established here and at Malta.

Kingston.—Low-tension mains will be laid in Brunswick-road and also in a portion of Coombe-road.

Keeles.—A new feeder cable is to be obtained at an estimated cost of £515 to cope with the present demand.

Maidenhead.—The Council have decided to hold a special meeting on Nov. 14 to discuss the subject of electric lighting.

Birstall.—The District Council have decided to apply for an order authorising them to supply electric light and power within their district.

Kidderminster and District Electric Lighting and Traction Co.—The transfer-books and register of members will be closed from 7th to 15th inst. inclusive.

Chapel Royal.—The Chapel Royal, St. James's Palace, is to be lighted in future by electricity. The work will probably be completed within the next fortnight.

Bridgwater.—On Friday Colonel A. J. Hepper held an enquiry into the application by the Town Council for powers to borrow £20,000 for purposes of electric lighting.

Wellingborough.—The refuse destructor is now approaching completion. The Council have decided to apply for an order enabling them to carry out their electric lighting scheme.

Theft of Wire.—Arthur Green, a labourer employed by the City Electric Lighting Company, was charged with theft of electric cables at Southwark Police Court, and remanded for a week.

Folkestone.—The sub-committee have prepared a report of their proceedings in connection with the application of the National Telephone Company for permission to put their lines underground.

Sale of Plant.—The Corporation of West Ham and Messrs. Mather and Platt are advertising sales of gas-engines and of dynamos respectively, details of which appear in another column.

Belfast.—The license which the Postmaster-General is prepared to grant to the Corporation for the establishment of a municipal system of telephones in the telephone area of Belfast extends into Down.

"The London Technical Education Gazette."—The last number (September and October) contains a detailed list of evening classes that are conducted in London during the session 1900-1.

London Gazette.—Notices of intention to apply for orders have appeared in the *Gazette* as follows: Electric lighting—Friern Barnet Urban District Council and Cannock Urban District Council.

Holyhead.—The experts who examined the force of water running through Pont Lusinwan with a view of setting plant to generate electricity have guaranteed sufficient power to generate 25 000 c.p.

Guildford.—A tracing of the route of the supplementary mains proposed to be laid by the Electricity Supply Company in the eastern portion of the town has been referred to the Paving Committee.

Otley.—The Urban District Council have instructed Mr. G. Wilkinson, electrical engineer, of Harrogate, to conduct an enquiry and submit a scheme for the lighting of the town by electricity.

Columbia Motorcar Co., Limited.—This Company has been registered with a capital of £1,000 in £1 shares, the object being to manufacture, sell, let on hire, and deal in electric motors, etc.

Stockton.—At a meeting of the Town Council on Nov. 6 it was reported that by the end of the month the electric lighting works would be completed so far as to enable the light to be turned on in the streets.

Partnership.—Mr. Haydn T. Harrison, M.I.E.E., has taken into partnership Mr. F. S. Pillean. The name of the new firm is Haydn Harrison and Co., having offices at 11, Victoria-street, Westminster, S.W.

Electrical Trades Supply, Limited.—This Company has been registered with a capital of £5,000 in £1 shares, the object being to carry on at Birmingham or elsewhere the business of electric appliance manufacturers, etc.

Automatic Telephones.—The Victorian postal authorities are perfectly satisfied with the income earned by automatic telephones. During the 12 months the sixpence-in-the-slot instruments have been in use they have earned £127. 6s. 3d.

Pocklington.—The Urban District Council have decided to send a deputation to the Northallerton electrical works, with a view of considering the advisability of the installation of a similar plant for electric lighting purposes at Pocklington.

Pickering.—The Urban District Council have passed a resolution assenting to an application to the Board of Trade by an electricity supply company for an order empowering them to establish works for supplying electricity in the urban district.

Accident.—There is nothing like leather, for when a 60ft. telegraph pole fell at Southampton recently while a wireman in the employment of the General Post Office was working on it, the man, who was strapped to the top of the pole, escaped without injury.

Wellington.—The District Council have resolved to apply to the Board of Trade for a provisional order authorising them to supply electricity for all public and private purposes within the Council's district. Mr. T. L. Miller, of Liverpool, is the consulting engineer to the Council.

London Electric Warehouse Co.—This Company has been registered with a capital of £1,000 in £10 shares, the object being to carry on the business of electrical engineers, electricians, suppliers of electricity, manufacturers of and dealers in electrical machinery, plant, apparatus, etc.

Walton.—The Urban District Council do not approve the application of Edmundson's Electricity Corporation for a provisional order, and have referred it to a committee of the whole Council to consider whether they should not themselves take the necessary steps to apply for an order.

Yorkshire Electric Power Syndicate, Limited.—This Company has been registered with a capital of £10,000 in £10 shares, the object being to carry on in the West Riding of Yorkshire, south of the River Wharfe, or elsewhere, the business of an electric power supply company in all its branches.

Portsmouth.—The Town Council have adopted a report of the Finance Committee recommending the adoption of the smaller scheme for the establishment of a municipal telephone exchange mentioned in Mr. Bennett's report, and the appointment of Mr. Bennett as consulting engineer at a fee of 5 per cent. on the outlay.

King's Norton.—The Urban District Council have passed a resolution in the following form: "That the Council do take into consideration the desirability of proceeding with the powers to establish electric lighting undertaking under the powers of the provisional order obtained in 1898, and that instructions be given for the preparation of the plans; and, further, that the clerk inform the Board of Trade of the action taken, and do apply to them to allow a further period before considering the question of revoking the order."

Camera Club.—At the meeting on Thursday night last week Mr. James Cadett, lecturing on the latest in X rays, gave an account of his experiments with X ray tubes in regard to their behaviour to photographic plates or sensitised papers. He also, with the assistance of Mr. Cook, turned the current through a number of tubes, demonstrating how the electric current refuses to penetrate the dark spot in the tube, supposed to be the place where the highest vacuum exists, and follows the walls of the tube or the gaseous matter near them. This was most remarkable in the case of tubes with considerably elongated ends, forming a spiral course of perhaps 20 times the distance between cathode and anode. He also found, when applying the wire to the most distant ends of a tube of moderate vacuum and disconnecting the anti cathode that, contrary to the generally adopted theory, the current flowed twice as easily as before. An interesting debate ensued, and afterwards some pretty specimens of fluorescence were shown.

Appointments Vacant.—Applications are invited for the post of manager and engineer to the Portsmouth Corporation telephone exchange.—The Cardiff Corporation have vacancies for a chief assistant engineer to the electrical tramway engineer, and an electrical mains superintendent.—Assistant engineers are also wanted at Newcastle under-Lyme and at Bolton.—The Electricity Department of Aberdeen require a junior station assistant, salary commencing at 30s. per week. Applications, stating age, etc., to be sent by 14th inst. to Mr. J. Alex. Bell, city electrical engineer, Cotton-street, Aberdeen.—The Warrington Electric Lighting Committee are about to advertise for an electrical engineer at a salary of £250 per annum.—A resident electrical engineer is also required at Barking Town, Essex. Particulars of these vacancies and others relating to articled pupils, draughtsmen, jointers, etc., will be found in our advertisement columns.

Digitized by Google

West Bromwich.—The Electric Lighting Committee have received 64 applications for the position of borough electrical engineer, and will recommend that Mr. J. H. Wray, of Blackpool, be appointed, at a commencing salary of £250 per annum. The construction and laying down of the works and mains is now well in hand.

West Hartlepool.—At the monthly meeting of the Town Council on Tuesday the Council accepted a recommendation of the Finance Committee that the services of an expert be engaged to report on the desirability and cost of installing a municipal telephone service in the town. Mr. J. G. Steel was appointed assistant electrical engineer.

Skipton.—With regard to the proposed electric light supply for the town we learn that 281 circulars have been sent out by the Council. Of these 90 replied assenting to the Council's proposal, 95 refused, and 96 have not yet replied. No price has been fixed at present. It is stated that next week everything will be ready for the application for an order.

Blairgowrie.—When a number of years ago the Ericht linen works were lighted by electricity, steam was the motive power. Water power has, however, now been adapted by means of the water-wheel at the "Muckle Mill." Messrs. Lowdon, electricians, Dundee, superintended the operations, and the dynamo and shafting were supplied by Mr. Abercrombie, engineer, Blairgowrie.

Wolverhampton.—The annual report of the Lighting Committee, which will be submitted to the Council to-day, states that the profits during the year had amounted to £402. 6s. 11d. The demand for electricity continued to increase, and extra machinery was being put down. The units sold to private consumers during the 12 months to Sept. 29 last were 653,216, as against 331,203 in the previous year.

Bristol.—A proposal to extend several mains has been accepted. The committee have decided to carry out Sir Benjamin Baker's recommendation that the foundations of the new electric lighting station should be strengthened by buttresses instead of cross walls. In recommending this the engineer pointed out that the buttresses would involve less expenditure than walls, and would achieve the object in view.

Elland.—Unless a move is made shortly toward the construction of an electric installation, the Council will be in danger of losing the powers conferred upon them some time ago by the granting of an electric lighting provisional order. The negotiations are at present in progress as to a proposed site, and until some definite arrangement has been made with Mr. Lipscomb, Lord Savile's agent, little more can be done.

Walmer.—The Electric Lighting Committee have been discussing a report of an electric lighting installation at a cost of £60,000, which would show an annual profit of £2,000. It has been left to the committee to confer with Deal in order to ascertain what steps that Council are going to take, the Walmer Council being of the opinion that, to make it a paying concern, it could only be done jointly between the two places.

Newport.—The Electrical Committee of the Council have adopted a report in favour of the free wiring of private residences in the borough. The present rate per unit for lighting purposes is from 5d. to 6d.; but where an outlay is made for wiring the premises the charge will be 6d. to 7d. per unit. The kind of fittings, too, are prescribed, and should the householder require very elaborate or ornate fittings he will have to pay the difference.

Beetle.—The Town Council have agreed that, pursuant to the sanction of the Local Government Board to the borrowing of £19,819 for the purposes of electric lighting, the Finance Committee be authorised to take up on loan the following sums: for electric lighting purposes in Linacre lane and Hawthorne-road, £1,662; for the same purposes in Stanley-road, £790; and for Derby-road, Rimrose-road, Knowsley-road, and Marsh-lane, £6 855.

Sam Deard's Glazing.—We learn that Sam Deard's patent glazing system has been adopted for the Wantage Engineering Company, Limited, workshops, boiler and sanitary buildings, etc., at Wantage; also at Tendring, near Colchester, for the workhouse buildings, for new warehouse roof at Dawson-street, Dublin; and also for the new electric light buildings at Chelmsford. The patentee's works are at Harlow, Essex, and London offices, 34, Old Broad-street, E.C.

Plumstead.—At a special meeting of the Vestry on Friday a report was adopted from the Lighting Committee on the provision for electric lighting, which recommended that tenders be accepted, amounting to a total of £36,816 16s. 10d., for various works in connection therewith. It was also resolved that detailed plans be furnished to the County Council as early as possible, and that the Borough Council be requested to expedite the scheme for electric lighting and the dust destructor.

Government Telephones.—At the Court of Common Council on Thursday a letter was read from the Postmaster-General relative to the excavations in the City for the purpose of laying telegraph and telephone pipes, and stating that in the more important thoroughfares the work had been carried on day and night whenever practicable without infringement of the restrictions imposed by the city engineer, and that the work would be continued to be pushed on as rapidly as possible.

Glover's Sports.—Glover's Salford Works played Glover's Trafford Park Works on Saturday, the parent works being defeated by nine goals to nil. A combined works club was formed after the game with the special object of promoting matches (or, if possible, a football league) among the electrical engineering works in Manchester and district. The hon. secretary, Mr. W. G. Tickle, will be glad to receive challenges or communication to this end. Address, Springfield Cable Works, Salford.

Westinghouse Co.—We have received from the British Westinghouse Electric and Manufacturing Company, Limited, a copy of their circular No. 1,034, which deals with the direct-current engine-type generators at 250 volts which are manufactured by the firm. The generators are more particularly constructed for supplying power to machine tools, cranes, pumps, etc. As is usual in these circulars, the machines are described in detail, and illustrations and diagrams are given, as are also tables giving the standard sizes and approximate dimensions of the generators.

Strike.—The strike of tramway men at Ashton-under-Lyne ended on Saturday. The men on strike returned to work pending the Board of Trade arbitration on the points in dispute. The free labour men who took the places of the strikers five weeks ago, when this dispute began, have been paid up and granted a bonus. The arbitrator, the company, and the men's representative have agreed that the arbitration shall take place at the Ashton Town Hall on the 15th inst. On Saturday two men were charged with assaulting police officers, and were each fined £1 and costs or a month's imprisonment.

Airdrie.—The amended draft agreement between the Council and the Scottish House-to-House Electricity Company, Limited, as to electric lighting of the streets will come before the Town Council next month. The draft is divided as follows: (1) agreement as to the Tramway Act obtained by the New General Traction Company, Limited, in last session of Parliament; (2) conditional agreement for the transfer of powers, duties, and liabilities of the Airdrie Burgh Electric Lighting Order, 1898; (3) agreement transferring powers, duties, and liabilities of the Airdrie Burgh Electric Lighting Order, 1898; and (4) agreement for public lighting.

Cardiff.—Members of both the Cardiff Electric Lighting and Tramways Committees met at the town hall on Monday to consider a suggestion that the two committees should be amalgamated. After discussion, the question of amalgamation was dropped, and it was decided that, with a view of avoiding the building of another station, the two engineers of the electrical and tramways departments respectively should prepare separate reports as to how the existing station and the power station at Roath could be utilised for supplying additional current for lighting and traction purposes, the date upon which current would be available, and the price thereof.

Amalgamation.—We are informed that an amalgamation has been effected between Messrs. the Maxim Electrical and Engineering Export Company, Limited, 65, 66, and 67, Gracechurch-street, E.C., and Messrs. Edwards and Barnes, engineers, Westminster. The allied firms will trade under the style of the Maxim Electrical and Engineering Export Company, Limited, 65, 66, and 67, Gracechurch-street, E.C. The entire staff of this business is still retained, and Mr. Howard T. Wright remains manager of the department taken over. This company are making a speciality of central electric light and power station steam accessories, including condensers and economising plants.

Price-Lists.—We have received from Messrs. J. Gibbs and Son, of Duke-street, Liverpool, a copy of their latest price list dealing with their patent air propelling and ventilating fans. The diameter of the blades of these fans varies from 15in. up to 72in., and the price from £3 to £41. 10s. Their electrical fans are fitted with an enclosed motor, and in order to meet the demand for small apparatus for ships' cabins, offices, etc., the firm are now producing a fan of small size at a reasonable cost, and capable of being driven at various speeds. We have also received from Messrs. Gibbs and Son a copy of a testimonial recently received from Mr. S. B. Cottrell, M.I.C.E., M.I.M.E. from which we gather that the firm have been successful in reducing the temperature of the Liverpool Overhead Railway Company's generating station by nearly 15deg. F. by means of some of their fans.

Hull.—The council of the Hull Incorporated Chamber of Commerce and Shipping held its monthly meeting on Monday. Referring to the decision of a committee of the City Corporation to apply to the Postmaster-General for a license to establish a municipal telephone system it was asked whether it would be substituted for the old system, or whether it would be an additional one. It would be a serious inconvenience to have two systems in operation. The Chairman understood that the two systems would be joined together, so that subscribers to the Corporation system would have access to the National one. If the two did not interwork no one would support the new one. The council expressed dissatisfaction with the rebate offered by the National Telephone Company with respect to the breakdown last February, and they therefore withheld the payment of the year's account.

South African Contracts.—The *British and South African Export Gazette* contains the following information on South African contracts: "A complete electric power installation for the Rezende gold mine, Rhodesia is in course of shipment. A small generating plant is to be ordered for the electric lighting service of East London, Cape Colony. The installation of an electric lighting service, at an estimated expenditure of from £3 000 to £8.000, is under consideration by the Uitenhage Town Council, Cape Colony. The Cape Government propose to make additions to their telegraph and telephone systems to the extent of £30,018. The details include additional telegraph wire, £9,105; automatic fast-speed apparatus, £3,150; extensions of telephone systems, £15,263; additional switchboards for Cape Town and Port Elizabeth,

Digitized by Google

£2,000. The Durban Corporation are about to place an order for two additional engines for the electric lighting service.

Dudley.—The Mayor (Mr. E. Grainger) and the chairman of the Electric Lighting Committee on Monday initiated the lighting of the principal streets of the town. Mrs. Dunn switched on the current The sum of £33,000 has been borrowed to carry out the scheme, and an additional £10,000 is to be obtained for free wiring houses and business premises for electric lighting purposes. In connection with private consumption the cost will be 6d. per unit (equivalent to 9d. per 1,000ft. for gas) for two hours per day, and 1½d. per unit for the remaining 22, which is stated to be the lowest price charged by any municipality in England. It is estimated that the electric lighting in Dudley will consume 270,000 units a year. The newly-erected power station at Springsmire is not quite completed, but current has been supplied to the tramways to Cradley Heath and Sedgley during the last fortnight.

Islington.—At the last meeting of the Vestry, the treasurer gave some interesting figures relating to the cost of the electric light undertaking. He said the ratable value of the electric lighting property was at the present time £3,094, but at the last quinquennial valuation the amount was raised to £3 790. The amount of outstanding loans on the undertaking was £325,863. For the past six months ending June 30 there was a profit in the working of the undertaking of £5,087. 14s. 10d. A sum of £1,523. 5s. 3d. had to be set aside for redemption of debt, a sum of £4,158. 15s. 7d. for paying interest on loans, and a sum of £64. 8s. 10d. had to be written off for bad debts. The profit on the undertaking was insufficient to meet those charges by £638. 14s. 10d. The ratable value of the parish for the year ending September, 1894 was £1 717 414. At the present time the ratable value was £1,835,193. Mr. H. L. Mills, the electrician-on-mains, has resigned his position.

Wrexham.—The extension to Ruthin-road has been confirmed by the Council. The cost, including cable for the two arc lamps, will be £172. The following epitome has been prepared by Mr. Trentham of the expenses undertaken or recommended by the Town Council up to the 16th inst.—viz.: Messrs. Davies Bros.' contract, £1 122; boiler setting, £143. 13s. 9d.; new girders for water-tanks, £44. 10s; Messrs. Babcock and Wilcox, two water-tube boilers £1,761. 16s. 7d., water softener £250; Mr Lord, Lancashire boiler, £825; Lancashire Dynamo Company, £7 286. 10s.; Messrs. Brook, Hirst, and Co., switchboard, £589; St. Helens Dable Company, £4,499. 11s. 7d., nine extra arc lamps, Egerton-street extension and Ruthin-road extension, £438. 10s.; Chloride Battery Company, £991; Messrs. Carrick and Ritchie, £140 and £16; Messrs. Meldrum, destructor, £1 630; and consumers' connections and meters arranged for, £500—making a total of £20 240. 11s. 11d. To this has to be added engineering fees and presumably tipping platform for destructor.

Sheffield.—The Markets Committee of the Corporation, says the *Sheffield Daily Telegraph*, might very well take a hint from Leeds as to the lighting of the markets by electricity. Mr. S. E Fedden, chief engineer and manager of the Sheffield electric light department, recently visited Leeds and inspected the new installation of arc lighting at the covered market there. Eighty enclosed alternating arc lamps of the "Reason" type have already been installed, and another 40 are on order for extension of the buildings not yet completed. The Markets Committee have put in a large number of lamps, and the light at night is almost equal to daylight. Apparently the question of cost has not so much been considered as the obtaining of a thoroughly good light, and thus facilitating the transaction of business. The charge to the committee is 3½d. per unit for lighting, but this figure will probably be reduced after a time. The results obtained are eminently satisfactory, and there is no doubt that the cost incurred will in the near future be indirectly if not directly recouped.

Presentations.—Mr. John Ferguson Bell, A.M.I.C.E., late engineer and manager of the gas and electricity works of the Stafford Corporation, was presented last week with a testimonial from many friends in the town on his leaving to take the management of the Derby gasworks. The presentation was made in the Mayor's parlour at the borough hall, Mr. C. H. Wright (chairman of the Gas and Electricity Committee) presiding. The testimonial consisted of an illuminated address and a silver tea and coffee service and salver. The inscription upon the latter referred in most eulogistic terms to Mr. Bell's services to the Corporation during the last 17 years. The employés at the gas and electric light works presented Mr. Bell with a very handsome silver tray suitably inscribed.—The staff and employés of the electricity works of the Huddersfield Corporation have presented Mr. J. R. P. Lunn, the mains superintendent, who has left to take the position of borough electrical engineer at Darlington, with a timepiece and ornamental figures which had been subscribed for by the staff and employés.

Personal.—Mr. G. Swift, of the Electric Construction Corporation, Wolverhampton, has been appointed a shift engineer at the Blackburn electricity works in the place of Mr. J. W. A. Binnes, who has been appointed assistant engineer at the Accrington Corporation electricity works.—Mr. Samuel Hartford, of Collier-street, Salford, Manchester, having resigned the secretaryship of Messrs. W. T. Glover and Co., Limited, Salford and Trafford Park, Manchester, has commenced business at that address as agent for the following firms: the British Insulated Wire Company, Limited, Prescot; the Brockie-Pell Arc Lamp, Limited; Mr. Wm. Rickard, Derby; and Messrs. W. N. Brunton and Son, Musselburgh, Scotland.—We are informed that Mr. C. McDermid has been appointed secretary to the Institution of Mining and Metallurgy, of London, and he is consequently leaving the Iron and Steel Institute, where he has for seven or eight years been assistant secretary under Mr. Bennett Brough. We wish Mr. McDermid every success in the new position which he is about to occupy.

Leigh.—Mr. G. W. Wilcocks has held an enquiry into the application by the Town Council to borrow £5,000 for electric lighting extensions. The electricity works were completed in January last. Sanction has been given to a loan of £10,216, but £10,546 has been expended on capital account up to the present time. The number of consumers at present is 67, and the number of private 8 c.p. lamps 3,766. There is no public electric lighting at present. The length of the mains already laid is 2 miles 382 yards, and the £5,000 is for extension of mains amounting to an additional 4 miles 1,444 yards. A canvass of the area through which the new mains are to run has been made, resulting in applications from about 50 consumers for 1,500 8 c.p. lamps, and it is estimated that each lamp will burn in a year 5s. 6d. worth of electricity, bringing in a total revenue of £412. 10s. Sufficient power is now available, the additional cost will only be in the generating of the current, estimated at £70. 0s. 3d. The amount of interest and capital required yearly to repay the loan within 25 years amounts to £323. 3s. 9d. The total cost will thus be £393. 4s., leaving a balance of £19 6s.

New Issue.—The Electrical Power Distribution Company, Limited, are making an issue of 12,980 ordinary shares of £10 each, at a premium of £1 per share, through the Electric and General Investment Company, Limited, 1 and 2, Great Winchester-street, London, E.C. The board of directors consists of Mr. J. S. Raworth, M.I.C.E., chairman; Messrs. Emile Garcke M.I.E.E.; C. Shirreff Hilton; R. Percy Sellon, M.I.E.E; and Wm. L. Madgen, M.I.E.E. (managing director). This company was formed in 1898 with a nominal capital of £20,200, the whole of which has been paid up, for the purpose of securing and working concessions for electrical power distribution. The prospectus gives particulars of Acts, and of provisional orders under the Electric Lighting Acts, promoted or secured by the company, or by associated companies, in which the company holds or controls all the shares; also of electric tramways promoted so far by the British Electric Traction Company, Limited. They refer to Gateshead, Durham (City), Jarrow, Hertford, Barnet, Sutton, Carshalton, Wallington, Weston-super-Mare, Penarth, Lewes, Banbury, Sevenoaks, Sheerness, Staines, Egham, and Chertsey, and Wellingborough.

Wednesbury.—In discussing the electric question the *Midland Counties Express* says: "Whilst, as yet, nothing definite has been decided upon by the Town Council, it is pretty certain that no electrical scheme involving any great outlay will be embarked upon at present. But although no course of action has been resolved upon, there is, we understand, a strong feeling amongst the local municipal rulers in favour of leasing the tramway lines in the borough when they belong to the Corporation to some company, who will be expected to run electric cars, and pay every attention to the comfort and convenience of the travelling public. The electricity question, and how to provide an ample supply for the tradesmen and other inhabitants, and also for public lighting, will be the most difficult to grapple with, and in the absence of their own electrical undertaking, the Corporation contemplate, it is believed, purchasing their electricity in bulk from the company who take over the working of the trams, and be responsible themselves for its distribution throughout the town. Whether such an arrangement is possible or not remains to be seen." The Midland Electric Corporation for Power Distribution, Limited, have just given notice of their intention to open and break up certain streets in the borough, pursuant to the powers contained in their provisional order.

London County Council.—On Tuesday the following notices under Electric Lighting Acts and Orders were agreed to: The County of London and Brush Provincial Electric Lighting Company, under the County of London (Northern Extensions) Order, 1897, of intention to lay power mains along Baldwin's gardens; the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay low-tension mains (*a*) along a portion of London-street, and (*b*) along and across Trafalgar-road; the Westminster Electric Supply Corporation, under the Westminster Order, 1899, of intention to lay mains along both sides of Graham-street; the Vestry of St. Pancras, under the St. Pancras (Middlesex) Order, 1883, of intention to lay mains (*a*) along a portion of King's Cross-road and along Woodsome road, and (*b*) along George-street, Euston buildings, and Tonbridge-street. The following notices under orders granted to local authorities were reported: Whitechapel District Board, under the Whitechapel District Order, 1892, of intention to lay mains along Trinity-square, Little and Great Tower-hill, George street, High street, and Norton Folgate; and Vestry of Hampstead, under the Hampstead Order, 1893, of intention to lay mains along Fortune Green-road, Boundary-road, Adelaide-road, Mill-lane, and Westbere-road.

Salford.—The members of the Electric Light Committee and a few other gentlemen met at the new electric light works last week in Strawberry-road, Pendleton, in response to the invitation of Alderman Shaw, chairman of the Electric Lighting Committee, when the new electric works were formally taken over by the Corporation. The Chairman said when the building was finished there would be working 12 large steam dynamos, which would be equal to 12 000 h.p. The electricity produced by these dynamos would not all be used for lighting, but some of it for traction. The steam-boilers would require 36,000 gallons of water to be generated into steam. There would also be required 480,000 gallons of water for the working of the condensers for condensing the exhaust steam, and to assist the engines. This water they had

Digitized by Google

arranged to take from the Lancashire and Yorkshire Railway Canal. There would be five contracts for the buildings, amounting to about £55,000; 14 contracts for machinery and plant, amounting to about £136,000; and four contracts for cable, tramway equipment, etc., amounting to about £180,000—making a grand total of £371,000. At the Wallness-road station a plant had been working continuously for five years, and with very little expense. The demand for current had been so great that it gave the Electric Light Committee great concern. They thought it would be best for them to make provision for the coming winter and they, therefore, engaged Messrs. Mather and Platt to put a 200-h.p steam dynamo there, and it had started working, so that they thought they should get through the winter all right. There are to be 16 boilers in all, each weighing 32 tons, and tested to a pressure of 250lb., while the working pressure will be 160lb. It is considered that two chimneys, each 200ft. high, will be absolutely necessary, and arrangements are being made whereby one chimney can be shut off and the other used as occasion requires. Alderman Linsley (chairman of the Tramways Committee) said the Tramways Committee and the Electric Light Committee had about the same amount of money to spend, and it was their anxious care to put that money to the best possible use. Since February last eight or nine miles of single track of tramlines had been laid, and they hoped to be able to run the electric cars on April 29 next on some of the lines in Salford, and he thought they would be ready in Cross-lane and in Pendleton by that time.

PROVISIONAL PATENTS, 1900.

OCTOBER 29.

19294. The B.B. improved semi-dry storage battery or accumulator for storing electrical energy. Henry K. P. Barham and Edgar N. Bambury, 60, Fratton-road, Fratton, Portsmouth.

19334. Improvements in automatic switches. William Edward Wilson, Daramona House, Streete, co. Westmeath.

OCTOBER 30.

19371. Improvements in starting switches for electric motors. Edward Norris, 284, West-parade, Lincoln.

19338. Improvements in and connected with electric arc lamps. Frederick Richard Boardman, 10, Union-court, Old Broad-street, London.

19386. Improvements in automatic time switches. Charles Herbert Offord and Samuel Jevons, 77, Colmore-row, Birmingham.

19393. Improvements in apparatus for electrically treating air gases and gaseous mixtures. Reginald John Yarnold, 321, High Holborn, London.

19394. Improvements in lampholder switches for electric lighting. George Henry Chard, 5, Budge-row, London. (Complete specification.)

19395. An anti vibration base-frame for motors, dynamos, and other machinery. George Middleton, 8, Quality-court, Chancery-lane, London.

19416. Improvements relating to telephone call recorders. Harold Dudley Stroud, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19438. Improvements in electric arc lamps. Carl Schuster, 18, Buckingham-street, Strand, London. (Complete specification.)

19444. Improvements in arc lamps. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Continentale Jandus Electricitäts A.-G. Societe Anonyme, Belgium.)

19448. A new or improved method of controlling the action of electromotors. Charles Ashley Carus-Wilson, Norfolk House, Norfolk-street, Strand, London.

19449. A new or improved method of controlling the action of electromotors. Charles Ashley Carus-Wilson, Norfolk House, Norfolk-street, Strand, London.

19451. Improvements in and relating to electrical condensers George Frederick Mansbridge, 322, High Holborn, London.

OCTOBER 31.

19470. Improvements in electric switches. Crompton and Co., Limited, and Sydney Linton Brunton, Arc Works, Chelmsford.

19471. Improvements in electrical switches. Crompton and Co., Limited, and Henry William Wartnaby Dix, Arc Works, Chelmsford.

19482. Improvements in electric ignition for internal-combustion motors. William John Crossley and Cyril Joseph Atkinson, Openshaw, Manchester.

19486. Improvements in electric clocks. Frederick William Leake, Liverpool-street Station, London.

19494. Improvements in slot wedges for dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.) (Complete specification.)

19495. Improvements in systems of electrical distribution. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (William Le R. Emmet, United States.) (Complete specification.)

19496. Improvements in induction electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

19497. Improvements in automatic circuit breakers for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

19498. Improvements in circuit breakers for electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

19499. Improvements in systems for controlling electric motors and electrically-propelled railway trains. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

19500. Improvements in electric switches. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

19506. Improvements in electric arc lamps. Frederick James Green, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19509. Improvements in the manufacture and production of solid ends on wire ropes, electrical conductors, and the like. Thomas Joseph McTighe, 47, Lincoln's-inn-fields, London.

19511. Improvements in dynamo-electric and electro-dynamic machines. John Herbert St. Hill Mawdsley, Norfolk House, Norfolk-street, Strand, London.

19512. Improvements relating to electric circuit breakers or switches. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (McElroy-Grunow Electric Railway System, United States.) (Complete specification).

19516. An improved device for regulating engines for driving electrical dynamos and the like. Johann Rudolf Frikart, 6, Lord-street, Liverpool.

NOVEMBER 1.

19539. Improvements in trolley poles and standards. Arthur James Ireland and Charles William Godson Little, 10, Mortlake-road, Kew, Surrey.

19554. Improvements in and relating to combined telephone and sound telegraph apparatus. Carl Ernest Ljungman, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19570. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, or the like. Augustus Wyvill Hancock, John Leighton, and Robert Hacking, 111, Hatton-garden, London.

19576. Improvements in electric switches and in ships' telegraphs, railway signalling apparatus, and the like. Adrien Louis Augustin Charles d'Arlincourt, 53, Chancery-lane, London.

19588. Improvements in automatic electrical switches and circuit breakers. Joseph Booker and Piers Sumner, 70, Chancery-lane, London.

19594. Improvements in alternating-current transformers or economy coils. John Llewellyn Davies, 40, Chancery-lane, London.

19595. Improvements in or connected with arc lamps. John Llewellyn Davies, 40, Chancery-lane, London.

19612. Improvements in or relating to the renovating of electric incandescent lamps. Alfred Julius Boult, 111, Hatton-garden, London. (La Saymar Omnium Industriel d'Electricité Societe Anonyme, France.)

NOVEMBER 2.

19616. Improvements in electric railway car or vehicle trolleys. George Prescott, 15, Water-street, Liverpool.

19623. An improved gastight fuse and junction box for electric cables. Percy Joseph Emmerson Kennedy and Harold Cornelius Reading, Bretby, Burton-on-Trent.

19658. A new and improved process of insulation of electric wires or cables. Max Hankin, 15, Copthall-avenue, London.

19672. Improvements in wireless telegraphy and in apparatus therefor. Eugène Pilsoudsky, 6, Lord-street, Liverpool.

19674. Improvements relating to electric railways working on the surface-contact system. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Milton Brown, United States.) (Complete specification.)

19686. Improvements in accumulators. Georges de Roussy de Sales and François Gueugnon, 24, Southampton-buildings, Chancery lane, London. (Complete specification.)

NOVEMBER 3.

19736. Improvements in de-cohering apparatus for wireless telegraphy. Jonathan Zenneck and the Prof. Braun's Telegraphie Gesellschaft mit beschränkter Haftung, 55, Chancery-lane, London.

19737. Improvements in signalling by means of electric waves. Jonathan Zenneck and the Prof. Braun's Telegraphie Gesellschaft mit beschränkter Haftung, 55, Chancery-lane, London.

Digitized by Google

19754. Improvements in and relating to key sockets for incandescent electric lamps. Owen David Lucas, Thomas Herbert Marsh, and Albert Vandam, 322, High Holborn, London. (Complete specification.)

19759. Improvements in electric traction systems. William Aitken, Pine Glen, Muswell-avenue, Muswell-hill, London.

19765. Improvements in electric resistances. Walter Pitt, 24, Southampton-buildings, Chancery-lane, London.

19766. Improvements connected with overhead trolley poles used in electrical traction. William Ellison Rowlands, 10, St. George's-crescent, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Nov. 24.

1899.

21844. Portable telephonic apparatus. Holden.

22163. Continuous current electricity meters. Schattner.

24524. Electric accumulators. Leve and Monobloc Accumulator Syndicate, Limited.

24805. Appliances for reversing the current in continuous-current dynamos. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellshaft.)

25053 Connectors for electrical wires or cables. Sowerbutts.

25353. Liquid resistances for electrical circuits. Moy, Bastie, and Ernest F. Moy, Limited.

25628. Electric fishing apparatus. Lindbohm.

1900.

81. Electrically-operated clip to be employed in machines for tentering and stretching fabrics Whiteley and Whiteley, jun.

163. Automatic make and break for electric circuits. McFarlane and Reid.

216. Manufacture of active mass for accumulator batteries. Rodrian.

3158. Fluid pressure thermo-dynamic engines. Wainwright.

5764. Means for retaining the field-magnet coils of electric motors and dynamos in position. Lindstrom. (Date applied for under International Convention, Oct. 16, 1899.)

13048. Means for controlling the speed of electromotors. Elliott and Eskholme.

14458. Telegraphic relays. Wilson.

14582. Electric furnaces. Chavarria-Contardo.

15298. Wireless telegraphy. Wilson.

16129. Dynamo-electric machines. British Thomson-Houston Company, Limited. (Steinmetz.)

16130. High-potential electric switches. British Thomson-Houston Company, Limited. (Hewlett and Emmet.)

16147. Electrically-propelled motor road vehicles. Ryan.

16483. Portable electric batteries. Fuld.

17549. Electrically operating signal bells and apparatus for that purpose. Jerrard.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Nov. 3	619	500	+ 119	16,341	14,147
Birmingham Trams.	,, 3	4,561	4,339	+ 222*c*	192,815	183,325
Blackburn Corp'rat'n	,, 3	437	389	+ 48	19 833	17 579
Blackpool Corporatn.	,, 1	266	172	+ 94	26,528	19,569
Blackpool-Fleetwood	,, 3	205	189	+ 16	19,086	19,061
Bolton Corporation..	Oct. 28	1,254	—	—	42,293*a*	—
Bradford City Trams	Nov. 6	630	348	+ 282	16,268	12,455
Bristol Tramways Co.	,, 2	2,897	3,139	- 242	—	—
Carlisle Tr'mw'ys Co	,, 3	140	—	—	3 476*f*	—
Central London Ry.	,, 3	6,064	—	—	71,162*e*	—
City & South London	,, 4	1,936	1,045	+ 891	28,394	—
Cork E. T. and L. Co.	,, 1	384	353	+ 30	18,261*c*	16,766
Dover Tramways ...	,, 3	187	175	+ 12	9,244	8,818
Dublin & Lucan E.R	Oct. 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	Nov. 2	3,465	2,671	+ 794	—	—
Dublin S.D. Electric	,, 2	705	692	+ 13	—	—
Glasgow Corporation	,, 3	9,468	8,740	+ 728	—	—
Halifax Corporation	,, 5	737	601	+ 136	24,764	19,512
Hull Corporat'n E.S.	,, 3	1,385	645	+ 740	40,299*a*	11,659
Liverpool Corporat'n	Oct. 27*b*	8,521	7,028	+1,493	339 202	295,746
Liverpool Overhead	Nov. 4	1,561	1,873	- 312	30,455	29,677
St. Helens Tramwys.	Oct. 24	—	—	+ 217	—	—
Sheffield Corporation	Nov. 4	2,643	—	—	—	—
Southampton Trams	,, 1	659	382	+ 276	—	—
Southport Corporat'n	Oct. 27	374	—	—	2 399*a*	—
Swansea Tramways..	,, 5	447	263	+ 184	7,093	4,462

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *e* From July 30. *f* From June 30

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	9½-10½
—— 40,001-70,000	5	—	10 1/16-10 3/16
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5⅞-6⅛
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	⅞-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅞-1
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4⅞-5⅛
Brush Electrical Engineering, Ordinary	2	—	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	..	2-2⅛
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures.	100	—	110-114
—— Ordinary	5	—	12½-13⅛ xd
—— 5 per cent. Pref.	5	—	5-5⅛
Crompton and Co.	3	—	3⅛-4
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	1⅜-2⅛
—— 5 per cent. Debentures	5	—	3⅛-4⅛
—— 4 per cent. Deb. Stock, Red.	100	..	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	..	96-100
Electric Construction	2	—	2-2⅛
—— 7 per cent. Cumulative Pref.	2	—	2⅛-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12⅛-13⅛
—— 4½ per cent. Preference	5	—	5⅛-5⅝
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20-21
—— 4 per cent. Debentures	100	—	99-102
Telegraph Construction and Maintenance	15	—	36 40
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11⅛
—— 5 per cent. Cum. Pref.	5	..	5⅛-5⅜
Willans and Robinson, Ordinary, 1-30,000	5	..	10½-11⅛
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6⅛-7⅛
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-⅞
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6⅛-6⅝
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5⅛-6
Chelsea Electricity Supply	5	—	6-6½
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	8½-9½
—— 6 per cent. Cumulative Pref.	10	—	13-15½
—— 5 per cent. Debenture Stock	100	..	125-130
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	—	101-104
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	—	1⅞-2⅛
—— 6 per cent. Pref.	5	—	4⅝-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	112-115
—— 3½ per cent. Mortgage Debenture, Red	100	..	97-100
Notting Hill Electric Lighting	10	..	15-16
Oriental, 1879	1	..	1-1⅛
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	5⅞-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6⅛
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	180-200
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	98-101
Westminster, Ordinary	5	—	12-13
—— 80,001-109,437	5	—	11½-12½
Electric Railways.—			
Central London, Ordinary	10	..	10-10⅛
—— Pref. Half-Shares	5	..	5-5⅛
—— ,, ,, deferred	5	..	5 5⅛
City and South London, Consolidated Ordinary	100	—	54-58
—— Ordinary	10	—	5-6
—— 4 per cent. Debenture Stock	100	—	118 123 xd
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	..	130-135
Liverpool Overhead, 5 per cent. Pref.	—	..	13-13½
Waterloo and City, Ordinary	100	—	93 96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	14-16
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9⅝-10½
British Electric Traction, Ordinary	10	..	13-14
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	3⅞-4⅛
—— 5 per cent. Deb. Stock, Red.	100	—	105-108
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9⅝-10½
New General Traction, Ordinary	5	—	3½-3⅝
—— 6 per cent. Cum. Pref.	5	—	4⅜-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17½
—— 5 per cent. Cum. Pref.	10	—	10½-10⅝
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
—— 4½ per cent. Debenture Stock	100	—	104-107
Telephones.—			
National Telephone, Ordinary	5	—	4⅞-4⅝
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref	5	—	5-5⅛
—— 4 per cent. Deb. Stock, Red.	100	..	101-104
—— 3½ per cent. Deb. Stock, Red.	100	—	96 99
Oriental Telephone and Electric Company	1	—	¾-1⅛ xd

Digitized by Google

NOTES.

Personal.—We are informed that the council of the Tramways and Light Railways Association have appointed Mr. Norman Thompson, B.A. (Cantab), A.I.E.E., as secretary of the association, his offices being at Clun House, Surrey-street, W.C.

A New Appointment.—The Postmaster-General has, we learn, appointed Mr. Thomas Mason, the chief superintendent of the special telegraph arrangements branch, to be traffic manager for telegraph business in the United Kingdom. This is a new departmental post, and we hope that Mr. T. Mason will have every success in the first occupancy of it.

Institution of Electrical Engineers.—We are informed by the secretary that an extra meeting of the Institution will be held, by kind permission, in the rooms of the Institution of Mechanical Engineers, at 8 p.m., on Thursday, Nov. 29, when a paper will be read by Mr. W. E. Langdon, vice-president, on "The Supersession of the Steam by the Electric Locomotive."

The Harness Case.—There is an echo in the daily Press this week of a case which interested electrical engineers very much a few years ago. We refer to the bankruptcy examination of Mr. C. B. B. Harness, who was so prominently connected with the Harness electric belts. His present condition is stated to be—assets, nil; liabilities, £7,500. It was stated in the course of the examination that from 1890 to 1892 over £15,000 profit was made out of the electric belts.

Obituary Notice.—We sincerely regret to have to announce the death, on the 7th inst., of Herr Johannes Hausmann, who for close upon 25 years has acted in the capacity of chief engineer to the world-famed firm, Felten and Guilleaume, Carlswerk, Mulheim-am-Rhein, Herr Hausmann seems to have won the high esteem of his employers, not only on account of the distinguished abilities which he displayed in assisting to build up a magnificent business, but also in virtue of his splendid social qualities.

The Paris Medals.—The Parisians do not appear to have had a very great amount of success with their exhibition, and in awarding the medals and prizes things have, it would seem, become a trifle mixed. Large numbers of gold and silver medals were to have been awarded, but the expense appears to have frightened the French Government, who have now decided that only bronze medals can be given. It is very considerate, however, and kindly offers if gold and silver medallists care to take their bronze medals to the Mint and to pay for having facsimiles struck in the more precious metals, to do the minting work for them.

Acetylene Gas.—Dr. Frederick Rose, the British Consul at Stüttgart, reporting on the trade, etc., of Wurtemberg in 1899-1900, refers to the rise and progress of the acetylene gas industry. It is at present impossible to predict, he asserts, the ultimate result of the struggle between this new illuminant and its rivals. The probability is, he adds, that petroleum will suffer most, that coal-gas will be superseded to a great extent, especially with regard to the lighting of small towns. Electricity, however, will not, he thinks, be appreciably affected, and this opinion will probably be gratefully received by the holders of electric shares.

High Voltage Through Cables.—We understand that some successful experiments have been made at St. Paul, U.S.A., on underground cables using 30,200 volts. In this case a triple-core cable was employed, with paper insulation and lead sheathing. The cable in question was drawn into stoneware ducts about three miles in length. Up to the present satisfactory results have been obtained, and the cable is to be used in connection with a system of distribution of power. Besides the underground portion of the cable, 24 more miles of overhead wire will be required in order to reach the Apple River, where the power station is situated.

Incandescent Lamps for High Voltages.—While the 220-volt lamp is now the standard article in England, it has not found favour to such an extent abroad. In the States, for instance, they still talk about the unsatisfactory performance of the 16-c.p. 220-volt lamp, and of the worse troubles which arise from the use of smaller candle-power lamps at that voltage. Our success in this is due to the competition between the very numerous lampmakers in this country. Of course, the higher-voltage lamps are not yet quite so efficient as those made for 100 volts, but it is very much better than was the case two years ago. As a consequence, English engineers are able to obtain much more income from the same size network than their American contemporaries.

Elberfeld.—Good reports of the 1,000-kw. steam turbo-generator constructed by Messrs. Parsons and Co., Newcastle-on-Tyne, for the new electricity works in Elberfeld, Germany, are to hand. The set was run in position for the first time on the 9th ult., and on the 13th was paralleled with the 1,000-kw. triple-expansion steam alternator comprised in the other plant installed, subsequently taking over the whole of the Sunday night alternating-current load, which represented a maximum output of 550 kw. The paralleling of the turbo-generator running at 1,500 revolutions per minute with the triple-expansion set running at 93¾ revolutions per minute, which speeds correspond to the full periodicity of 50, was accomplished, we understand, without the slightest difficulty. We trust this success will influence further orders for British-made generating plant in the same direction.

Unauthorised Supply.—What seems to us to be a hard case was recently tried at the Barnsley Borough Court. An electrical engineer was charged with supplying his next-door neighbour without having obtained the permission of the Corporation to do so. The next-door neighbour had applied to the Corporation for a supply, and there was evidence brought of the fact that the electrical engineer connected his neighbour's wiring on to his own meter for his neighbour's convenience until the Corporation had completed their connections. That no fraud was intended is doubly assured, in that the electrical engineer would have the electricity registered on his own meter, the other proof being that he told an assistant engineer of the Corporation that he had made the connection. After hearing the case, the magistrates inflicted a fine of £1 and costs. While we quite believe in upholding by-laws and regulations, we think from the report that we have seen of the case that this prosecution was absolutely unwarranted, as in cases of emergency all rules may have to be broken.

The Liverpool Self-Propelled Traffic Association.—The opening meeting of the session of this local section of the Automobile Club of Great Britain and Ireland is to be held on Dec. 3 at the Royal Institution, Colquitt-street, Liverpool, when an address will be delivered by Mr. M. G. Forestier on "Heavy Motor Traffic in France." The lecture should be a very interesting one, as Mr. Forestier, in addition to his office as engineer-in-chief to the Department of Roads and Bridges under the French Government, is president of the technical commission which conducted the heavy motor trials at the recent

Digitized by Google

International Exhibition at Paris, and of the commission of organisation for various trials arranged by the Automobile Club of France. He was also president of the International Congress on Automobilism held in Paris last July. The cinematograph has been pressed into the service of the lecturer, and those who attend the meeting should receive a good impression as to the extent to which traffic with heavy motor vehicles has advanced in France. A luncheon is also to be given to the club by the Lord Mayor of Liverpool (Councillor Crosthwaite) at the town hall, on the day following the opening meeting—viz, Dec. 4.

The Capital Value of Waterfalls.—The continent of North America is wonderfully favoured in respect to the water power which it has available in connection with what is the largest system of fresh-water lakes and rivers in the world. As our contemporary, the *Electrical Review* of New York, justly points out in an editorial article, the value of large waterways has been realised from the first settlement in the country, and the connections between the great chain of inland seas and the ocean has been greatly improved. A new phase of the value of this large water system is now beginning to be developed, and our contemporary points out that no less than 400,000 h.p. of plant is being laid down at the present time or is in actual work. Still, this horse-power represents but a very small percentage of what could be obtained, but the capital cost of the same is by no means insignificant. Our contemporary estimates the income from the above-mentioned horse-power at £1,600,000 per annum. The capital value of an income of this kind is, of course, very much larger, but our contemporary is quite wrong in putting it so high as 500 millions sterling, as at this figure the income is not 1 per cent. However, even with another cipher struck off the capital sum, one cannot but realise what a large value the waterfalls are to the country in which they are situated.

Institution of Electrical Engineers.—We have received from Mr. E. W. Cowan a copy of the programme of the Manchester section of the Institution of Electrical Engineers. In this section of the Institution the meetings are held fortnightly, on Tuesday evenings at 7.30 p m. The first meeting took place last Wednesday, Nov. 13, Dr. E Hopkinson being in the chair, when Prof. A. Schuster, F.R.S., read a paper on "Some Phenomena of Electric Sparks." Other papers to be read are on "Relative Advantages of Direct-Current and Three-Phase Distribution for Small Installations," by Mr. Hardman A. Earle; "The Proposed Manchester and Liverpool Express Railway," by Mr. F. B. Behr; "Direct-Current Generators," by Mr. L. H. Short; "The Training of Electrical Engineers," by Dr. John T. Nicolson; "The Use of Storage Batteries in Connection with Electric Tramways," by Mr. G. A. Grindle; and "The Adaptation of the Steam-Engine to the Generation of Electricity," by Mr. J. S. Raworth. There are yet two or three dates for which papers have not yet apparently been sent in, but it is probable that once the section gets properly to work there will be no lack of offers for papers to supply these vacant dates. The hon. secretary of this section of the Institution is Mr. E. W. Cowan, Springfield-lane, Salford, Manchester.

The American Street Railway Convention.—The November number of the *Street Railway Journal* contains a very long notice of the American Street Railway Convention, recently held at Kansas City. The list of exhibits, which is given by our contemporary, is very full, and one notices a good many exhibits which are of general interest. For instance, the Wheel Truing Brake-Shoe Company, of Detroit, Michigan, exhibited a special form of brake-shoe, which consisted of an iron frame in the form of a brake-shoe, but which was filled with an abrasive material, probably emery, which is intended to be put on in place of the ordinary iron brake in cases where a flat wheel occurs. The special shoe is kept in service until the flat place has been worn off. An extensive use is claimed for the shoe in the United States, it being stated that the factory is now working night and day in order to fill orders. Another device was that shown by the Garton-Daniells Company, of Keokuk, and called the "automotoneer." This arrangement is intended to be applied to the controllers on street cars in order to prevent the motorman from starting off too suddenly or from throwing the handle too far on an emergency stop, which usually has destructive effects. The device in question enforces a pause on each notch of a controller, and can be adjusted to allow the car to be started in seven, ten, or twelve seconds.

The Mansion House Subways.—We have received from Mr. David Ross, the engineer to the Corporation of London, a copy of a report prepared by him as to the number of persons using the subways beneath the open space in front of the Mansion House. The first observation, taken on March 12 last, when the subways were partially completed, showed that the number of persons entering the subway was 25,637, of which some 6,400 booked from the Bank to Waterloo by the Waterloo and City Railway, leaving a total of 19,237 persons who used the subways without the railway. On April 25 the number, exclusive of railway passengers, was 15,276. The whole of the subways were opened on July 30, when the Central London Railway was opened to the public, and on Aug. 15 the returns showed a total number of persons using the subways, exclusive of railway passengers, of 19,600. On Oct. 3 the observations taken showed a decrease on this figure, the number being only 16,011. The observations were made over a period of 20 hours, from 5 a.m. to 1 a.m. The engineer therefore thinks that the number of persons making use of the subways with the object of avoiding danger and difficulty in crossing the open space in front of the Mansion House is but small compared with the enormous number of pedestrians passing over the surface at this spot. It is difficult to ascertain the exact number of these, but it is estimated from recent observations to be between 180,000 and 200,000 in the 20 hours from 5 a.m. to 1 a.m.

The Faradian Club.—The first smoking concert in connection with the Faradian Club was held at St. James's Restaurant last Friday evening, when Mr. Robt. Hammond filled the office of chairman. Before giving the word to proceed with the concert, Mr. Hammond said it gave him great pleasure to preside at this first smoker of the club, although it was not the first thing which the club had done, as they had previously had a club dinner. He was pleased to preside because the club was connected with an institution with the founding of which he had to do. He was glad to see in the room some of the old members of the Hammond College, out of which had sprung the Electrical Standardising Institution. It delighted him to think that if the old Hammond College was a bit too soon in the electrical world, it had been worthily succeeded by the Electrical Standardising Institution, and he was glad to know that there was such a bond between the members of the institution as had brought them there that evening. Although Prof. Perry had told them the previous evening that they should be purely mathematical and theoretical to the core, there were certain events, of which this was one, which did not come under these heads. He then mentioned that it was the Prince of Wales's birthday, and asked Mr. G. W. Lloyds, the pianist, to open the

Digitized by Google

concert with something appropriate to that day. The concert then commenced with a pianoforte solo, "God Bless the Prince of Wales.' The songs on the whole were humorous, Messrs. Will Edwards, H. W. Berry, R. Ganthony, and H. Harvey shining particularly. Mr. W. Murray Bemister sang some very striking songs, particularly an Hungarian folk song, in which a shepherd intimated his intention of hurting a prospective bridegroom with a bludgeon. Banjo duets and coon songs were well rendered by Messrs. Montagu and Robson, Mr. Montagu also giving a solo on the mandoline.

The Electrolytic Production of Soda and Chlorine.—Mr. Jas. F. Hobart has been contributing a useful series of articles on the above subject to the *American Electrician*. In the earlier issues he has dealt generally with the apparatus, giving most useful information, but in the last article, which appears in the November number, he deals with the general arrangement of a number of cells such as are used in commercial work. The arrangements he describes were got out for the Mercer cells when the experimental plant for the same was being laid down as a guide for larger practice. In this case the earthenware porous pots were about 18in. in diameter, the total height of the cells being about 3ft. These pots form the diaphragm of a double-fluid cell for the production of chlorine and caustic soda. Round the outside of the porous pots a layer of asbestos paper were wrapped, on to which a perforated iron strip about 12in. wide was secured by iron clamping bands. This formed the negative element. The porous pot with its iron sheath was then placed in an iron tank which was built to contain five cells. The positive plate was of carbon. Illustrations are given of the cells to show how the chlorine was collected. One of the most interesting features about the arrangement is that by which the liquid was kept circulated and the cells kept full by placing 20 of them in a line, each one a fraction of an inch below the one preceding. An outlet for the liquid was then provided through what is known as a drip pipe. It was necessary that the water should drip, as otherwise a stream would provide a path for current between one cell and the next. Both the solutions were circulated in this way. For instance, in the alkali side pure water was poured into the first tank, it coming out practically strong caustic alkali at the other end of the series. The author also gives some interesting details as to the reservoir for chlorine gas, which was led out from the cell into an earthenware pipe and thence to the reservoir, where it was mixed with water. The following figures were obtained with this plant in January last on a 23 hours' trial: the average ampere-hours were 138, the available chlorine liberated being 563lb., and the available caustic soda liberated 630lb.

Shipbuilding.—We have received a proof of the presidential address by Mr. H. Withy to the North-East Coast Institution of Engineers and Shipbuilders. The remarks naturally refer almost entirely to shipbuilding and its allied trades. To show the advance made in shipbuilding the president instanced the cases of the "Phœnix" paddle steamer, which in 1819 went across the Atlantic in 29 days 11 hours, and the "Deutschland," which recently crossed in 5 days 11 hours. The use of pneumatic tools for riveting, drilling, caulking, etc., is then mentioned, there being, it was stated, a great field open for the substitution of machine riveting in the place of hand labour, which was more difficult as the size of the vessels increased. The number of vessels of a large size built in Britain for foreigners was commented on, the Continental supply not appearing to be nearly equal to the demand. As to the use of electricity, he thought a plant of multitubular boilers, with triple-expansion engines coupled direct or connected by belts to dynamos, left very little to be desired, either in economy or upkeep. At Middleton Shipyard they had for over five years employed a plant of this description, and during 1896-7 the cost of power production, attendance, and repairs was 6·4d. per pound of wages paid; or, to take another figure, the cost of power production worked out at ·9d. per Board of Trade unit. Since introducing electric driving the wages bill had been doubled, and also the number of machines, but the cost of superintendence had not relatively increased, and it was considered that electric driving was a large factor in the increased output. Middleton Yard was the first in the world to be wholly worked by electricity. Great strides were being made in America with large electric cranes for dealing with coal, ores, etc., and before long an electric crane would be at work in a shipyard on the Tyne with a fore and aft travel of 950ft., and an outreach from the centre on each side of about 100ft., and a lift of 80ft. Great improvements had been made in the manufacture of tools during the last few years, and although there were a large number of American tools of a high efficiency in this country, he believed it possible to get machines of equal or better design and quality made in England. He thought our manufacturers would do well to specialise as the Americans had done.

Polyphase Motors. — In *Cassier's Magazine* for November there is an interesting article on "Polyphase Motors for Driving Tramcars," from which we take the following abstract. The author points out that one of the characteristics favourable to the use of polyphase tramway motors is their action in holding back, by returning energy to the feeders, when they are driven above speed by a car running down hill. This action is entirely different from any that may be simply gained in series-wound continuous-current motors, but is analogous to the performance which would be shown by shunt-wound motors under similar conditions if they could be satisfactorily adapted to the requirements of electric traction. The action is very simple, and is a safeguard which cannot be over-estimated for cars operated over heavy grades. Suppose, for instance, that a car approaches a dip in grade with the motors working. Upon entering the grade it is natural for the speed of the car to increase, which, with continuous-current series-wound motors, will continue until the speed quickly becomes dangerous unless the motors are cut off and the brakes applied. A failure in brakes under these conditions has often resulted in frightful accidents. With induction motors, however, as the car increases in speed the forward rotary effort of the motors decreases, and gradually and smoothly changes into a retarding effort, while the power given up by the car as it runs down hill is automatically returned by the motors to the line. Thus the power of the descending car is automatically placed where it may be usefully applied in operating other cars, instead of being lost in wasteful and injurious friction between brake shoes and wheels. All this is done by inherent action in the motors themselves, and is entirely independent of the motorman. Stops may be made on a grade in the usual manner by cutting off the motors and applying the brakes, and starting is accomplished by the ordinary process, after which the motors may again be left to care for themselves. It is also interesting to note that polyphase alternating-current railway plant, properly installed, removes much of the difficulty from electrolysis of water-pipes and other underground metallic structures, notwithstanding the use of the rails for one branch of the circuit; but, on the other hand, in the line construction are involved all the difficulties of the double trolley.

Digitized by Google

The Automobile Club.—In the trials which took place last week in connection with the Automobile Club, in the trial over 30 miles of hilly road the Electrical Vehicles Company's "Powerful" completed 28 out of the 30 miles and then withdrew owing to accident caused by shying horse. The National Motor Syndicate's "Joel" car covered 26½ miles, but was delayed by chain coming off; the Electrical Motive Power Company's car, the Canadian Electric Motor Company's car, and the Electrical Undertakings' car each completed 22 miles, the Canadian car having four passengers and the other cars two passengers, including driver. The "Columbia Stanhope," the Delivery car, and "Tourjours Contente" were withdrawn from trials on Wednesday. The concluding run on Friday last took place over a fairly level course, the object being to show how far the vehicles could go on one charge. Unfortunately, owing to the heavy rain on Thursday night, the roads were deep in thick and greasy mud, this considerably retarding the progress of the machines. The British and Foreign Electrical Vehicle Company's "Powerful" carriage, however, completed 65 miles. The Canadian Electric Motor Company's car had to abandon the run at the end of 23 miles owing to an accident to a ball bearing, the Electric Motive Power Company's car being also withdrawn at the end of 15 miles. The "Joel" car was withdrawn at the end of three miles owing to punctures, but the Electrical Undertakings' carriage completed 38½ miles. In view of the fourth anniversary of the Locomotives on Highways Act of 1896, the Automobile Club held their annual run on Nov. 10 to 12, the destination being Southsea. The number of vehicles entered for the run was 149, some 110 cars actually starting on Saturday morning. The programme issued by the club for the run bound down all drivers not to run at a greater speed than 12 miles per hour on clear country roads and eight miles per hour in towns and villages. Diplomas for completing the journey from London to Godalming, and from Godalming to Portsdown, without a stop, and at a speed not greater than 12 miles an hour, were offered. At Portsmouth the Mayor reviewed the cars, a dinner being given in the evening, at which some 200 owners and drivers of motorcars were present, the Hon. J. Scott Montagu, M.P., being in the chair. A silver cup, value £5, was offered for the cleanest vehicle on its arrival at Southsea Common, and was won by Mr. H. Edmunds, to whom it was presented by the Mayor of Portsmouth.

A Self-Driving Weight Motor. — It will be remembered that some months ago we published a description of what Mr. A. E. Gilbert considered to be a perpetual motion machine, or, even more than that, a machine by which power could be obtained from gravity. Mr. Gilbert now forwards us the following note, which we insert in order that we may at the same time point out to our readers the absurdity of the claims made by the inventor. There is in this country no objection to any man patenting the most absurd device he can think of. In the same way there is nothing to prevent him offering this device to her Majesty's Government through Lord Salisbury, but we do think there are grave objections to Mr. Gilbert or any other inventor asking for financial assistance in connection with a scheme which is based on the assumption that the well-known laws of the conservation of energy have been successfully broken. We are sorry that Mr. Gilbert has, after our repeated warnings, wasted his own money on a patent for a form of gravity motor. This money would have been much more profitably spent in class fees for a theoretical mechanics' course at one of the many technical schools with which Newcastle-on-Tyne is blessed. We sincerely hope that he will not get anyone else's money to waste in such absurd schemes. The following is the note as received by us under the above heading: "Mr. Arthur E. Gilbert, A.I.E.E, tells us that he has patented another machine to work on an entirely different principle from those already illustrated in this journal, and that it is one of the grandest and most valuable inventions fathomed during the Queen's reign, on account of his discovering a method whereby the driving power will be quite as great on the ascending side as on the descending side of the wheel. Mr. Gilbert also states that he has made an offer to H.M. Government, through Lord Salisbury, to drive and illuminate all the machinery in Woolwich Arsenal by electricity from one year's end to another without using an ounce of fuel. We are debarred from giving further particulars just yet, as the patents are incomplete in other countries. We, however, wish Mr. Gilbert all success, and that he will soon find the financial assistance he is in search of to complete a model of his wonderful machine. Readers interested in this invention would do well to communicate with Mr. Gilbert direct at 23, King John-terrace, Heaton, Newcastle-on-Tyne." We regret that we cannot endorse the good wishes Mr. Gilbert expresses towards himself in our name.

Increasing Power Factor.—We notice in the *American Electrician* a most interesting description of a three-phase plant used by the Pelzer Manufacturing Company, of Pelzer, Columbia, for their various cotton mills, in which some 120,000 spindles are at work. The water power to drive the electric motors in these four mills is obtained from a point 2½ miles away, where a dam has been built across the Saluda River, giving a fall of 39ft. At present three turbines have been erected, each of 1,200 h.p., which drive directly three 750-kw. alternators, the voltage being 3,600 volts. The equipment of plant in the various mills is largely determined by the fact that certain of them had already a good steam plant available before the water-power station was built. In consequence of this, in mill No. 3 a large synchronous motor only is installed, which will either drive the whole of the load of the mills or will assist the engine when required. Mill No. 4 is entirely driven by motors, which are employed to drive long lengths of shafting for the looms. The motors, which are of the induction type, are of fairly large size. One of the most interesting points in the installation is the use of an over-excited motor of 400 kw. capacity to increase the power factor of the plant. This so-called condenser motor is connected in parallel to the secondary 220-volt mains, so that by its use the watt less currents in transformer line and generators are greatly reduced, thus giving a lower temperature in the transformers and the generator, and less inductive drop in the line. The reduction in inductive drop allowed the generator E.M.F. to be reduced 90 volts with the same impressed E.M.F. at the motor terminals as formerly. The reduction of the current output varied from 8 to 11 per cent. This condenser motor is self-starting from rest, and after once being started and adjusted needs no attention. Repeated tests have shown that this condenser has no effect on the turbine gate opening—that is, the amount of power it saves by the reduction of heat losses in the transformer line and generators, and in the diminished exciting power required for the generator, practically balances the power required for the operation of the condenser motor itself. The exciter of the condenser motor is on the same shaft, so that the machine is a very simple one and works very satisfactorily. Its capacity as a condenser can be quickly varied to suit the character of the load. When the synchronous motor at mill No. 3 is running alone there is absolutely no need for the condenser motor. The power

Digitized by Google

factor of this plant with the full load on without the condenser motor is 86 per cent., and with the condenser it is 94 per cent. Readings are given to show the effect of the condenser motor, the generator E.M.F. without the condenser being 3,780 and the current output 435. With the condenser the E.M.F. was 3,690, and the current output 402. The E.M.F. at the motor terminals was in this test kept constant.

Black Electricians.—From an article in the *Electrical World* we gather that an effort is being made at the Normal and Industrial Institute at Tuskegee, Alabama, to educate the negro and to fit him for occupations rather higher than the ordinary labourer. For this purpose no less than 26 trades are taught in the institute, amongst them being electrical engineering, the course in which is at present being taken by about a dozen students. During recent years some very interesting work has been done by these students under the direction of Prof. Arthur U. Craig, who is himself a man of colour. The electrical department of the institute was started by Prof. Craig in 1895, up to which time only oil lighting had been used in the buildings and extensive grounds. Prof. Craig, however, set to work and designed the building for the central station, and the electrical machinery was given by several of the large manufacturing companies. The plant first installed consisted of one 50-kw. 60-cycle machine of the G.E. type, connected with an exciter, and driven by a Westinghouse engine. The switchboard was of the G.E. type, equipped with a full complement of instruments, also of the G.E. make. This plant was amply sufficient for the first few years, but the growth of the institute has now necessitated the planning of a larger central station. This is now under way, the work throughout—designing and building—being the work of the students of the institute. For the whole of this electrical department no outside help has been used—the installation of the plant, the construction of a pole line in the grounds, the wiring of buildings, etc., being all done by the students. A church which was built by the students some two years ago, having a seating capacity for nearly 3,000 persons, has been fitted with a fine system of steam heating and an artistic installation of electric lighting. In view of the growing demand for current, and the new generating station being well under way, the students in the electrical department are now at work building a large dynamo with capacity sufficient to light the entire institute and grounds. This machine is to be of the multipolar type, and the castings for it have been made in their own foundry from models made in the pattern shop. It is, our contemporary thinks, within the range of probability that as the small city of Tuskegee, within half a mile of the Industrial Institute, is not yet lighted by electricity, some day in the near future the institute may undertake to build a central station, or else supply the city with current as a business enterprise. Also, since the teaming between the railroad station and the institute is something enormous, and calls for the regular use of a long string of mule teams, an electric railway from the steam railroad track direct to the institute, if not indeed the electrical equipment of the dummy railroad, five miles long, which connects Tuskegee with the main line of the Western Railway of Alabama, may some time in the near future be determined upon.

Technical Education.—We have received a copy of the inaugural address given by Sir Alexander Binnie on the occasion of the opening of the session 1900-1901 at the Central Technical College of the City and Guilds of London Institute. He stated that if his remarks seemed to apply more particularly to engineering education, they should understand that they pointed equally to all departments of scientific work and training. He could not but contrast the advantages which they possessed with the scanty means available for scientific education in his earlier years. This was not, however, altogether a disadvantage, as it taught a young man to rely to a great extent on his own endeavours, although there was also much waste of energy. He wished to impress upon them that he had learnt from past experience that without a natural taste for scientific pursuits, without perseverance and determination ultimately to succeed, no college or school training could lead to success. Many young men in his own profession had wasted many valuable years of their early lives in study by entering it without any natural taste for it, or determination to succeed, and have, at the time when they should have been useful though junior members of a great profession, begun to have second thoughts of other spheres of action, and gradually drifted away after having spent several years endeavouring to fit themselves for a calling to which they were indifferent. The classes were divided into various departments for studying certain branches of science, but he wished to urge upon them the advantage of not confining themselves to any hard-and-fast curriculum, but while paying special attention to the branch in which they were interested, to study other branches of knowledge, although this might entail very hard reading and hard work. It was not a question of the number of marks in the institution, but of their success in life, and in life one could never tell when entering upon active work into what avenues or by-paths of practice circumstances might lead. Many men starting in life with fixed ideas of what they were going to do might in course of time find themselves gradually diverted by opportunities opening out before them into quite different branches of practice. To illustrate this, he mentioned his own case. He stated that though originally educated as a railway engineer, circumstances compelled him to take up the study of hydraulic engineering. Again, he had a call of the Indian Government to embark on an enquiry as to the discovery of coal in India, this requiring considerable local geological knowledge. He then went back to hydraulic work and waterworks construction, and later had to do with drainage schemes for large towns, which had made him study biological chemistry. Recently he had been brought much into contact with the use of electricity for various public purposes, the department of engineering knowledge not existing at the time he was a student. He urged upon them the recommendation to study the history of their profession and of the various discoveries which had been made in the past in their different branches of science. With regard to reading, he advised them to read widely and fully on all subjects, however remotely connected with their scientific studies, making copious notes for future reference. He emphasised the need of honesty and straightforwardness in the performance of all duties brought before them, and without fear or favour of any kind whatever. Punctuality and regularity in carrying out their work was spoken of, and also the need for reasonable exercise and recreation. All work should be done with a clear idea of the end to which the work is to be applied, and not merely in order to earn scholarships, degrees, or other honours. It was a frame of mind which he was sorry to see existed in our universities among students who, when questioned as to their future career, reply that they have not made up their mind, and are waiting until after taking their degree. This habit he called drifting, and strongly deprecated, for without a clear perception of what a man was going to be, and how he was going to attain that end, it was almost impossible for him to educate himself properly in the right direction.

Digitized by Google

THE SCHUCKERT CONTACT SYSTEM OF ELECTRIC TRACTION.

We have received from the British Schuckert Company a well-illustrated description of a number of the most important systems of working electric traction by street contacts which have been tried in the various parts of the world. The volume is rendered more complete by a description of that special stud system of electric traction which has been introduced and perfected by the Schuckert Company of Nuremburg. It was in 1896 that the firm first laid down a contact system for the electric tramways in Munich, and we do not think we shall offend anyone if we say that this system was not a great success. It, however, enabled the firm to obtain a great deal of experience of the trouble and faults of a service on contact systems, and this experience has resulted in the perfection of the system we are now about to describe. In the middle of last year this new system was introduced into Munich, and since then has given, we are informed, complete satisfaction, as, in spite of adverse conditions, it has worked without breakdown.

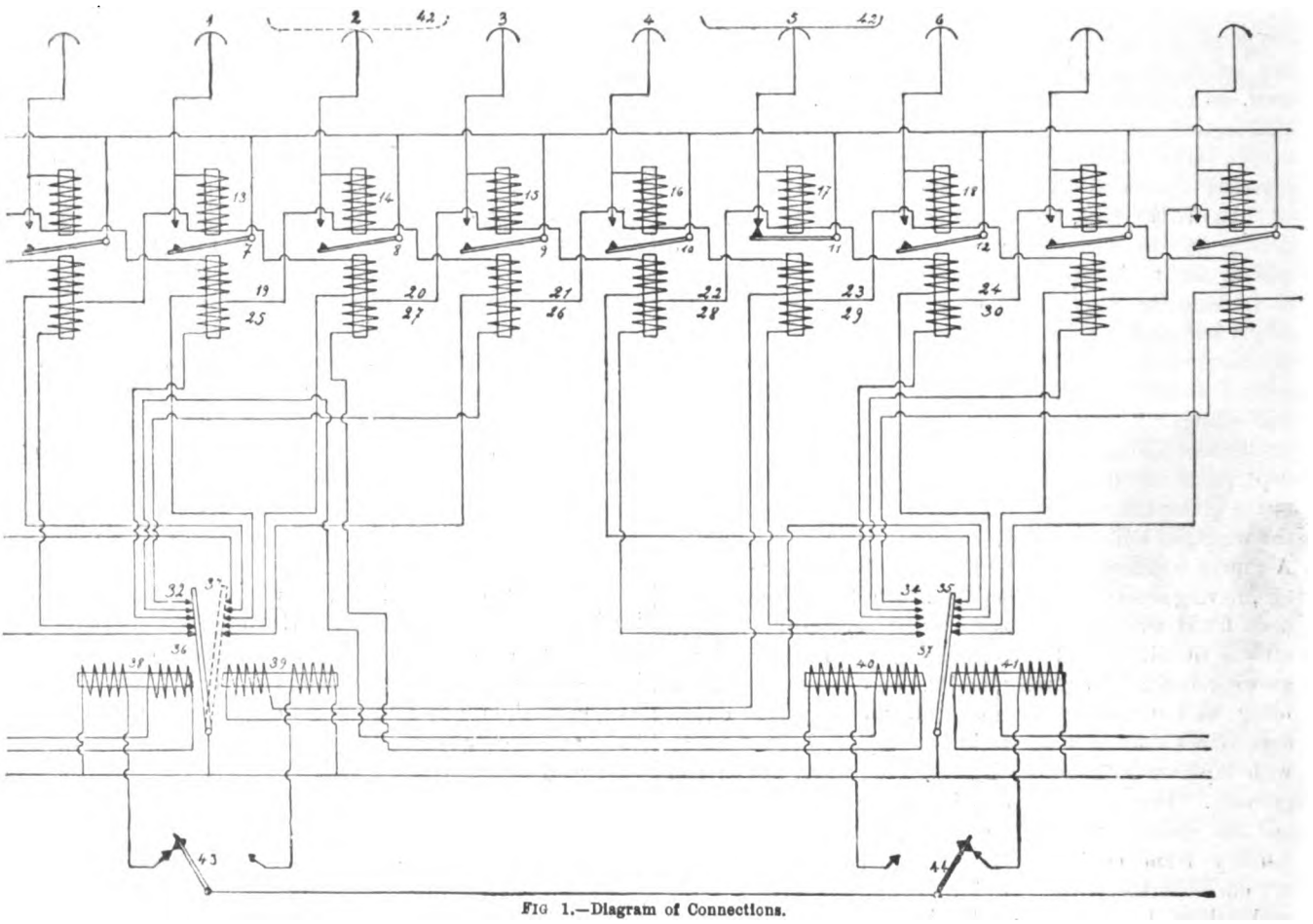


FIG 1.—Diagram of Connections.

The general principle of the system consists in placing the automatic switch gear in groups along the line of route, so that they are easily accessible for inspection. Fig. 1 shows the diagram of connections employed, from which it will be seen that the gear for each stud consists of a contact lever, numbered 7 to 12, which connect the sectional conductor with the main feeder. In connection with each of these levers there are two electromagnets, one of which is used to lift the lever and make connection, whilst the other serves to draw off the lever and break the local circuit. It will be seen that each of the draw-off magnets has two windings on it in order that it may be operated from the adjacent stud in either direction. This is required in order that the cars may run in both directions over the same lines. The coils of the draw-off magnet are connected in groups to contact pieces, which are numbered 32, 33, or 34, 35, which are arranged symmetrically to each other. These are actuated by levers, as shown, by means of other electromagnets, which serve to control the direction in which the car travels. The working of the above system of connections may be briefly described as follows.

Assuming that the current collector, 42, of the car is situated on the contact stud 5, and that the car is required to travel in the direction indicated by the arrow, then the course of the current is as follows: In starting, the current from a small accumulator carried on the car is made use of in the customary way, and passes through the skate, 42, the contact block 5, the magnet coil 17, magnet coil 12, to the corresponding contact of the group 35 through the multiple-switch lever, 37, and thence to the return circuit or to earth. The magnet coil 17 attracts the contact lever 11, and thereby connects the feeder main with the contact stud 5, enabling the car to proceed in the direction indicated by the arrow. The further working of the relays takes place in such a manner that the advance relay in the direction travelled is excited, and closes the circuit immediately its respective contact block is touched by the skate, while the draw-off coil of the surface contact just passed by the collector, but still beneath the car, and which is energised by a shunt current of the advance apparatus, attracts the contact lever and switches the respective section. It should be noted that the multiple-switch levers, 36 and 37, with the travelling direction here assumed, are laid over to the right, touching a series of contacts, 33 and 35 respectively. These levers are reversed automatically and quite independently of the direction travelled as soon as the skate has touched the last of the contact studs belonging to the respective group and connected with the end relay of such group. Assuming that the car is situated with its skate on contact stud 5, and moves to the left in the direction indicated by the arrow, then upon the skate touching stud 4 closing the circuit, the multiple-switch lever, 36, will be reversed, but the current continues to flow through the switch lever, 37, of the rear group, and only commences to flow also through the switch lever 36 when the skate reaches stud 2.

When the car is running in one direction on a double line the reversal of the direction switches is done auto-

Digitized by Google

matically, but if it should be desirable at any time to move cars back in the opposite direction, this can be done by working these switches by hand from boxes placed along the route. In Fig. 2 we give a complete diagram of connections for one car and line, which can be easily understood by following the circuits through. Coming now to the details of the system, Fig. 3 shows a car on the line actually equipped in Goethe-strasse, in Munich, which line

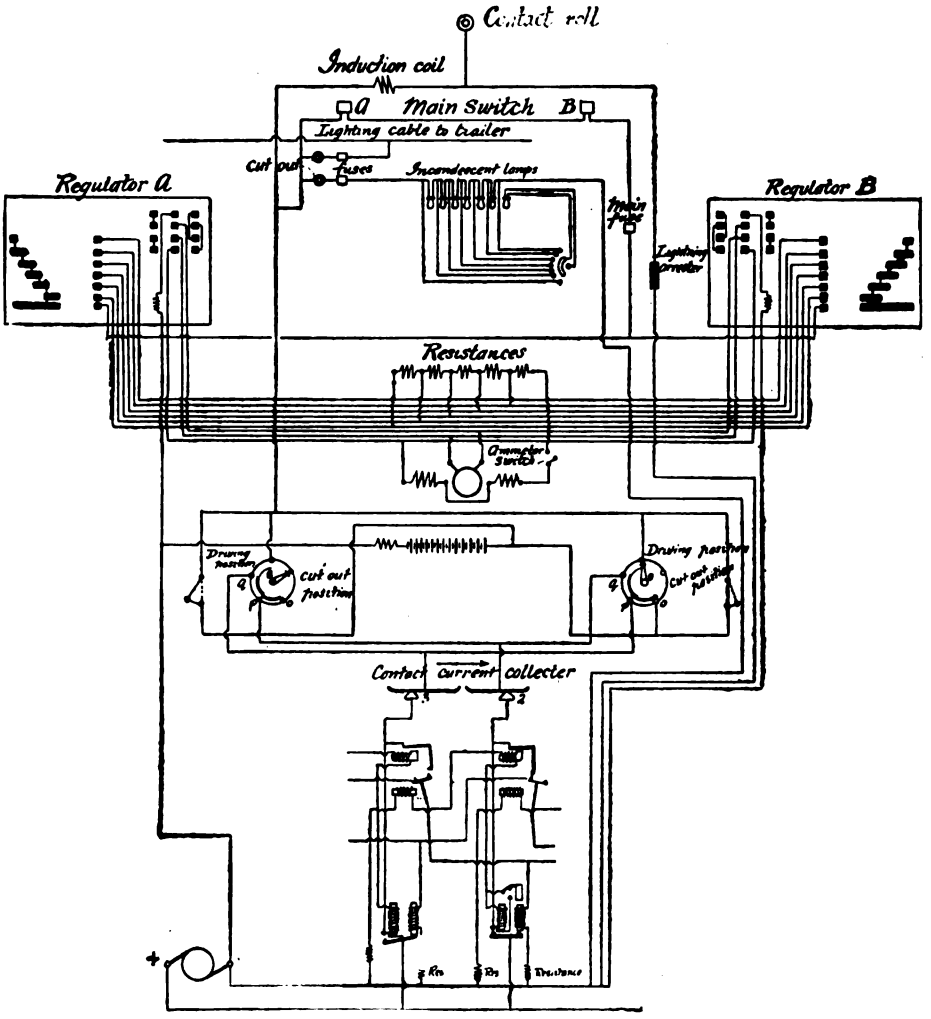


FIG. 2.

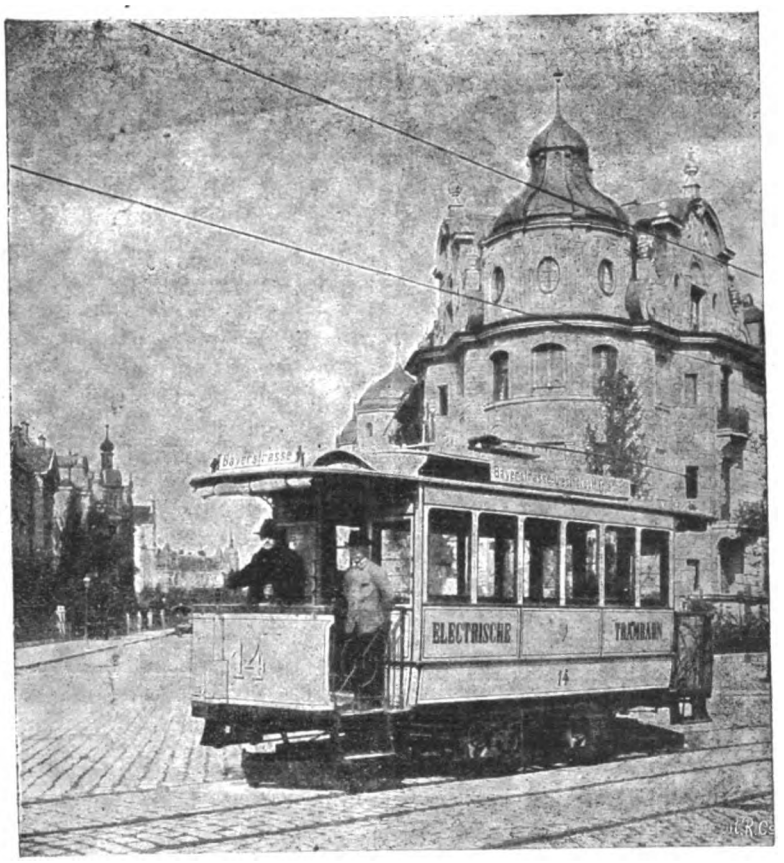


FIG. 3.—View of a Car Running on the Contact System.

Digitized by Google

has been working since the summer of last year. One of the section switches and maximum cut-outs used on this line can be seen in Fig. 4. It will be noticed that the box does not occupy much space, and that it is

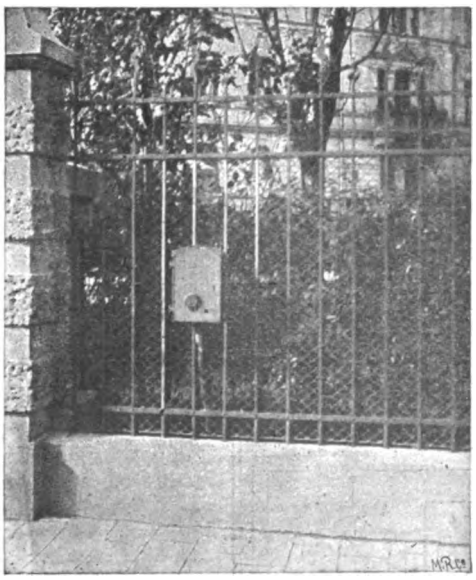


FIG. .—Automatic Cut-Out in Goethestrasse, Munich.

very conveniently placed for access. In Fig. 5 is shown the method of mounting the contact block of the sleeper, which also supports the running rails. This contact consists of a hardened cast-steel stud let into a granite block of practically the same size as an ordinary paving stone. The height of the contact above the rest of the pavement varies

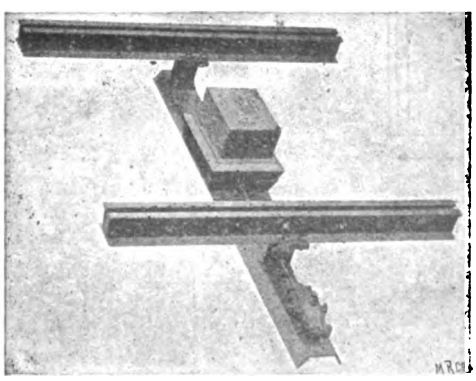


FIG. 5.—Contact Block on Sleeper.

from ¾in. to 1⅛in. The space between the contact and the rails is, with a normal gauge, about 2ft. 3½in. The leakage from the stud to the rail only takes place when the car is over the stud, and even then is not a serious matter—in fact, the company state that the total leakage over the line is not so great as that with the overhead system of supporting a trolley wire. The average distance between the

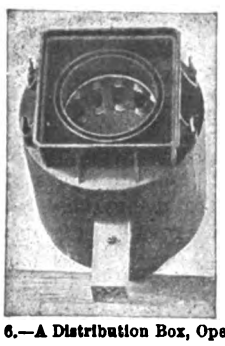


FIG. 6.—A Distribution Box, Open.

blocks is about 13ft. on a straight line, and, of course, considerably less on the curves. At points where the tracks cross it is usual to insert insulated dummy contact blocks to keep the collectors in passing from becoming short-circuited on to the rails. As a rule, about 30 switch gears in connection with the studs are kept in the one distributing street box. These boxes are, as a rule, placed in the middle of the tracks, but they can be placed under the footpath if required. Access is obtained to them by manholes, so that the gear can be readily inspected. A small view of one of these street boxes with its lid off, and before being placed in the ground, is shown in Fig. 6. The arrangement of the lid is such that an airtight seal is obtained, while at the same time moisture does not get through the seal into

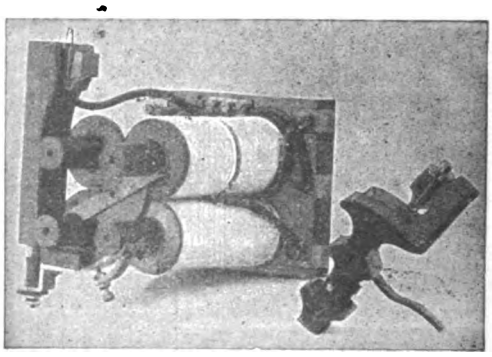


FIG. 7.—View of the Parts of the Contact Apparatus.

the box. These switch gears, or relays, are secured to a wood lining, which is supported clear of the iron sides of the box, so that there is air all round. These boxes are completely equipped before leaving the works, so that all that remains to be done is to insert the wires from each stud.

The individual switch gear for each stud is illustrated in Figs. 7 and 8, from which it will be seen that they

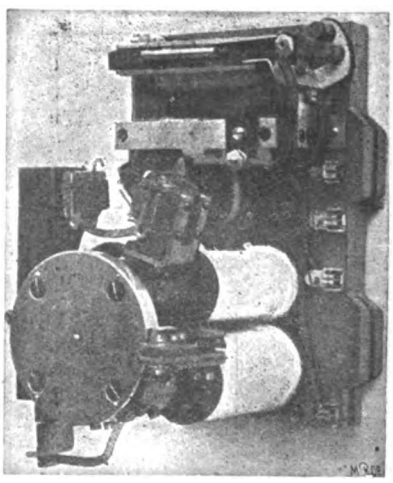


FIG. 8.—Contact Apparatus with Safety Device.

consist of two pairs of magnets arranged with the axes joining their poles at right angles to each other. The one pair then serves to complete the circuit, while the other opens it. The coils are shunt wound, taking about half an

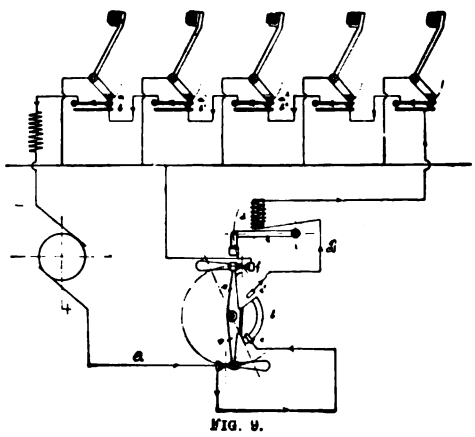


FIG. 9.

ampere at 500 volts. The actual contacts are made and broken through carbon, and it is found that this gives every satisfaction. A switch which had been opened and closed 54,000 times showed practically no deterioration at

Digitized by Google

the point of contact. The chief point at which arcing takes place, if any, is between the brush and the contact point in the street, but this does not occur when the system is working well. This is so because the contact is made by the front relay before it is broken at the back. The only current which remains to be interrupted is the leakage due to the moisture in the street. A special safety device in connection with the relays prevents three studs in a line remaining connected with the feeder without the automatic cut-out coming into operation. This automatic cut-out is so arranged with a lock that it can only be worked by one of the skilled engineers, as the driver and conductors are not allowed to open the same. It has in connection with it a special locking device, shown in Fig. 9, which prevents the cut-out being raised unless all the studs in the circuit are disconnected from the main feeder. In Fig. 10 an illustration is given of the sectional switch, which is also placed in the distribution boxes. The object of this switch is to put the current from one section on to the next as the car passes. If one desires to change the travelling direction when in the middle of a section, the circuit operating the sectional switch has to be closed by hand. These hand switches are placed at intervals of about 65 yards along the track. It will be seen, however, that while this hand switching might be considered a defect, it prevents a car backing along the line without due warning to those cars following. A car can, however, return along the line for a distance equal to the length of its collecting skate without operating this hand switch. Two forms of collectors have been tried on the line at Munich, both of which we illustrate.

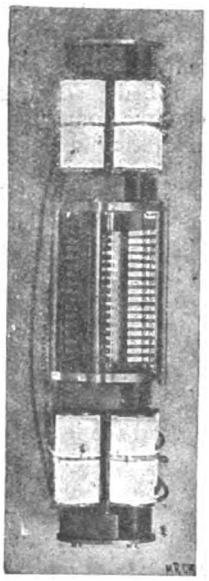


FIG. 10.—Group Switch.

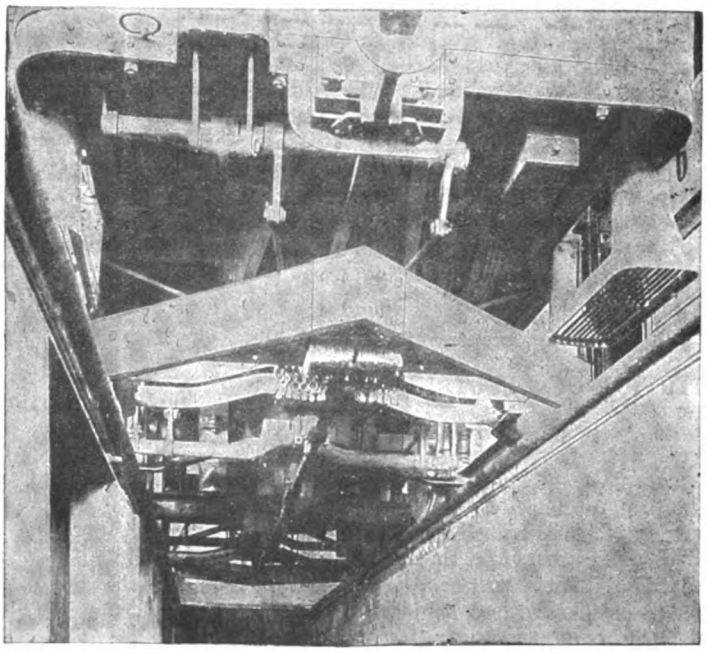


FIG. 12.—Chain Collector.

The first of these (Fig. 11) consists of a wire brush, which is made of steel wire, the other (Fig. 12) consists of a link chain. From actual experience it has been found that these current collectors work well, even with heavy snow and mud on the line. They also have the further advantage that they do not make a noise when passing over the contacts. Both before and behind the current collector another metallic brush is placed,

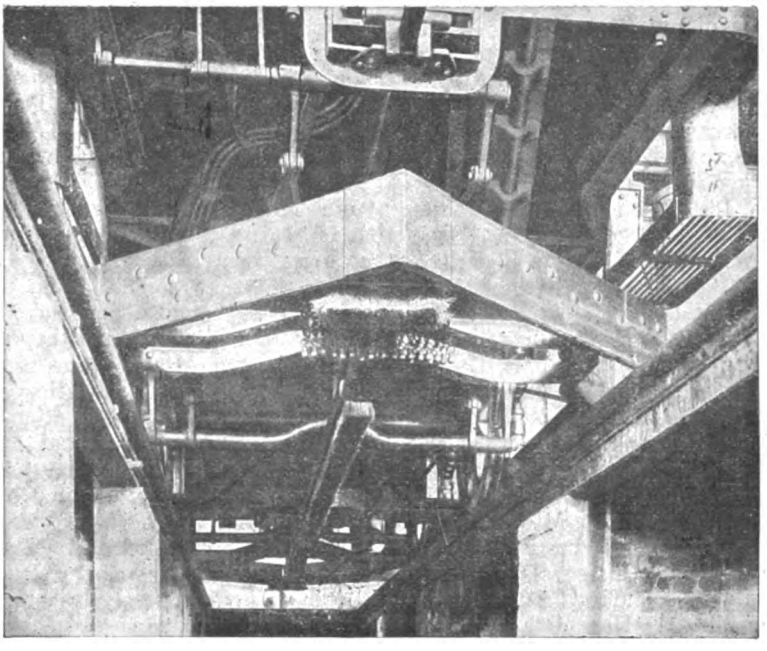


FIG 11.—Brush Collector.

which connects the rails with the contact studs. This prevents any contact being left alive after the car has passed due to faults in the switch gear, as then the brushes would practically cause a short-circuit which would operate the automatic cut-out, and the section on which the car was would then be disconnected until the fault had been remedied. This secures absolute safety to the public.

This system of traction is worked in Munich with a

Digitized by Google

voltage of 640, and curves of current consumption show that the contact system works quite as economically as the trolley system. The great advantage in the system, in our opinion, is that all the automatic switch gear is placed in such positions that it is readily of access for inspection. In the event of one of the relays over the studs not working satisfactorily, it is quite a simple matter for an inspecting engineer to watch the operation of the relay without interrupting at all the traffic, and at the same time slight adjustments can be made, which is not the case when each individual stud has its own switch gear in its own base. The relays also have all their contacts with the system and the direction switches made by plates on their bases, so in the event of a faulty relay it is a most simple operation to replace it. The act of securing of the new relay in the box makes all necessary connections. We also learn that by standardising the various parts, and by erecting the same in their positions in the distributing boxes before the same leave the workshops, the first cost of the system is kept down.

INSTITUTION OF ELECTRICAL ENGINEERS.

The opening meeting of the Institution of Electrical Engineers took place on Thursday week, when Prof. Perry delivered his inaugural address. It was stated that a letter had been received from Lord Kelvin expressing regret at being unable to be present on that evening. The list of donations to the library was then read out, Prof. PERRY stating that Major Crompton was bringing an interesting donation to the Institution—viz., an exploder, used for blowing up bridges and other property in the Transvaal.

Speaking of this exploder, Major CROMPTON said he had brought it along with him for some 8,000 miles, to be presented by the Electrical Engineers to the Institution of Electrical Engineers. The corps would be home in two or three weeks' time, and they would speak more about it then. The exploder, which was a little dynamo in an iron case, had been through several adventures since it was captured, and the train in which it had been brought from the front narrowly missed being held up by the Boers. The dynamo was supposed to be the one used by Commandant Theron for blowing up over a million pounds' worth of property in the shape of railway bridges.

In acknowledging the donations to the library, building fund, and benevolent fund, Prof. PERRY spoke of Major Crompton's gift, and said they were to have during the session something of even more value from him—namely, a paper on his South African experiences.

Prof. S. P. THOMPSON then presented the following premiums and prizes: The Institution Premium, value £25, to Mr. C. E. Groves for his paper on the "Electrical Equipment of Ships of War"; the Paris Electrical Exhibition Premium, value £10, to Mr. S. Evershed for his paper on "A Frictionless Motor Meter"; two extra premiums, each value £10, to Prof. G. Forbes for his paper on "Distant Electric Power Transmission," and to Mr. H. M. Sayers for his paper on "The Calculation of Distributing Systems of Electric Traction under British Conditions"; a premium, value £5, to Mr. A. Russell for an original communication, entitled "How Condenser and Choking-Coil Currents vary with the Shape of the Wave of the Applied E.M.F."; a premium, value £5, to Messrs. C. C. Hawkins and R. Wightman for an original communication, entitled "The Air-Gap in Continuous-Current Dynamos." The Salomons Scholarship, value £50, and the first student's premium, value, £10, were won by Mr. Howgrave-Graham, of the Finsbury Technical College; the second student's premium, value £5, was awarded to Mr. C. B. Nixon for a paper on "Switch Gear for the Generation of the Electric Current"; and the third student's premium, also value £5, to Mr. H. J. Humphreys for a paper on "Permanent Magnets."

Major CROMPTON then proposed that the thanks of the Institution should be given to Prof. S. P. Thompson for the very able manner in which he had filled the chair during his year of office. It was not for him to remind them of Prof. Thompson's services to his profession, but he would remind them that it was during his year of office that that experimental tour had taken place which had been such a great success, and which had done much good in the Institution. This could not have been such a success if they had not had such a man as Prof. Thompson with them, who was acquainted with the various places and who could speak the languages so fluently, and consequently saved them from much of the ridicule to which they might otherwise have been exposed. He considered it mainly due to Prof. Thompson that the tour took place at all.

Mr. MORDEY said it gave him great pleasure to second the vote of thanks. The President of the Institution had more work to do on the committees than at the actual meetings, and Prof. Thompson had helped greatly in organising and dealing with matters connected with the Institution. He thought there had been no more successful president than Prof. Thompson.

Prof. S. P. THOMPSON, in reply, said he thanked them for the kind vote which had been proposed. The statistics of the Institution showed that they were not yet at the highest point of increase. It had happened that the curve of membership rose more during his year of office than it had ever done in any previous year. It was not, of course, due to his occupancy of the chair, but it was gratifying to find it so. During the past year they had had the splendid gift of £1,500 by Mr. H. Wilde, to form a special Wilde benevolent fund. They had also had the legacy of £2,000 from their beloved past-president, Prof. Hughes. The Institution was making great progress in more directions than one, and he was the more confident as to its future in knowing that the chair was to be occupied by a man so capable of maintaining the ever-increasing functions of the Institution. He had known Prof. Perry for 20 years, and had had intimate dealings with him for 12 years as his colleague, and one could never want a better friend than Dr. John Perry. He would therefore, before retiring into the office of ex-president, congratulate the Institution on the choice of his successor.

Prof. PERRY then delivered his presidential address.

Prof. GEORGE FORBES said he had much pleasure in proposing a vote of thanks to Prof. Perry, and to ask that with his permission the address should be printed in the *Journal* of the Institution. They would all agree that they had a president who could form his views in an independent spirit, who could bring forward his ideas in the right manner, and who had no fear of being pleasing or displeasing, as long as he could put them forward. As long as they had such men as Prof. Perry there was no fear of their profession falling behind. There was much, he was sure, that Prof. Perry had kept back which he might have said in the same strain. Everyone of them would like to argue certain points with Prof. Perry, but that was not the fitting time for such arguments. However, there was no doubt that every point raised by Prof. Perry was one for discussion, and they would benefit by thinking of it themselves. He had told them that their profession was in danger of falling behind, and they must all feel that there was this danger. He thought it augured well for their profession in this country that this address had been listened to, not only with such rapt attention, but such manifest appreciation by an audience of engineers. In the early days of electrical engineering he thought Prof. Perry would not have been appreciated so much when speaking of the benefits of theory. The period was, however, past when engineers despised knowledge. The practical man was the man who knew all about his profession, and had imagination and resource to apply it when required. They must all appreciate the value he had put on pure physical science, and also on mathematics, which was the tool which enabled them to put their knowledge into a practical form. It was, he thought, however, Sir W. Siemens who told them that mathematics was a good servant, but a bad master.

Mr. SPAGNOLETTI, in seconding the vote of thanks, said all who had heard Prof. Perry's address would profit by it. Prof. Perry was a man of great energy and power. He had attended the dinner of the Newcastle section the previous evening, and had hurried down to give them the address that evening. He had great pleasure in seconding the vote of thanks.

Digitized by Google

Prof. JOHN PERRY said he knew they would not mind him giving them a lesson. He knew what they thought about the address, and that they would like to argue it out. He knew there was a lot to be said on the other side, but he wanted to say the things he had said. He had heard all the other side from Major Crompton when they were out cycling together. Their new colonies were wonderful things. At Newcastle on the previous evening about 60 had sat down to dinner, and he never saw a better collection of engineering heads. The next meeting was to be on Nov. 22, when a paper would be read by Mr. J. Gavey on "Telegraphs and Telephones at the Paris Exhibition."

Inaugural Address.

BY PROF. JOHN PERRY, M.E, D SC., F R S, PRESIDENT.

(Concluded from page 665.)

Just think of what is occurring at the present time. In England we have cheap coal, and it can be carried easily. In Switzerland and other countries where there is no cheap coal the water power had to be utilised, and power had to be transmitted great distances electrically. This needed high voltage, and as it is difficult to get high voltage with direct-current machines, alternating currents were used, and on account of motor troubles multiphase working has been introduced. What a revelation it was to almost all of us, that visit of a year ago to Switzerland! We saw enormous schemes of lighting and traction and power. We saw electric trains driven by distant waterfalls sandwiched in among ordinary trains, keeping proper time on working railways. We had known that there were great schemes carried out in Germany and America and other countries, and yet all the machines were quite unfamiliar to us. We were very much like what engineers of 1870 would have been if suddenly brought into a generating station. Is it not a fact that some of us, said to be eminent and thought to be practical, asked questions and made remarks which showed that we did not know the most elementary principles of three-phase working. Is it, then, any wonder that the traction schemes now being developed in England, on lines that are certainly not the best for this country of their adoption, are altogether dependent on the use of foreign electrical machinery and employ foreign electrical engineers? I am not putting this altogether fairly, for municipal procrastination has prevented our development, and yet I am not putting it altogether unfairly. We know too little theory.

I am afraid that just now we are in a rather tight place. I would give something to know how we in this room are going to get acquainted with modern electrical engineering. Our usual way of learning is by actual handling of things. But if the millions of pounds' worth of machinery coming to England every year is all foreign and is used mainly under foreign superintendence, our usual method of study is made very difficult. True there are American and German, and, indeed, English publications, which would give a knowledge of the theory, but not, I think, to the average English electrical engineer. I know of many men 25 to 40 years of age who seldom come to our meetings, and who say they are silent in discussions because they cannot be understood. Perhaps these men will find a way to save us all from being left behind. There is much more that I might say in this connection. An individual Englishman may be left behind other Englishmen, and all English electrical engineers may be left behind the rest of the world, but all electrical engineers of the world may even be left behind other appliers of science. It is not merely that the incandescent mantle of the gas engineer is improving and necessitates improvements in our filaments, but in spite of the flourishing conditions of our factories just now, I could give many other illustrations of how we shall all suffer if we do not keep adding to our knowledge. Twenty years ago, when giving some lectures in Clerkenwell to workers in the then flourishing watch trade, I ventured to prophesy the decay of that trade; but I am afraid that the case of Jonah and Nineveh is the only one in which prediction of disaster led to reform. I venture on no prophecy, therefore, because it might harden your hearts.

Much of the evil we suffer from is due to our average young men being pitchforked into works where they get no instruction as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters could be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through common-sense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science, and he learns what is called mathematics in such a fashion that he hates the sight of a mathematical expression all his life after.

And what is the result? English engineers do make a wonderfully intimate acquaintance with the machines and tools that they work with, but when it comes to the manufacture of new things they do it by fitting and trying, by quite unnecessary expenditure of money through trial and error. A machine is made and tried and then another better one, until a good result is arrived at. And this method did well enough in the past, and would do well enough in the future if only we had not to compete with foreigners who can really calculate. It is not all smoke; there is a real danger in this foreign competition unless we mend our ways. There is an absolute necessity for great change in English ways; but there are so many people interested in the maintenance of old methods of working; so many people who think they will lose their bread and butter if a change takes place; so much capital, scholastic and other, invested in our old machinery, that it takes a catastrophe to produce changes. Much of the strength and weakness of England has always lain in her conservatism. We have been talking of standardisation of machinery lately, so I may say that things have been standardised in England for a long time. Now, to get all the good effect of standardisation it is occasionally necessary to go in for wholesale scrapping, and it is this scrapping part of the business that we dislike in England. We here all know that the District and Metropolitan Railways might have been worked electrically years ago just as easily as they will be when we are allowed to begin upon them, but, of course, the scrapping of a lot of steam locomotives was a serious thing. The loss of experience to English electrical engineers, because of this hatred of scrapping, is leading to other incalculable losses. I understand that the whole generating and line plant—the whole machinery of the Boston tramways—has been scrapped several times since they first were driven electrically. Japan has scrapped all her old civilisation just as France did. During the century now dying Germany has made the most sweeping changes in her law and school legislation, and indeed in everything. England and Spain and China, how they differ in this respect even from England's own colonies. Of course, it may be said that English customs have grown during centuries; they are well tried, and there is no pressing need for sudden alteration. I quite agree, but unfortunately this very perfection and fitness of our customs have bred in us a want of flexibility, so that in cases where a sudden change is really necessary, we are disinclined to make the change merely because it is a change, and for no other reason.

No one has ever heard me speak of the decadence of England. When the greatness and the wealth, the manliness and the strength, the healthiness and good life of England are shown forth to the as yet ignorant world in all their magnitude there will be some astonishment. But it is our duty to keep up our high standards. We must change what is bad when we know it to be bad, and not let bad things* continue to exist, parasitic growths, maintained because, on the whole, we are strong and healthy. You will, perhaps, think that this is a very serious exordium when I tell you that I have introduced it all on account of the state of mathematics in our profession. I feel a sort

* Such as our wretched system of weights and measures. Oh, young America and Australia, is it wise to waste a year of every child's life, and years of the life of every business man, merely because we do it in England? You get many of your pedagogues from us, and of course they say that without hundredweights, quarters, and pounds, and Latin declensions and Euclid, the mind cannot be trained. Do you believe them, or are you with open eyes making a great sentimental sacrifice?

Digitized by Google

of degradation every time that I hear a successful, clever old member of this Institution sneering at mathematics. There is a plausibility about his statements; he himself has been very successful in life without much help from mathematics; but, indeed, his sneer is doing a great deal of harm to the younger members who admire his success, who forget that he has succeeded in spite of, and not because of, his neglect of mathematics.

Our knowledge of electrical phenomena must be quantitative to be of practical use; we must be able to calculate. Mathematics is the science of calculation, and we must, therefore, be able to employ, and we all do necessarily employ, less or more mathematics every hour of our professional lives. The draper and the grocer and the housekeeper merely need arithmetic. Everybody now knows some arithmetic. Everybody can add and subtract and multiply and divide, and keep accounts in some simple sort of way. This is due to the fact that arithmetic is no longer taught in the old Greek method with its 27 independent characters (for our 10 figures), the study of which required a lifetime, so that only old men could do multiplication, and they not only needed many hours to do one easy bit of multiplication, but declared that if the art were not practised every day it could not be remembered. Reading and writing and ciphering are now taught to everybody. It used to be that only learned men and philosophers could read, write, and compute. You will remember the charge that was brought against one of Shakspere's characters, who was said to possess mere bookish theory without practical knowledge. "And what was he?" "Forsooth a great arithmetician." Nowadays, when everybody can compute, we should say of the possessor of mere bookish theory, "Forsooth he knows the calculus."

For in mediæval times things were taught in such a way that only a few men had a chance of knowing how to read, write, and cipher. We have been compelled to change all that, the pedagogue has by compulsion given up his mediæval methods of teaching in these things, although in all other matters he retains them. But a time has come when we see that ciphering is not enough mathematics for us to be familiar with; we need a little algebra, we need co-ordinate geometry, we need the differential and integral calculus. The pedagogue tells us that we must follow the orthodox course of study, which takes many years; and some of us, many of us, who have followed the orthodox method find that we have spent so much time and mental power upon it and its thousands of unnecessary tricks and contrivances and philosophy, that we can take in no more ideas. We cannot utilise our mathematics on engineering problems, because we are too old and tired and *blasé* to comprehend these problems. Nevertheless, we are the only people who know mathematics, and so we publish volumes of unmeaning and useless disquisitions on problems that we do not understand. Or we know just enough mathematics to be able to show our ignorance to experts, but quite enough to impress engineers with our knowledge; and we know just enough about engineering problems to show our ignorance to engineers, but quite enough to impress mathematicians, and what we publish is merely as the crackling of thorns under a pot. As for the man who does understand electrical problems, he remembers that there was a something called a study of mathematics at his school, that he did pass certain examinations with much difficulty and tribulation, that the subject had no real meaning to him even when he was supposed to know it, and he now hates the sight of anything that looks like mathematics.

I tell you, gentlemen, that there is only one remedy for this sort of thing. Just as the antiquated method of studying arithmetic has been given up, so the antiquated method of studying other parts of mathematics must be given up. The practical engineer needs to use squared paper. What is the use of telling him that he has taken an unauthorised way to the study of co-ordinate geometry, that he cannot approach it except through Euclid and modern geometry and geometrical conics and algebra and trigonometry. He says the youngest child can be made to understand diagrams on squared paper. So, again, the idea underlying the calculus is one that every child, every boy, every man possesses and uses every day of his life, and there are useful methods of the calculus that might be taught quite quickly to boys, and which it would be a pleasure to boys and men to use continually in all sorts of practical problems, but, of course, the subject of the differential and integral calculus is one that must come at the end of a long course of what is to the average boy utterly uninteresting and unmeaning mathematics. Indeed, the average boy never reaches the subject, whose very names, differential and integral calculus, are enough to drive him frantic. Yes, the schoolmasters say that we must follow the mediæval rules of the game, and all sorts of fine things are said about them, but as a matter of fact we only need to bring a little common-sense to bear upon schoolmasters. At present most of us stick to our arithmetic as a safe and well-tried friend. We compute after the manner of the draper and grocer and housekeeper. In finding out what is the best size of conductor, or armature winding or core, or iron and winding of a field magnet, we calculate by mere arithmetic for one size and then for another; perhaps we have weeks of arithmetical computation before we find the right size of thing to use, and we cannot frame general rules. And some foolish person who knows a little mathematics works at the problem (as we ought to be able to do, but are not), and he frames a general rule, and we laugh at it and sneer at mathematics because he has probably left out of account the most important consideration. We know that the result is wrong, but we cannot say why it is wrong.

Then there are some far-reaching, labour-saving ideas that we simply cannot get into our heads at all—we cannot comprehend them. Am I sinning against the rule as to good comradeship which exists here if I say that some of us are ignorant of the most fundamental fact regulating economy in arranging sizes of conductors? Suppose we find the total cost of installing a conductor of a certain length using one square inch section of copper. We do the same thing for other sizes, and we plot total cost and weight of mere copper on squared paper. I do not care what system we adopt if it is the same system for all sizes, and if we buy our materials from the same manufacturers and use the same kind of labour, our points will lie very nearly in a straight line on the squared paper. Hence increased cost will be proportioned to increased weight of copper, and, indeed, increased total cost will be like the mere increase in the cost of copper, taking a slightly higher price of copper per ton. Some of us, ignorant of the elementary mathematics involved in the problem, think that the mistake has been made of assuming that the cost of an installed conductor is merely the cost of the copper in it, and, of course, he must feel that it is too absurd a mistake not to be laughed over. With an elementary knowledge of mathematics his mistake would be impossible, and without such a knowledge the clever electrical engineer is constantly discovering mare's nests in the investigations which he criticises.

I know of long misleading accounts of the results of good experimental observations which might have been described in a few clear words by the aid of elementary mathematics. I know men who spend on a particular problem 10 times the amount of worrying thought that would enable them to master the easy mathematics that include all such problems. Quite recently one of our most eminent members declared to me that he had not really grasped the reason for small economy at a power station when there is a small load factor until he studied the common-sense mathematical form which has been given in a recent publication. And yet he is a man who has heard much, and read much, and talked much on this subject.

Every electrical engineer has a correct idea of how a transformer acts, or how the E.M.F. in one of the coils of an armature of a direct-current or other generator, or, let us say, a rotary transformer, changes during a revolution, and how the E.M.F.'s of all the coils are combined to produce currents in the external circuits. But through how much mathematical tribulation must most of us have passed from our state of ignorance to our present state of knowledge! It is no wonder that we are disinclined to the study of a new phenomenon which seems as if it might lead us through the like tribulation. The tribulation is least because it is suffered only once if we first learn the calculus method which underlies all our work; it is greatest

Digitized by Google

if we get it up in a completely new-looking form in every new problem. I speak now of what is most difficult in our study, for there is thought required in applying the calculus method. Thus, for example, in multiphase work at the present time, the best mathematicians wonder how it is possible for easy calculation to be made in such a subject. What we want just now is that an electrical engineer, acquainted with three-phase current phenomena, should be so much a master of ordinary easy mathematics that he has a chance of discovering a very simple way of putting the matter before us. At present calculation is easy but tedious, and, indeed, repellant; but I am perfectly certain that a competent man might quickly invent methods of calculation which are not only easy, but short and thinkable. Mathematicians with the requisite electrical knowledge, again, may be lacking in sympathy and humour. I know a book of more than 300 large pages on ordinary alternating currents, and all the information in it is given far more simply in two pages of another book with which some of you are acquainted. Possibly, just now, mathematicians who are electrical, and who have common-sense, have too much other work to do, and we must wait their leisure.

The fact is mathematics ought to be the natural language of the electrical engineer, and at present it is a foreign language; we cannot read or write or think in it. We are at the beginning of our development, like monkeys, whose necessities have increased faster than their powers of speech.

Some of you are aware that a new method of teaching mathematics has recently been introduced in nearly all evening classes in science schools throughout the country.* I wish I could say that there was a prospect of its being introduced in all schools, for it seems to me that this would lead to the result that all young men entering works would be masters of that kind of calculation which is most important in electrical engineering; not merely a few men having this power, but the average men, just as average men can read and write.

I am addressing engineers, men who utilise the results arrived at by scientific workers, men whose profession is applied science. But surely if we are to apply the results arrived at by scientific men, if the laboratory experiment of to-day is the engineering achievement of to-morrow, we ought to be very much alive to all that is going on in the scientific world. All men ought to be far more alive to the importance of scientific work. On the psychological side, it is perfectly exasperating to me to see how few are the men who know that Darwin has given a key to almost all the great philosophical problems of antiquity, and that there is a great mental development accompanying the more evident engineering development now going on in the world. Again, it is the fault of our methods of education that all our great men, our most important, most brilliant, best educated men, our poets and novelists, our legislators and lawyers, our soldiers and sailors, our great manufacturers and merchants, our clergymen and schoolmasters, should remain so ignorant of physical science, the application of which by a few men not ignorant is transforming all the conditions of civilisation. But of all men, just think what it means for engineers to be ignorant of science, or neglectful of its new developments, and of all engineers think what it would mean if electrical engineers sinned in this way.

Except ours, all other branches of industry have taken thousands of years to grow. There were bridge and hydraulic and sanitary and harbour and river engineers in ancient Rome, and such engineers existed thousands of years before the first papyrus was written in Egypt. But no Assyrian tile or Egyptian hieroglyphic or relic from a tomb indicates that telephones or electric motors or electric lights existed before our time. No gradual improvement in our methods of conquering nature led up from small beginnings in our electrical engineering. Our profession has not grown during thousands of years of time, like other professions. It has sprung suddenly, full grown, from the new spirit which is going to rule the souls and bodies of men—the spirit of research in pure science. The new spirit puts knowledge, mere knowledge of nature, as its highest aim. The scientific student knows that all sorts of good must come to mankind from his studies; all sorts of scientific knowledge are sure to be utilised by engineers, but in the pursuit of science the usefulness and utility of the result are of no importance. And are we—we who have received the first-fruits of the labours of scientific men, we the first-born spoilt children of the great parent of all that is to come, we who form the foremost files of the present time—are we going to turn upon our beautiful young mother and say she is useless and ugly, and she hinders our money-making, and that we are willing to kill her for the sake of the burial fee? Thank God, that is the spirit of only a few of us. Have we not, as an Institution, gone to great expense in the publication of *Science Abstracts* in partnership with the Physical Society? That publication has been and continues to be of the very greatest value to all students of pure and applied science who read our language, for it tells them the results of all the scientific work now being done in all parts of the world. And even if some of us do not read that useful publication, do we not know that it is there to read if we like? Do we not know that it is a symbol of our redemption from the yoke of the Philistine? It is one of many signs that in answer to the question which I have asked in this address, we can truthfully say that we are professional men, that our profession has promise of enormous expansion and improvement, and that we are not mere tradesmen.

I am afraid that you will think that I have a personal interest in putting before you the claims for consideration of the pursuit of pure science, because you know that I am trying to defend Kew Observatory from imminent danger. In truth I have no interest in this matter unbecoming a president of this Institution. For two years I have been trying to reason with traction engineers. Like many other electrical engineers, these gentlemen desire to use uninsulated return conductors. If they do so near a magnetic observatory certain records of terrestrial magnetic disturbances are quite spoilt. At Potsdam this sacrilege has been forbidden. At Washington, Toronto, Cape Town, and most other important places, the magnetic records have already been rendered useless. Prof. Rücker and I were asked by the other members of the committee of the Royal Society which was in charge of the Kew Observatory to defend Kew, and with the help of her Majesty's Treasury we thought we were able to insist upon the use of insulated returns in all undertakings authorised by Parliament where harm was likely to be inflicted on Government observatories. I may say that the scheme designed by Mr. Clifton Robinson for using an insulated return conductor in the working of the tramways of the London United Tramways Company, in consequence of our action, was a thoroughly good scheme which it gave one satisfaction to look at—not ugly and not expensive. It seemed to me a fit scheme for any tramway system, however complex, in which overhead conductors are used. You are aware that for an electric railway, or for a tramway where a conduit is employed, it is in every way better, and is in a large scheme actually cheaper, to use an insulated return. We felt therefore very happy, for magnetic observatories seemed quite safe from interference. We were, however, mistaken, for the only clause which we have been able to get inserted in all parliamentary authorisations of undertakings, leaves it to the Board of Trade to substitute other methods of protection than the insulation of the return conductors in cases where these other methods seem to be sufficiently good for the protection of laboratories and observatories, and this is why the Board of Trade appointed the committee which met on Oct. 31 probably for the last time.

Prof. Rücker, Prof. Ayrton, and I have made many tests on the magnetic disturbances produced by tramways and railways, particularly by the Stockton tramways and by the Waterloo and City Railway, and we have had many meetings with the traction engineers, but nothing has yet been decided. I mention this matter, which has given great

* See summary of "Lectures on Practical Mathematics," also the "Science and Art Directory" and the "Reports of Examiners on the Science Examinations of 1899 and 1900"—all published by the Education Department, South Kensington, S W. The reforms now advocated in mathematical and science teaching are all clearly described in a paper read before the Society of Arts in January, 1880.

Digitized by Google

anxiety to scientific men, because I am afraid that some of you may think when you hear of it that I have been acting against the interests of the electrical industry. I beg to assure you that I have been acting in your best interests. As an electrical engineer I ought surely to regret the use of uninsulated returns even if we leave Kew Observatory out of account. Suppose we do not now insulate our returns. Electricity will certainly return by gas and water pipes, and the amount of harm done to those pipes is merely a question of time. Because of the ignorance of legislators and gas and water companies nothing is said just now, but will nothing be said at the end of 10 or 20 years, when pipes are found to be eaten away everywhere? And if by a slight increase of expense, or, rather, as I think, actually no increase of expense, but merely a little increase in inventiveness and common-sense on the part of electrical engineers, this evil may be entirely prevented, surely it is in the interests of all of us that insulated returns should be insisted upon. But even if we do not insist on insulating the returns in all systems, surely something may be said for the giving of this protection on lines near such a magnetic observatory as Kew. Even the magnetograph records now being made have been continuous for 45 years, and if Kew is interfered with no sum of money can compensate for the interference, for if the Observatory were removed the future observations would have no link with the past. An engineer in this room declared that it seemed to him an injustice to hamper the progress of electric tramways "for the sake of making observations that never have given, and never may give, to the world any important results." Now, it is not so much on account of Kew that I object to this sort of observation, as to its general spirit of antagonism to scientific research.

There is no doubt that the answer to the old question which Gilbert might have asked 300 years ago, "What is the cause of terrestrial magnetism?" is very jealously hidden from us by Nature. The earth probably contains much iron, but its great internal heat seems to forbid our imagining the iron to be magnetic. The assumption that a negative electric charge on the rotating earth will explain things, requires such an enormous charge that this assumption has been discarded. There are annual and diurnal variations of a fairly regular kind; there are storms which have some relation to the Aurora Borealis, to sun-spots, and to earth currents. There are small sudden changes which seem to occur almost instantaneously all over the earth. Observations of these things may be useless from some points of view, but scientific men have been and continue to be willing to give up time and much money for this object. Utilitarians had to be cajoled through superstition to allow observations of the stars to be carried on in ancient times, and we have no such cajolery to offer. We simply say that it has been through this sort of useless-looking method of working that all our progress in science has come.

Engineers descended from men who sneered at Cavendish and Franklin and Volta and Oersted and Ohm and Faraday, are you who utilise the results of the work so sneered at, and pile up fortunes in consequence of it, are you the men to sneer at and ridicule the scientific work of the present day because it seems to you useless? Tell us a better method of observation; give us better suggestions as to what these magnetic phenomena may mean; but the past record of scientific observation enables us to laugh at you when you say that magnetic observations may never give the world any important results. Was Nature ever so open and yet so closed about a secret as she is about this one of terrestrial magnetism? Was there ever one whose revelation promised so much? How very little we know of electricity and magnetism! Does the mere motion of the earth, taking no account of electric charges at all, cause it to be magnetic? Almost anything is on the cards. Surely I need not appeal to your cupidity, but it is quite possible that our knowledge of this secret may enable us to tap a tremendous store of Nature's energy.

Gentlemen, this is not a trades union, and it is not a society for the furtherance of pure scientific research, but it is a society of professional men who recognise the past services of scientific observers with gratitude and respect, and hope for greater ones in the future. And shall it be said of us that our gratitude is not greater than that of Judas, to whom, indeed, 30 pieces of silver was doubtless a large sum; that "we have given our hearts away a sordid boon"; and that as to our future hopes we are willing to sell our birthright for a mess of pottage.

THE TELAUTOGRAPH.

In our issue for July 27 we gave a general description of the telautograph, which is the invention of Mr. Foster Ritchie. We were at that time debarred from going into technical details for reasons connected with the Patent Office routine. Now that the patent rights are fully secured to the company, we have again examined the instrument and were permitted to take photographs, from which the accompanying illustrations are prepared. We do not propose to recapitulate the general description now, but merely state that the instrument is one for transmitting writing and diagrams in such a way that the personality of the sender is displayed in the message received. In fact, the record at the sending end and the message received are exact duplicates. Figs. 1, 2, and 3 show the instrument by which this is done, while Fig. 4

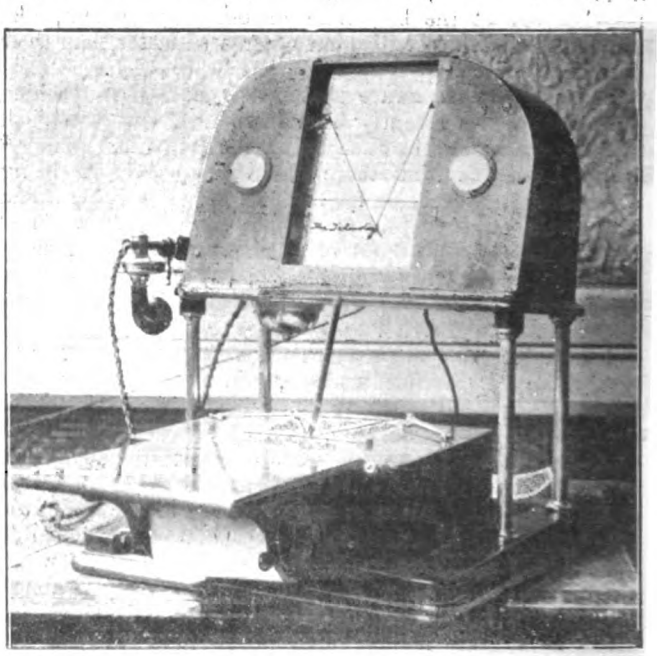


FIG. 1.—The Telautograph with the Cover on, and with the Pen supported as in the act of writing.

is a diagram of the circuits. This diagram includes only the sending parts of one instrument and the receiving apparatus of another, in order for the sake of clearness. The working is then as follows: At the transmitter two distinct currents flow from the battery A, through the switch, H, and the wires 1 and 2 to the rheostats, B B, thence by the brushes and arms, C C, to the line wires 3 and 4. The two currents then pass through the swinging coils, D D, of the receiving instrument, and through relays, E' and E, to the battery Z, and thence to earth. The movements of the brushes, C C, throw more or less of the resistance of the rheostats, B B, into the respective circuits, thus changing the amount of current passing to each of the line wires. These changes cause the swinging coils, D D, to move through angles exactly equal to those through which the brushes on the rheostats, B B, have been moved.

The linkwork by which these rheostat lines, C C, are moved is shown in the photographs. In the centre of this linkwork is the pencil with which the message to be sent is written. The recording pen is at the receiving end, connected by an exactly similar series of links to the moving coils of the receivers. Thus it follows that any one position of the pen on the paper corresponds to two definite angles only of the arms, C C. These two angles are reproduced exactly on the moving coils of the receiver, and in consequence the position of the receiving pen exactly

Digitized by Google

corresponds to that of the sending pencil. The induction coil, F, at the transmitter is controlled by the vertical movement of platen, G, which is under the sending pencil, allowing the primary circuit to be completed through the contact, 5, when the plate is pressed down by the act of writing. This causes the induction-coil hammer to vibrate, sending alternating currents through the condenser, I, to line 4, and by wire 6 to line 3 Owing to the

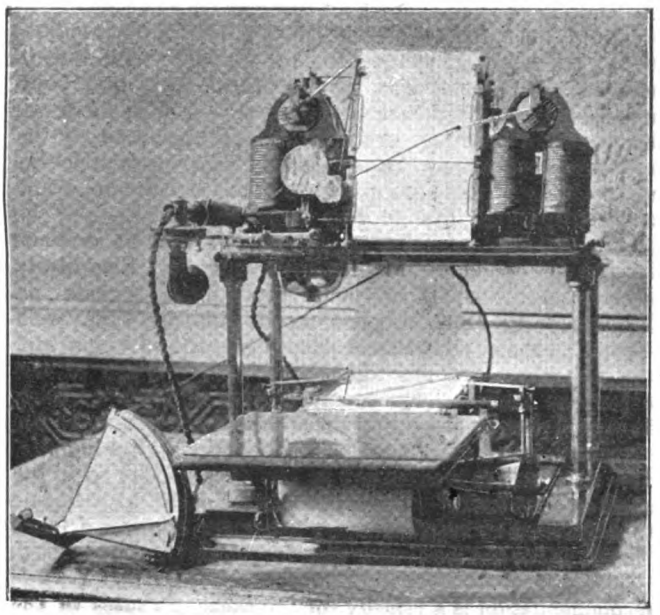


FIG. 2.—The Telautograph with Receiving Pen dipping in Ink Well.

great self-induction of the coils, D D, and the relays, E′ and E, at the receiver, these alternating currents pass principally between lines 3 and 4 by wire 7 and the condenser, L, thence through the small relay, K, and the wire 8. This alternating current then causes the relay, K, to control the penlifter, M, by means of a local current through wire 9, the contact 10, and the wire 11. The relays, E′ and E, are very sensitive and are operated by

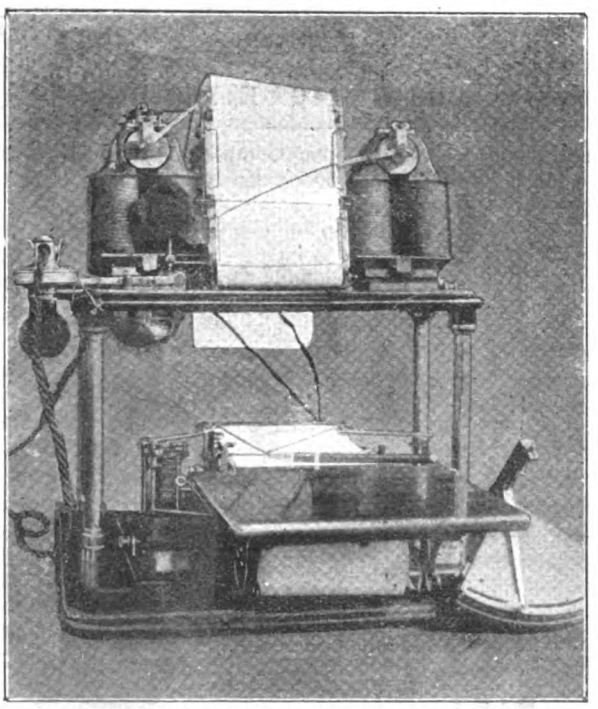


FIG. 3.—Another View of the same.

very weak line currents. The relay, E′, controlling the paper-shifter, P, also opens the local circuit controlling the pen-lifter, M, so that a vertical line is not made by the pen when the paper is shifted. The relay E, in conjunction with E′, controls the signal-bell, N. For this purpose the transmitter is fitted with a push key, not shown on diagram, which breaks the line 3, and puts battery A direct to line 4, thus allowing a local current to pass through contact 15, wire 12, contact 13, and wire 14, to the bell, N. The lever, O, on the transmitter is operated by the pencil, and is mechanically connected with the paper-shifter. Its movement also operates a contact at 17, thereby breaking current from the lines when pushed in direction of the arrow, and actuating the paper-shifting apparatus at the receiver as already described. The wires marked + and − in the diagram are connected to their respective poles of the batteries, Z and A. It will be noticed that the batteries at either end are in series when signals are being sent, but that they are in opposition when no signalling is taking place. It seems to us that in practice the earth will not be convenient for a return, and that a third wire will be preferable. The whole instrument shows

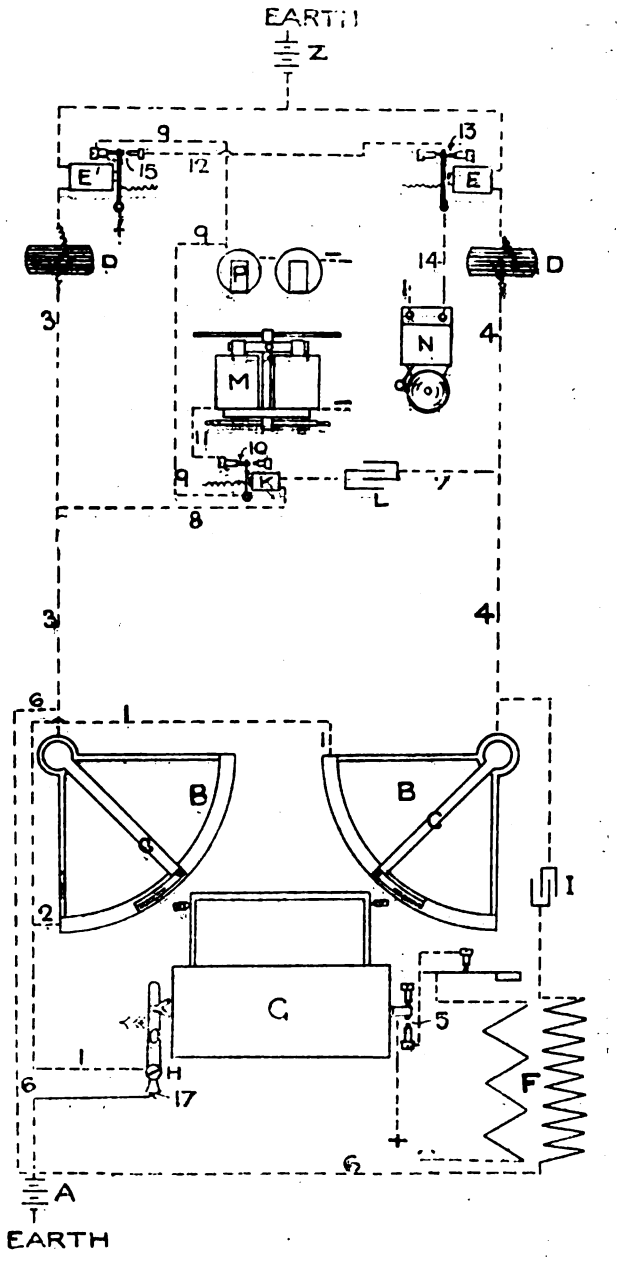


FIG. 4.—Diagram of Connections.

a wonderful combination of electrical knowledge and mechanical skill.

THE SLOUGH REPORT.

The report of Lieutenant-Colonel Yorke on the enquiry into the accident at Slough has been published. Colonel Yorke states that the driver takes the sole responsibility for the accident, and does not attempt to inculpate any other person. The report contains references to the failure of the fireman and the guards of the train to observe the positions of the signals, as was their duty according to rule, to the use of the "Section Clear but Station Blocked"

Digitized by Google

rule for such a train as that concerned, and to appliances which are designed to give supplementary indications of the positions of signals, some of which appear to have been brought under the inspector's notice, a few of which he states are under trial. He, however, appears to consider that with the most careful maintenance such apparatus might fail, and that drivers being made less alert by reliance on such mechanism, would be likely to pay less attention than at present to the ordinary signals.

As an expert in railway working Lieut.-Colonel Yorke's opinions are worthy of the most careful attention. Where blame is apportioned as the result of careful sifting of the evidence adduced there is nothing to be said. It *was* the duty of the men concerned to carefully observe the positions of the signals, according to rule, and in so far as they neglected to do this they are blameable. But when suggestions are made with a view to the prevention of similar occurrences, criticism becomes legitimate. Consider some extracts from the inspector's report which refer to the driver:

"He has a good character for sobriety, and his appearance is in his favour."

"But since the accident his eyesight has been tested by that eminent specialist, Dr. Cross, of Bristol, who certifies that Woodman's eyes are sound; that his power of vision for distant objects is, with two eyes together, about two-thirds of what it should be, and that his sight, though 'old,' is for practical purposes with good-sized objects 'good,' while 'his colour-vision is particularly acute.'"

"Nor is there any ground for supposing that he was taken suddenly ill. He says he was not asleep. But it seems to me he might be in a drowsy state without being aware of the fact, or that his attention may unwittingly have wandered from his duty, and his mental faculties have become temporarily deadened or inactive and have so produced that condition which is familiarly known as 'absence of mind.' It is to one or other of these latter alternatives, or perhaps a combination of the two, that I am inclined to attribute Woodman's failure to observe the signals at which it was his duty to stop. Woodman has nearly completed his sixtieth year, but he has all appearance of a man 10 years older than this. His age and the fact that he had been up since 5 a.m. probably predisposed him to the condition which I have suggested, of which the taking of food may have been the more immediate cause."

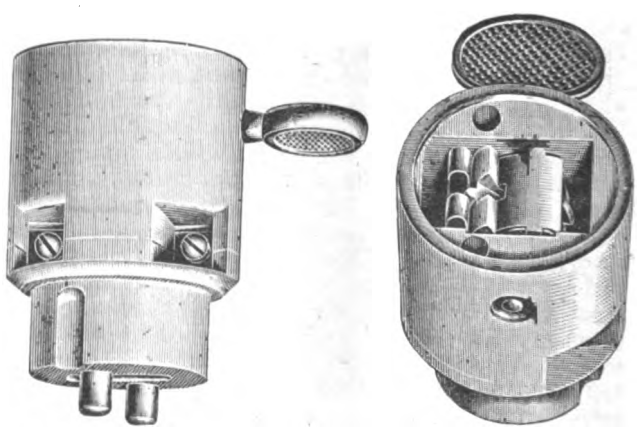
Colonel Yorke considers that the chief lesson taught by the accident is the necessity for the periodical examination of all drivers after passing the prime of life to ascertain their fitness physically and mentally without waiting until they are 60 years of age, as at present. And yet Colonel Yorke attributes the driver's failure to "absence of mind," and the report tends clearly to show that to outward appearance the driver's condition was normal. How will periodical examinations tend to show a predisposition to absent-mindedness? If a man is ever on the alert, it will be when he knows he is undergoing an examination, upon the results of which his bread and butter depends. Examinations for fitness physically and mentally involve the establishment of standards. Who will set the standards, and who also will determine at the periodical examinations whether a man rises to them? If a man passes the standards imposed, he is practically given a certificate of fitness. If after such certification he contributes to an accident, will he be criminally liable? Will the person who certifies his fitness be in any way responsible? Do not all classes of railway workmen undergo a continuous examination by their contact with their superiors? Do not drivers have to submit now to periodical eyesight tests without waiting until they are 60? If the taking of food predisposes to absence of mind, will periodical examinations neutralise the tendency, or should the taking of food when on duty be prohibited?

It seems very strange that an inspector of the Railway Department of the Board of Trade should show such distrust of supplementary apparatus to enable drivers to ascertain the positions of signals. The old, old fear of diminishing the alertness of the men by contributing towards the certainty of their obtaining proper notice of the indications exhibited for their guidance is very manifest. Coming from a representative of the department of State which compels railway companies to interlock their points and signals to prevent fouling combinations being made by the signalman, which compels the use of apparatus for indicating the condition of the line at all times, and which favours still further restrictions on the signalman's action such as are obtained from lock and block working, the remarks on supplementary apparatus for the advantage of the driver seem very strange indeed. Such errors as a signalman could make without the protection compulsorily afforded him, and some that he can make now, would, we may be sure, be the result of misapprehension or absent-mindedness. The driver, however, controls the situation in every case. It is for his guidance that the whole of the elaborate system of signalling is set in operation. If he misapprehends the position the whole system with all its checks goes by the board, and those who control him ordinarily are powerless to stop him, or to call his attention promptly to the error, as is evidenced by the case being considered. But to give the driver such checks upon himself as are given to the signalman would apparently teach him to rely upon the checks, and he would pay less attention to the signals than at present. In the discussion on Mr. Hollins's paper on "Electrically Interlocking the Block and Mechanical Signals on Railways," in 1897, Lieut.-Colonel Addison said, with regard to the advisability of adopting lock and block, and the objections brought against its use: "Some of the objections really apply to any system of *block* working. It is said that by providing these safeguards you make the signalman into a mere machine and destroy his intelligence. I do not think it is necessary in the present day to argue at all on that basis." These remarks are quite as applicable to objections to supplementary apparatus for the driver's benefit as for the particular case for which they were used.

It is difficult to ascertain in what respect Colonel Yorke's recommendation is a remedy for the cause or causes of the accident, as shown by the report. Examinations such as are suggested in this case, or as suggested by the coroner's jury in the Bermondsey case lately, will not confer on the examinee the faculty to always do the right thing at the right time. Such a faculty is instinctive, and the splendid record of English railways shows how widely it is spread amongst those engaged in working so enormous a traffic. Such momentary aberrations are the common lot, and it is only in the case of those saddled with large responsibility that the results are so terrible. The true remedy for such lapses is to provide means for calling attention to them as they occur.

A HIGH-VOLTAGE KEYHOLDER.

The International Electric Company, of 55, Redcross-street, E.C., are now placing on the market a new type of high-voltage keyholder, which is designed with a view to prevent arcing. In this holder the switching-off is done in one direction only, as if the handle is turned to the left the switch remains inoperative. The fitting is very highly



insulated, as the switching movement is entirely enclosed by the porcelain body, and arcing is thus rendered impossible. The switch would, it appear, possess the advantage of having a quick breaking action, and of making a good rubbing contact when switched on. The holder is not any larger in size than the ordinary switch-holder, and it has a very neat appearance. From the above illustrations the working of the apparatus can be fairly well understood,

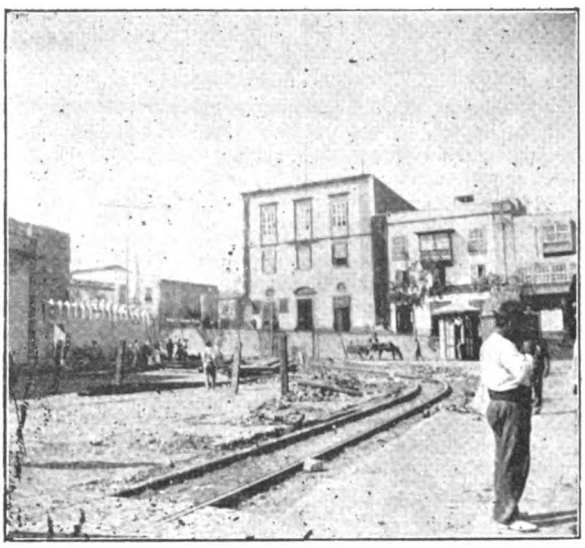
Digitized by Google

MEMORIAL STONE LAYING AT KEIGHLEY.

The election of the Mayor of Keighley, which took place on Nov. 9, was followed immediately by an interesting ceremony—namely, that of laying a memorial stone at the new electricity works. The Mayor (Mr. H. C. Longsdon), who had just been re-elected, performed the ceremony of laying the stone, being presented with a silver trowel and wooden mallet by Alderman Brigg. We have received from Mr. Smyth, the borough electrical engineer, a description of the works. In July, 1899, the Royal assent was obtained to the provisional order giving the Corporation power to supply electric energy within the borough. The designs for the works were started shortly afterwards, and a scheme drawn up to include a supply of electricity for lighting and power, provision being made for a probable demand for a supply of power for the tramways. The scheme was approved by the Corporation on Dec. 19, 1899, and application was made to the Local Government Board to borrow the necessary capital. Tenders were obtained for the supply of machinery, mains, etc., most of the contracts being placed in April and May, 1900. On May 23 a Local Government Board enquiry was held at the municipal offices into the application for borrowing powers, no public opposition being raised. The sanction of the Local Government Board to a loan of £34,600 was duly obtained. On July 3 building operations were commenced on the Coney-lane site, and have proceeded extremely well, in spite of bad weather and difficulties which have been experienced in the foundations of the building. One of the main features of the works will be a large and commodious block of offices, two storeys in height. The offices have been designed to meet all future requirements, and a corner of the site, in a prominent position, but which was useless for machinery purposes, has been utilised. The offices consist of a general office, chief engineer's and assistant engineer's offices, testing and show rooms. Immediately behind the offices, but separated from it by a passage, is the accumulator-house—a building 60ft. long by 26ft. wide—where a storage battery of 256 cells will be placed. This building is lofty and well ventilated, and is separated as far as possible from the other buildings, so that a minimum of inconvenience is felt from the acid spray during charging. Adjoining this, and leading into the engine-house, will be a well-lighted workshop and stores. The engine-house, which has a main entrance in Coney-lane, is a well-lighted building, 85ft. long by 40ft. wide and 24ft. high. The walls will be lined inside with white glazed tiles, which will give a light and clean appearance to the interior. The machinery will consist of three engines and dynamos, having a total of 800 h.p., and a switchboard for regulating the supply. The engine-house will be capable of taking 3,000 h.p. of machinery without further extension, and the machinery will be ordered as the demand increases. The high-speed vertical type of engine direct-coupled to the dynamos has been adopted. The boiler-house, built parallel with the engine-house, is 85ft. long by 75ft. wide. Two Lancashire boilers, 30ft. long by 8ft. diameter, will be used at first, there being room for six boilers of this size. This part of the works is in close proximity to the sidings of the Great Northern Railway Company, and when the demand is sufficiently great to warrant the expenditure, a special siding will probably be run into the works for the coal supply. Water for condensing purposes will be obtained from the River Worth, the Corporation having recently obtained rights from the Great Northern Railway Company to use water for this purpose. Continuous current at 230 volts will be supplied in the town, the mains being arranged on the three-wire system. Continuous current being specially suitable for driving motors, it is expected that there will be a considerable demand for a supply of power as soon as the works are started. The Electricity Committee, in view of the fact that within a short time they may be called upon to supply electric power to the present tramways, have ordered engines and dynamos which can be used for either lighting or tramway work, and provision has been made, during the laying of the cables, for laying tramway cables when required at a minimum of expense. It is anticipated that a public supply of electricity will be available by Easter, 1901, or within a period of about 15 months from the date of approval of the scheme by the Council. Mr. J. M. Smyth, the borough electrical engineer, is responsible for all the works in connection with this undertaking, and he has been very ably assisted by Mr. H. Chilvers, his chief assistant, who has carried out the whole of the work relating to the buildings.

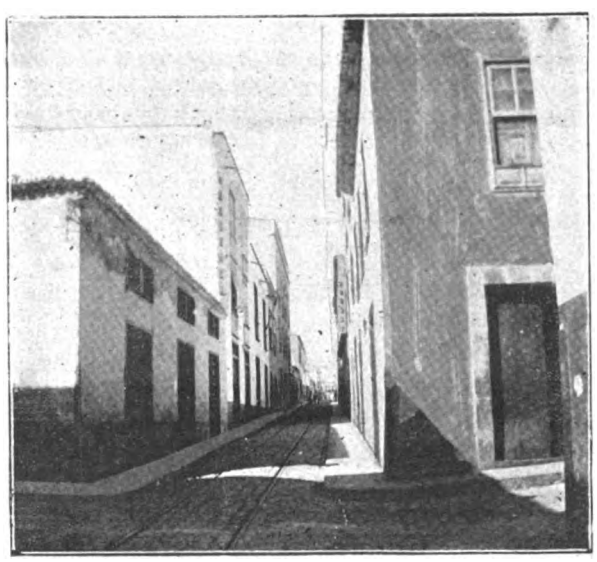
THE TENERIFFE ELECTRIC TRAMWAY.

The two photographs we reproduce herewith were taken of the electric tramway which is to be opened for working shortly in Teneriffe. One of these was taken from the



The Teneriffe Tramway from the Harbour.

harbour, while the other shows the extremely narrow street through which the cars have to pass. The actual space between the footboards of the car and the kerbs when the car is passing by the street will be only 15in. on either side. We suppose the inhabitants of Teneriffe would object to the drastic procedure adopted in Japan when



The Teneriffe Electric Tramway in Narrow Street.

laying down electric tramways. We understand that in certain towns in that country the best routes were selected for the tramways, and if the houses were then found to be too close they were pulled down, and their owners expected to re-erect them farther back from the street line at their own expense.

LEGAL.—The adjourned case of the Mayor and Corporation of Wolverhampton *v.* the British Electric Traction Company, Limited, was heard yesterday afternoon in the Chancery Division of the High Court, when judgment was reserved.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:
139-140, SALISBURY COURT, FLEET STREET.
LONDON, E.C.

CONTENTS.

Notes	685	The Automobile Club Trials of Electrical Vehicles	704
The Schuckert Contact System of Electric Traction	690	Fatality at the Metropolitan Electric Supply Company's Works	706
Institution of Electrical Engineers	694	Light Railways	706
The Telautograph	698	Forthcoming Events	707
The Slough Report	699	Questions and Answers	707
A High-Voltage Keyholder	700	Sheffield Corporation Electric Supply Department	709
Memorial Stone Laying at Keighley	701	Companies' Meetings and Reports	712
The Teneriffe Electric Tramway	701	Contracts for Electrical Supplies	713
Baker Street and Waterloo	702	Lighting Notes	713
The Electric Lighting of London	703	Traction Notes	716
Correspondence	703	Legal Intelligence	717
Reviews	703	New Committees	718
The Automobile Club Dinner	703	Provisional Patents	719
The Factors which Determine the Design of Monophase and Polyphase Generators	704	Specifications Accepted	720
		Traffic Returns	720
		Companies' Stock and Share List	720

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"The Electrical Engineer" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

BAKER STREET AND WATERLOO.

Consider that such a thing as a passenger steam railway was unknown at the beginning of the century, that goods were largely carried by means of pack-horses, and later by broad-wheeled wagons, passengers by horses or stage coaches, that during the century steam has come and reduced travelling to comparative insignificance, while at the close of the century electricity seems destined to largely supersede all other means of transport, we then recognise that progress has been extremely rapid. Semiramis is the first ruler history records as having ordered the construction of roads, but the business of civilisation till the dawn of the nineteenth century was principally transacted by water carriage. Rome, indeed, built magnificent military roads, but till the advent of steam intercommunication between inland towns was difficult. It is probable that the improved methods of intercommunication are, in a higher degree than the spread of education, answerable for the progress of civilisation. So recently as 1835 seven coaches started daily between London and Edinburgh, performing the journey in forty-eight hours. Within a period of sixty or seventy years the time of this journey has been reduced to only eight to nine hours. Practically it was seventy years ago—in 1830—that the first railway for general traffic in passengers and goods between Liverpool and Manchester was opened, and immediately thirty-four out of the thirty-five coaches previously running between the two places were discontinued, the remaining one being supported by passengers to intermediate places. We are almost tempted to put the starting point of modern life to the year 1851—the time of the first great international exhibition—though by the end of that year nearly two hundred and fifty millions of capital had been expended on British railways. Within the last twenty years the first electric trams—Brighton Beach in England, Portrush in Ireland—have been opened in this country. From these rudimentary efforts we have passed to the stage when the equipment not only of many miles of tramways, but of full-blown railways is electrical, and further railways of great importance have been constructed and are in contemplation which could be adequately equipped upon no other system. The South London and the Central London Railways are in full working order, and during the week the prospectus of the Baker-street and Waterloo line has been issued. The share capital of this line is £2,385,000, with boorrwing powers £794,000. The directorate consists of men familiar with railway work, and if success is to be attained, they should know how to obtain it. The thoughtful mind contemplating the progress made in so short a time almost stands aghast at its rapidity, and yet had there been no legislative restrictions it is more than probable that progress would have been still more rapid. It is hardly our purpose to discuss the prospects of the above line. If we did so, we should hardly feel inclined to be pessimistic, seeing that history teems with cases

Digitized by Google

where the increase of convenience to the travelling public has met with due pecuniary reward. Indeed, it is difficult to find exception to this rule, hence, while there may not at first sight seem to be in it the promise of the "twopenny tube," it must be recognised that the new line provides a very convenient means of communication across London and between the termini of many main lines of railway. One of the earliest papers to influence the introduction of steam railways appeared in 1825 in the columns of the *Scotsman*. Its first sentence reads thus: "There is no single circumstance so essential to the improvement of a country as abundant and easy means of internal communication." Those words are as pertinent now as they were seventy-five years ago, and if instead of "country" we write "city," the conclusion is just as apt.

THE ELECTRIC LIGHTING OF LONDON.

We understand from a parliamentary notice that the Board of Trade are proposing to introduce a Bill in the new session of Parliament for the adjustment of the electric lighting areas of London. The main object of the Bill will be to make the boundaries of the electric lighting areas conform with the areas of local government fixed by the London Government Act of 1899. In the notice given all the provisional orders granted up to the present for areas in London are scheduled, and one learns that powers will be sought to confirm arrangements made between companies and companies or between local authorities and companies with the above-mentioned object. While in certain cases the matter of the readjustment of areas will not be at all difficult, there are others in which we foresee that great objections will arise from the interference to vested interests which will result from the reduction of powers previously granted under the Electric Lighting Acts. How these difficulties are to be overcome remains to be seen, but it is doubtful whether it is worth while to undertake alterations in the area of supply which will involve a heavy compensation in order to make electric lighting areas and the new municipal areas agree. As seventeen local authorities and ten companies are interested in the proposed Bill, there will be ample employment for the members of the Parliamentary Bar.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MANCHESTER CORPORATION CONTRACTS.

SIR,—"Does the punishment fit the crime?" Mr. Higginbottom does not appear to have committed any heinous offence, yet the punishment is, perhaps, the hardest that could be inflicted upon a public man, especially one who has served his corporation with conspicuous ability.

Out of 25 charges brought against him, 23 have gone to the wall. Does not this speak volumes? Had there been two items dealt with, or practically one, the impression on the public mind would have been very different; for, after all, it is only a question of sub-letting contracts for cranes or parts of cranes to Messrs. Higginbottom and Mannock, the acceptance of which was indiscreet, but could certainly not be described as "altogether improper." If that were so, then why should a member of a private firm not do business with a corporation of which he is also a member *when* a director of a limited company can do so, having only to disclose the fact; when a member of Parliament associated with a limited company can do so with the Government, and even when a member of the Cabinet similarly situated can do so? If this is the conclusion, then the sooner a very large number of members of public bodies proceed to convert their establishments the better.

1. It has not been shown that the Corporation of Manchester lost a penny by giving contracts to Messrs. Pearn and Co., Limited, etc., and through them to Messrs. Higginbottom and Mannock.

2. It has not been shown that the Corporation of Manchester did not get full value for money.

3. It probably could be shown that the Corporation of Manchester have saved money by giving repeat orders indirectly to Messrs. Higginbottom and Mannock.

4. The excellence of Messrs. Higginbottom and Mannock's cranes is generally acknowledged; therefore by buying directly or indirectly, the Corporation of Manchester were not buying inferior goods.

5. Why was this attack kept in the dark until the eve of Mr. Higginbottom's election to the highest honour, next to its freedom, that the city of Manchester can bestow, when the first sub-contract to which his judges take exception dates back as far as 1892? It is strange that the persons who loaded the guns, if not the person who fired them, should have attached no importance to this matter of sub-contracts until *Oct. 27, 1900.*

To conclude, the city of Manchester has undoubtedly lost a valuable adviser, and its Electric Lighting Committee a most able leader—as a scientific journal admits—and difficult to replace, in order to start a cleansing scheme that may or may not be much needed, but too drastically applied in this instance; whereas people who have done infinitely worse have held high office, and still "flourish as the green bay tree."

It is to be hoped that this incident will not close the public career of so capable a man.—Yours, etc.,

Nov. 13, 1900. ELECTRIC.

[N B.—Our correspondent may question the consistency of the law, but the fact remains that Mr. Higginbottom's conduct in taking sub-contracts was in the present state of the law an illegal act.—ED. *E. E.*]

REVIEWS.

Manual of Electrical Undertakings, 1900-1901. Compiled under the direction of EMILE GARCKE, M.I.E.E., F.S.S., Donington House, Norfolk-street, Strand, W.C. 12s. 6d. net.

The fifth annual edition of this manual, just published, well illustrates, by its annual increase in bulk, the growth of electrical undertakings within recent years. Vol. I. contained 172 undertakings in 470 pages, the latter now number 1,272, and are devoted to 653 undertakings. While the number of works has thus increased more than fourfold, the capital has only just doubled itself. The 172 undertakings in 1896 had a capital of £61,109,000, and the capital of the 653 in 1900 only amounts to £123,636,000—another proof, if it were needed, of the fact that capital does not flow as freely in support of electrical industry in this country as it does on the continents of Europe and America. A number of interesting historical notes are added, and the usual carefully compiled statistical tables, carried up to date, are appended.

THE AUTOMOBILE CLUB DINNER.

In the Whitehall Rooms of the Hôtel Métropole on Wednesday night Mr. Roger W. Wallace, Q.C., the president, took the chair at the annual dinner of the Automobile Club of Great Britain and Ireland. Many notable men were present, including Lord Borthwick, the

Digitized by Google

Hon. C. S. Rolls, Sir R. Harrison, Colonel Crompton, Mr. Stuart-Wortley, M.P., Mr. Cumming Macdona, M.P., Mr. Scott Montagu, M.P., Prof. Boverton Redwood, Mr. C. H. Moore, etc.

After the loyal toasts, the CHAIRMAN gave the "Navy, Army, and Reserve Forces."

General Sir R. HARRISON, Inspector-General of Fortifications, in replying, pointed out how much the services depended on mechanical power. The transport of ammunition was getting beyond the power of animals. Unless there was a river or a railway it had become difficult to carry on a campaign. Mechanical power on the lines of communication and even on the battlefield for heavy guns was necessary, and automobiles there had their chance. The Royal Engineers had been trying to promote the use of traction engines. These used to be cumbrous, but had done good service. Twenty-four engines were sent out to Africa. Some were wrecked at Las Palmas, but those that arrived had done useful work where there was no railway. Engines had also been sent out in connection with the searchlight, as Colonel Crompton could tell them. As to the future, Lord Roberts had recognised the value of these engines, and the Royal Engineers would investigate the question of the best type of machine. If another war should occur, this country would be better prepared with automobiles.

Prof. BOVERTON REDWOOD, in giving "The Houses of Parliament," expressed the hope that they would see to it that what Parliament gave would not indirectly be taken away as regards motors, through the powers given to the local authorities.

Mr. STUART-WORTLEY, M.P., proposed "Success to the Automobile Club," to which Mr. SCOTT MONTAGU, M.P., replied, and the proceedings closed with the toast of "The Visitors."

THE AUTOMOBILE CLUB TRIALS OF ELECTRICAL VEHICLES.

We have received from the Automobile Club a most interesting series of figures, which, however, have yet to be confirmed by the Judges Committee, concerning the trials which took place last week. These may be taken to represent the most unfavourable results which can be obtained from electrical vehicles, as the roads were in a terribly greasy condition owing to the continued rains; also the routes chosen were not unduly favourable, as the cars had to go over some of the most hilly roads in the county of Kent. We abstract from the figures we have received the following information concerning the most successful vehicles. Thus the vehicle entered by the British and Foreign Electrical Vehicles Company, of 11, Devonshire-square, E.C., succeeded on Tuesday in traversing without recharging a 59-mile course. The total time on the journey was 5 hours 52 minutes, but allowing for stops, which were not due to any fault of the vehicle, the time would be reduced to 5 hours 24 minutes, giving an average speed of 10·92 miles per hour. On the Wednesday a run of 24¼ miles was made, at an average speed of 13·47 miles, and more would have been done but for an accident due to side slip. On the Thursday the vehicle did 29¼ miles in 2 hours 22 minutes, giving an average speed of 12·29 miles per hour. The last day of the trial the route selected was over a more level road, and the state of the road was rather better. On this day the vehicle in question went 60 miles without recharging, the average speed, including small stops, was 9·8 miles per hour, while the average running speed was 10·7 miles per hour. The total weight of this car was 48½cwt.

The car entered by the National Motor Carriage Syndicate, Limited, of 37, Walbrook, E.C., consisted of a Joel car to carry two persons, fitted with a Rosenthall battery and Joel motor, the total weight of the car being 19cwt. On Tuesday the car travelled some 34¾ miles, exclusive of a detour made in consequence of the driver losing his way. The driver seems not to have been up to the mark in health, as several stops had to be made on his account. The time taken was 5 hours 14 minutes, the average speed of the car being 6·6 miles per hour. Lubricating in this car seemed to be a rather serious trouble. On Wednesday the first stop was caused by a chain coming off, and on attempting to start again the chain mounted the pinion and bent it, the car having to be pushed a few hundred yards to a blacksmith's. After a stop of 1 hour 18 minutes a fresh start was made, and the run completed with sundry small stops to examine the motors, etc. The total distance covered was 30¾ miles, an examination at the end of the run showing a bent axle. On Thursday the car only went five miles, and had to return owing to one motor not working properly. On Friday, a proverbially unlucky day, the car started off at 10.30, and at 11.4 had a punctured tyre. It was restarted, and returned to Chislehurst after four punctures had had to be repaired. The Electric Motive Power Company, Limited, of 75, Caistor-road, Balham, entered a car to seat four, fitted with the company's batteries and a four-pole enclosed series motor, the weight of the car being 30½cwt. This car on Tuesday ran a total distance of 33 miles at an average speed of 8·25 miles per hour. The hill at Orpington seems to have been rather too much for the motor, and the observer had to get out and two people pushed the car up that and the next hill. Pushing was the order of the day, as after the fifth stop the car had to to be helped in this way. The total time taken on the journey was four hours. On Wednesday the vehicle ran the journey of 21¾ miles without a stop in 2 hours 17 minutes, the average speed being 8·8 miles per hour. On Thursday the car accomplished 29¼ miles in 3 hours 31 minutes, the only difficulty being Orpington Hill, up which the car was pushed for two minutes. The average speed on this journey was 8·3 miles per hour. On Friday 14¾ miles were covered in 2 hours 3 minutes, at an average speed of 7·2 miles per hour. The Canadian Electric Motor Company, of 5, Chapel-court, Long-acre, entered a Still Motor Company's car for four persons, fitted with the "Ideal" battery and Still Motor Company's motor. On Tuesday this car travelled 23 miles in 1 hour 39 minutes, the average speed being 13·94 miles per hour. Towards the end of the run the cells were nearly exhausted, and the passengers had to alight on all hills. On Wednesday no stops were made, and a distance of 21¾ miles was covered in 1 hour 56 minutes at an average speed of 11·25 miles per hour. On Thursday the distance of 29¼ miles took 3 hours 22 minutes, the average speed being 8·68 miles per hour. On this journey two passengers had to alight on the two hills at Orpington. On Friday the distance covered was 20 miles, which was accomplished in 2 hours 22 minutes, the average speed being 8·4 miles per hour. On this journey there were one or two little faults with the machinery.

The Electrical Undertakings, Limited, 12, Miller-street, Camden Town, N.W., had entered one car for three or four persons, fitted with a Leitner battery and Lundell motor. On Tuesday this car covered a distance of 33½ miles in 4 hours 26 minutes, the average speed being 7·5 miles per hour. On Wednesday the distance of 21¾ miles was, as in most of the other cases, accomplished without a stop. The time taken on the journey was 2 hours 33 minutes, the average speed being 8·5 miles per hour. On Thursday a distance of 29¼ miles was covered in 3 hours 50 minutes, the average speed being 7·63 miles per hour. On Friday a run taking 4 hours 50 minutes was made, the distance being 35¾ miles, and the average speed 7·4 miles per hour. The observer in this case remarks that he walked 1½ miles home.

THE FACTORS WHICH DETERMINE THE DESIGN OF MONOPHASE AND POLYPHASE GENERATORS.*

BY B. A. BEHREND.

(Continued from page 671.)

To enable the reader to judge for himself as to the correctness of the method here employed, other series of tests may be adduced. The Curves I. and II. in Fig. 4 represent the static and short-circuit characteristics of a

* From *Electrical World and Engineer* (New York).

Digitized by Google

three-phase inductor generator for 175 h.p., 5,200 volts, 500 revolutions per minute, and 50 periods per second.

TABLE II.

i	I.	II.	E_i	III.	Load amperes.
10·7	4,600	32	3,030	3,200	9·7
13·7	5,600	41	3,120	3,460	15·7
14·5	5,850	43	3,290	3,470	17·5
18	6,650	53	3,470	3,540	24·8
20	7,000	58	3,640	3,860	26
27·5	7,830	75	3,910	3,870	38

Table II. contains side by side the results of the tests and the calculated values of the voltage at the terminals. The

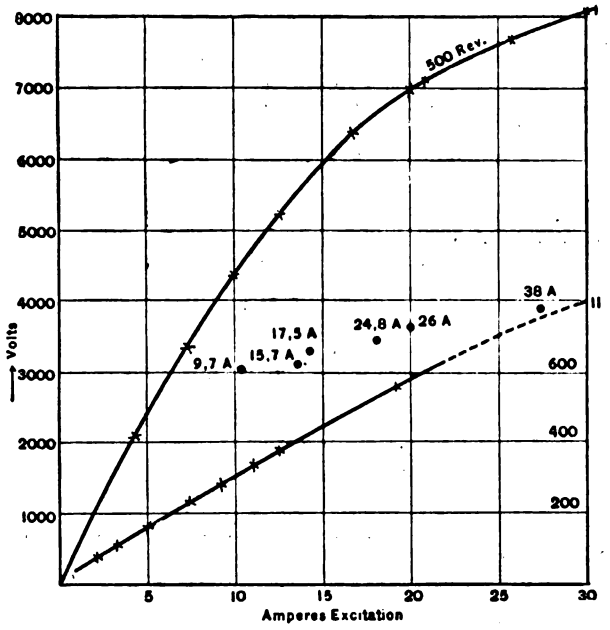


FIG. 4.—Static and Short-Circuit Characteristics of Three-Phase Inductor Generator.

symbols at the heads of the columns are the same that were used in the preceding table. The load of the generator consisted of wattless current This current is given in the sixth column of the table. The agreement is again good, especially if we take into consideration the difficulties connected with the measurement of such high voltages. Fig. 5 represents the characteristic of a 450-h.p. three-phase current generator of the inductor type. Number of revolutions per minute 600, frequency 60, voltage 6,700 between the lines. Pole-pitch, 33cm. The generator was loaded with a synchronous motor, and the following data were observed :

Generator.—530 revolutions per minute, 6,000 volts, 30 amperes, 34·5 amperes excitation. To this excitation correspond 97 amperes short-circuit current and 9,830 volts on open circuit at 600 revolutions per minute.

TABLE III.

Generator.				Motor.				
Amperes excitation.	Terminal volts observed for 655 amperes, Curve III.	E.M.F. interpolated Curve I.	Amperes short-circuit interpolated Curve III.	Terminal volts, calculated.	Amperes excitation.	E.M.F. volts, Curve IV.	Amperes short-circuit for excitation corresponding to terminal volts.	E.M.F. of motor calculated.
18·5	86	147	1,430	79·6	0	0	750	19
20·0	94	154	1,550	89	0·8	9	830	20
23·5	118	171	1,830	109·8	3·8	35	1,100	47·7
28·5	142	188	2,200	132	7·5	69	1,400	75·6
32	158	198	2,500	146·1	9·7	88	1,630	94·5
37·5	176	208	2,920	161·3	14·0	119	1,940	116·5
45	192	221	3,500	179·7	20·3	157	2,370	139

Synchronous Motor.—Excitation of the synchronous motor, 11·8 amperes. The synchronous motor as a generator developed with this excitation 55 amperes on short-circuit and 3,900 volts on open circuit.

With these data we find : (1) The terminal voltage of the generator ought to be, if the 30 amperes consist of wattless current, $9,830 - 30/97 \times 9,830 = 6,760$ volts at 600 revolutions per minute. Reduced to 530 revolutions per minute we get $530/600 \times 6,760 = 5,970$ volts, instead of 6,000 volts as observed. (2) If we start our calculation from the synchronous motor, the terminal voltage ought to be $3,900 + 30/55 \times 3,900 = 6,030$ volts. The three tests described above were made on inductive generators. The following data are from a very comprehensive series of observations on a generator with alternating poles. Two dynamos with four external poles and revolving armature in star connection were used for the tests. One machine was run as a generator, the other as a synchronous motor. The pole-pitch was 77cm., the air-gap 1·3cm. The ratio of width of pole to pitch of pole was 0·60. In a design

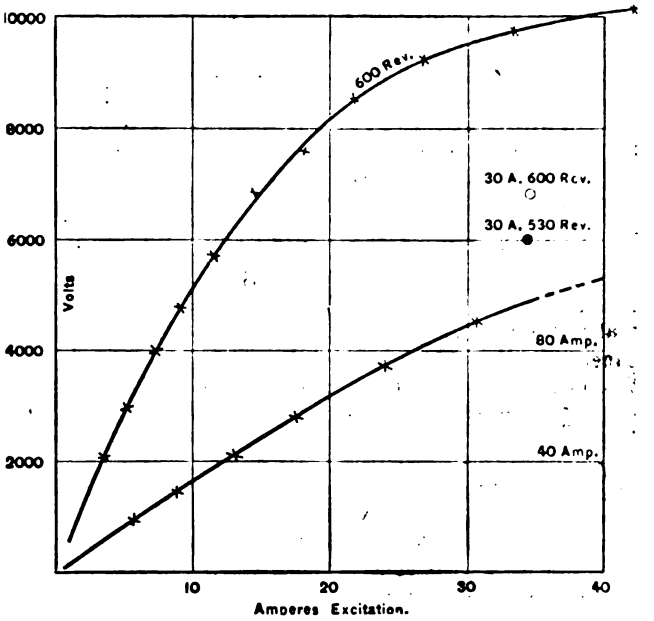


FIG. 5.—Characteristics of Three-Phase Inductor Generator.

like this the leakage is naturally very small. This is manifested by the low value of the ratio of the ampere-turns in the field to the ampere-turns in the armature, which ratio was 2·30. The number of revolutions per minute was 470, the frequency 15·7 periods per second. The voltage of this machine was 180 volts, the current in each phase 650 amperes, corresponding to an output of 200-kilo-volt-amperes. The accompanying table and Fig. 6 contain the results of the observations. The current between generator and motor was 655 amperes. Generator and motor being exactly alike, the much smaller excitation of the synchronous motor and the large current flowing between the two machines insured a power factor which did at all events not exceed 0·20. The terminal voltage of the generator is calculated as in the preceding examples. The

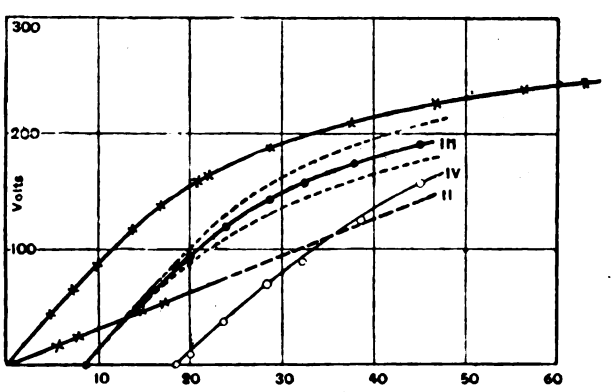


FIG. 6.—Curves relating to Test of Generator with Alternating Poles.

E.M.F. of the motor is computed from the terminal voltage and the short-circuit current belonging to an excitation which corresponds, not to the E.M.F., but to the terminal volts—that is to say, to that excitation of the machine which is necessary to produce the terminal voltage on open circuit.

The agreement of calculation and observation is by no

Digitized by Google

means so perfect in this case as in the foregoing examples. This difference is due without doubt to the considerably smaller leakage of these large four-pole dynamos. The armature winding was distributed over the surface of the armature in 216 open slots, thus greatly diminishing the self-inductance of the armature. The pole-pitch of 77cm. is much larger than usual, thus in its turn diminishing the leakage.

Curve I., Fig. 6, represents the static characteristic, equal in generator and motor. Curve II. is the short-circuit characteristic, also equal in the two machines. Curve III. is the dynamic characteristic for 655 amperes wattless current. Curve IV. is the E M F. of the synchronous motor, taken from its static characteristic by means of the values of the observed exciting current. This curve demonstrates that the current must have been practically in quadrature with the E M.F.'s and the terminal voltage. The broken line curve below Curve III. represents the values of the terminal voltage, calculated according to the method employed in this paper. The broken line curve above Curve III. represents the terminal voltage calculated by simply deducting the armature ampere-turns from the field ampere-turns.

This case is very instructive. First, it shows that neither method is theoretically correct. Secondly, it teaches us that the method which has been employed all through this paper may give values of the terminal voltage lower than those observed. Though this is certainly no advantage of the method, neither from the standpoint of the theorist nor from that of the designing engineer, yet it will be a "safe" method. The designer who is conversant with these facts knows beforehand that the terminal voltage, as determined in this manner, will surely be the lowest possible value. Some experience will soon teach him in what case he may expect a drop approaching the calculated one, and in what case the drop is likely to be smaller than he expected. The difference between the calculated and the observed values of the terminal voltage does not exceed, even in this case, 8 4 per cent. of the actual value. If, on the other hand, the designer relied on the method of the addition or subtraction of the ampere-turns of the armature and the field—treating them, of course, as vectors—he would attain results which might induce him to proportion insufficiently the magnetic circuit and the field coils.

It would be useless to here multiply the examples, as every electrical engineer can convince himself of the correctness, within wide limits, of this method.

As the drop is due to the combined effect of (1) the leakage of the field; (2) the reaction of the armature; and (3) the leakage of the armature, a satisfactory theory must account for each of these factors. Our method of determining the combined effect of these three factors from the short-circuit curve and the static characteristic does not do this. It can, therefore, not properly be called a theory. If, indeed, it were possible to design a generator without field leakage and without armature leakage, the method here adopted would give unsatisfactory results; but at present the best alternators have considerable stray fields, large enough to justify the application of the method here advocated for practical purposes.

Space does not permit me to discuss in detail the influence of the three factors mentioned above. Viewed from the practical standpoint, the question turns mainly on the avoidance of leakage. Now, the leakage in the field as well as in the armature can be diminished considerably by enlarging the pole-pitch—that is to say, by placing the poles apart as far as is compatible with an economical design. We shall dwell on this point in the third part of this article.

From the foregoing the reader will have gained the impression that if it were possible to predetermine the short-circuit characteristic of an alternator in such a manner as to take all important factors into account, we should have at our disposal a simple method which would enable us to calculate the dimensions of alternators with an exactness which would more than suffice for all practical purposes. I shall show in the following section how this may be done.

(To be continued.)

FATALITY AT THE METROPOLITAN ELECTRIC SUPPLY COMPANY'S WORKS.

On Thursday Dr. George Danford Thomas, coroner for Central London, held an enquiry at the Marylebone Coroner's Court into the circumstances attending the death of Rowland Herbert Pickworth, aged 22, an electrical engineer's assistant, lately living at 73, Park-road, Marylebone, who died from an electric shock whilst at work at the Metropolitan Electric Supply Company's works at South-street, Marylebone, on Tuesday morning last.

Mr. Gil Blenkinsopp (her Majesty's inspector of factories) watched the case on behalf of the Home Office.

Mr. REUBEN PICKWORTH, of independent means, residing at Dyke-road, Brighton, stated that the deceased, his son, had been in the employ of the Metropolitan Electric Supply Company as assistant electrical engineer at their works in South-street, Marylebone, for 18 months, and he enjoyed excellent health. On Tuesday morning he received a telegram informing him of the death of the deceased, and he afterwards heard that the deceased was attending the switchboard at the works when by some means his hands came into contact with a live conductor, which caused instant death.

GUY BRANDEN, a switchboard attendant in the employ of the Metropolitan Electric Supply Company, stated, in answer to questions by the Coroner, that men engaged at the works were instructed as to their duties and what precautions were necessary. Gloves were provided for use in the work. On Tuesday morning at seven o'clock witness went to the works and found the deceased there. At half-past eight he saw the deceased engaged in the connecting some large cables, and these had to be connected with a switch. He turned round and saw the deceased falling, and he then noticed that deceased had received a shock, he evidently having, instead of taking hold of the insulated handle of the switch, taken hold of the metal work with both hands, the result being that the current had passed through him. He went and pulled him away by taking hold of his coat. Means were at once used to restore him, but without avail; and on a doctor being called it was found that he was dead.

ARTHUR WYATT, superintendent of the South-street station, stated that the deceased had been an assistant for 18 months, and he was well acquainted with the duties and regulations with regard to what precautions were necessary to be taken for safety. There was at the works a large switchboard requiring certain connections made to it. The connections could have been made with perfect safety had the deceased taken hold of the insulated handle provided. The switchboard itself was insulated. Had deceased looked above his head, he would have seen whether the current was on or not by the pilot lamp. At the time of the accident the line voltage was 1,000.

Mr. REGINALD TODD, chief engineer to the company, said that the ordinary precautions were taken for the safety of those engaged at the works, and to enable anyone to see whether the current was on a switch, there was a pilot lamp above it, which a person could at once see by looking up, and it was evident that in this instance deceased took hold of the switch by the metal portion with both hands, thinking the current was off. He should consider whether it was not possible for some method to be adopted by which a similar accident to this would be avoided in the future.

The CORONER said that there was no doubt from the evidence that the deceased must have forgotten that the switch was charged when he took hold of it. He should not advise the jury to recommend in their verdict any particular kind of protection to be taken, because it might be that they as laymen might recommend something that might be unsuitable. They had better leave it to the company to find out what were the best methods to adopt.

The jury returned a verdict that the deceased died from the effects of shock from electricity arising at a time when the deceased's hands came in contact with the metal of a live switch, and that death arose from accidental causes. The jurors would recommend to the immediate consideration of the company the necessity of protecting the metal switches in such a manner that a similar occurrence could not happen again.

LIGHT RAILWAYS.

A meeting was held recently in Lyndhurst to discuss the proposal to have an electric railway from Lyndhurst Road to Lyndhurst.

The Commissioners have confirmed (1) an order for light railways in the borough of Dewsbury, the urban districts of Cleckheaton, Liversedge, Heckmondwike, Gomersal, Birkenshaw, Huntsworth, and Thornhill, and, under certain conditions, in the city of Bradford and the borough of Batley, in

Digitized by Google

the West Riding of the county of York; and (2) an order entitled the Gosforth and Ponteland Light Railway Order, 1900, authorising the construction of a light railway in the county of Northumberland between Gosforth and Ponteland.

The negotiations between the North-Eastern Railway Company and the directors of the Goole and Marshland and the Isle of Axholme light railways have resulted in an agreement on the part of the North-Eastern to purchase the two light railways and work the lines. The company are also about to ask for parliamentary sanction to put into force the powers which the Light Railway Commissioners have granted for the construction of a light railway from Haxey to Tickhill, which will thus give the North-Eastern direct access to the Derbyshire coalfield.

The Board of Trade have recently confirmed the undermentioned light railway orders: (1) Bourne Valley Light Railway Order, 1900, authorising the construction of a light railway in the county of Southampton from Whitchurch and Hurstbourne Stations to Vernhams Dean; (2) Bishop's Waltham Light Railway Order, 1900, authorising the construction of a light railway in the county of Southampton from Bishop's Waltham to a junction with the authorised Meon Valley railway near Brook Bridge, in the parish of Soberton; and (3) the Derby to Ashbourn light railway.

The Commissioners have issued the draft of an order they propose to make authorising the construction of the Darlington light railways.

FORTHCOMING EVENTS.

FRIDAY, NOV. 16.

Institution of Mechanical Engineers.—At 8 p.m., ordinary general meeting. Paper on "Capacity of Railway Wagons as affecting Cost of Transport," by Mr. J. D. Twinberrow.

Electro-Harmonic Society.—At 8 p.m., at St. James's Hall Restaurant, evening concert (ladies' night), Major Crompton presiding.

North-East Coast Institution of Engineers and Shipbuilders.—At Sunderland, ordinary meeting. Discussion on Mr. C. H. Innes's paper on "The Stress produced in a Connecting Rod by its Motion," and a paper on "Liquid Fuel," by Mr. E. L. Orde.

SATURDAY, NOV. 17.

Glasgow and West of Scotland Technical College Scientific Society.—At 7 30 p.m., ordinary meeting. Paper on "Some Notes on the Organisation of a Workshop," by Mr. H. D. Jackson.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle, graduates' meeting. Paper on "Comparison between British and American Locomotive Practice," by Mr. H. J. Potts.

MONDAY, NOV. 19.

Imperial Institute.—At 8.30 p.m., free lecture on "The Coal Resources of Victoria," by Mr. Jas. Stirling.

TUESDAY, NOV. 20.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Discussion on paper on "The Metropolitan Terminus of the Great Central Railway," by Messrs. G. A. Hobson and E. Wragge; and, time permitting, paper on "Machinery for the Manufacture of Smokeless Powder," by Mr. Oscar Guttmann.

WEDNESDAY, NOV. 21.

Society of Arts.—At 8 p.m., ordinary meeting. Opening address of the 147th session, by Sir John Evans, K.C.B., F.R.S., chairman.

Royal Meteorological Society.—At 7.30 p.m., at Institution of Civil Engineers, ordinary meeting. Paper on "An Improved Mounting for the Lens and Bowl of the Campbell-Stokes Sunshine Recorder," by Mr. Richard H. Curtis.

THURSDAY, NOV. 22.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper on "Telegraphs and Telephones at the Paris Exhibition," by Mr. J. Gavey.

Institution of Electrical Engineers (Dublin Section).—At rooms of Royal Dublin Society, first ordinary meeting.

FRIDAY, NOV. 23.

Physical Society.—At 5 p.m., ordinary meeting. Papers on "The Anomalous Dispersion of Carbon," by Prof. R. W. Wood; "The Liquefaction of Hydrogen," by Mr. M. W. Travers; and "On the Refraction of Sound by Wind," by Dr. E. H. Barton.

Institution of Junior Engineers.—At 7.30 p.m., joint meeting with the Architectural Association at 9, Conduit-street. Paper on "The Uses of Rolled Joists in Construction," by Mr. A. T. Walmesley.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

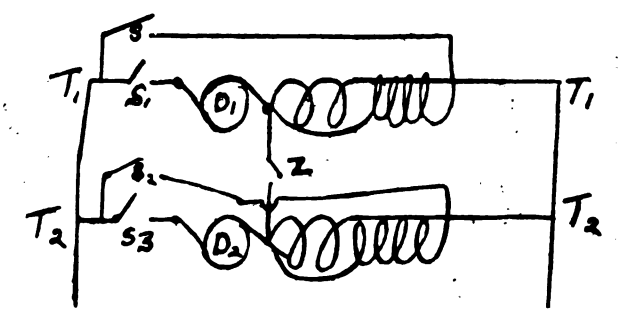
325. While in charge of the controlling board in a high-tension alternating-current station, the shift engineer switched in a machine without synchronising it with another machine on the 'bus bars. The former machine was high-speed—150 amperes at 2,000 volts; the latter being a low-speed—50 amperes at 2,000 volts. After the two machines were connected there was a drop of five volts on the low-tension voltmeter, and although I took all the resistance out of the shunts the voltage slowly dropped, until the light entirely faded out. Then the fuses of the low-speed machine became white hot and blew. Kindly explain the reason for the above.—A. H.

326. Describe and explain some method of determining the hysteresis loss in the armature of a continuous-current dynamo.—R. F. W.

ANSWERS.

Question No. 319.—Why is it not common to run compound dynamos with equalising cables connecting all the series coils in parallel on town-lighting supply? Would not this be advantageous where many heavy motors were coupled to the lighting mains? Give reasons for and against.

Best Answer to No. 319 *(awarded* 10*s.).*—To understand why compound machines are not used to any great extent in central-station work, a study of the working of these machines will be an advantage. The great convenience of compound-wound machines is that in a single machine the series-turns can be made to compensate for the drop in pressure between the dynamo and outside circuit. When compound-wound dynamos are run in parallel this effect cannot be produced, as the rise in pressure is caused by the individual machines, not the sum. To run compound machines in parallel two series windings would be required on each machine, one winding carrying the output of the machine alone and balancing the action of the machine itself—that is, the fall in voltage—and the other to effect the over-compounding, and thereby balance the drop in the feeder and distribution system—that is, this second winding carries the whole output of the station. This means complicating the field windings, and although a steadier pressure is obtained on the mains, especially in the case mentioned, it is not worth the extra cost which the winding would involve.



Another point against using machines as suggested is the fact that a somewhat complicated switching arrangement would have to be carefully followed out, or a serious accident would be likely to follow. Now, using shunt machines the magnets are excited from the mains, the machine is speeded up to the required voltage, and then

Digitized by Google

switched in. This is a simple process, but in running compound-wound machines in parallel the following method of putting a machine in circuit must be followed: Now suppose machine D_1 is running and D_2 is required to take up some of the load. Switch S_1 connecting on to the mains and S connecting the shunt will be on. To put D_2 in circuit, D_2 is speeded up and the shunt switch S_2 closed, exciting the field. Switch Z is then closed, and when voltage is right main switch S_3 is closed, putting machine in circuit. This sounds easily accomplished, but when the switches are on the board surrounded by others a mistake may easily occur. It is far better plan to use shunt machines and a booster to keep the voltage steady.—F. M. M.

Answer to No. 319 (*awarded* 5s.).—Practically the whole of the continuous-current stations installed during recent years have taken advantage of the copper economy afforded, and adopted the three-wire system, so that it is in conjunction with this system that the comparison between compound and shunt machines must be made.

Let us first consider the principal points of the system generally employed. Shunt machines are used in most stations connected across the outers, in conjunction with a relatively small balancing set, with the middle point between the two armatures connected to the middle wire. A battery also is generally installed, and this materially helps to balance the system, besides supplying a reserve of power at heavy loads, enabling the machines to be run at or near their most efficient point. If a small differential booster is connected in series with the battery, it is enabled more readily to give out power with a diminished drop in voltage at the battery terminals, and thus to aid the main machines; so that, if the size of the battery and booster are suitable, the volts at the station need not vary to any great extent, although it will be necessary to rise the pressure at the station in times of heavy load, so as to allow for the drop in potential up to the feeding points, which of course varies with the current in the feeder.

Now, if we are to adopt compound machines instead of shunt, still using the batteries, we need to see substantial reasons for so doing, as the machines themselves will be of higher cost. The main machine cables leading to the switchboard will need to be practically of double length (owing to the necessity of first connecting to the balancing 'bus bar and then back again to the series winding), and the switching arrangements will be somewhat more complex and expensive. If by their use we are enabled to obtain a constant voltage at the *feeding points* at all loads automatically, the extra outlay might be advisable. Let us see if this can be done. It is evident that to effect this the machines must be over-compounded, and in the event of a heavy load the station voltage will in consequence be raised above the normal. Now, if batteries are connected across the station mains, without any booster in circuit, they will at once commence to charge, or, at any rate, will reduce the amount of power they were formerly giving out to the circuit. Thus, when most needed as a help, they would prove a hindrance. But, to place the two systems under comparison on the same footing, let us assume that differential boosters are in circuit with the batteries, and are so designed that they will supplement the battery voltage sufficiently to enable the battery to give out an increased current with the increased load (they must be of larger range to do this than in the case of the shunt machine); difficulties still occur. The generators will, if properly compounded, compensate for the voltage drop in the feeders, provided the *whole* current can pass round the series coils, but with the battery supplying current for varying amount this is obviously impossible, so that the voltage could not be kept constant at the feeding points automatically, and if the services of the switchman are required to effect this object, why not employ the cheaper shunt system.

Apart from this, over-compounded machines are not considered suitable for employing with batteries, owing to the fact that any reverse current through the machine weakens the strength of the field magnets, instead of (as in the shunt machines) strengthening it, and this further reduces the voltage of the generator and renders it liable to a reversal of polarity. The shunt system therefore, in spite of its lower cost, seems preferable, if batteries are used in both cases. Let us deal with the case where compound machines are used without batteries, as compared to shunt machines with them. The whole load will now fall upon the generators, which, in consequence, must be of sufficient power to cope with the highest peak of the load curve, and this in some districts would render a considerable addition to the present plant necessary. The machines also, in times of comparatively light load (especially if a large part of that load consists of motors), must be run considerably under their full output, otherwise, although the series coils might endeavour to keep up the voltage in the event of a sudden addition to the load, the machines will slow up, and thus cause a drop in volts, to say nothing of the danger arising from overloading the machines. Under these circumstances, the efficiency of the plant will be decreased.

Again, the battery plays a most important part in the balancing of the system, and if it is dispensed with, having a larger balancing set will only partially compensate for the loss. In small stations also it is found to be a great advantage to be able to shut down the running plant at night, and to feed the mains entirely from the batteries, for by so doing a third shift is dispensed with, and as a large number of continuous-current stations avail themselves of this, it must be reckoned as a point against the employment of compound machines without batteries.

In conclusion, I think that although compound machines are undoubtedly beneficial for many purposes, yet for general distribution from a generating station, shunt machines, having a differential booster in series with the battery, have decided advantages, even though the proportion of motor load be comparatively large.—W. G. M.

Answer to No. 319 (*awarded* 5s.).—Though compound dynamos offer certain advantages for stations in which large and sudden variations occur, such as traction stations, they are not to be recommended for the ordinary lighting station. Even if the station supply a large amount of current for power purposes, it is most unusual for the general momentary load variation on the motors to be sufficiently large in themselves to affect the 'bus bar voltage. Further, the rules of most supply companies provide against a sudden rush of current when starting a motor by insisting on a certain small current (10 to 50 amperes) not being exceeded when the starting switch is on its first contact and the motor is at rest. This being the case, shunt dynamos regulated by hand are found quite satisfactory, though compound dynamos would undoubtedly require less attention in this respect. The latter would, therefore, probably come into more general use if it were not for the practical difficulties in running them in parallel. In spite of the use of an equalising lead putting the series windings of all the machines into parallel, there is distinctly more tendency to disproportionate loading with compound than with shunt dynamos. The reason is that if from any cause, such as a rise in speed, one of the dynamos give more than its proper proportion of load, the armature reaction will immediately lower the volts of a shunt machine, which thus tends to right itself, whilst in the case of a compound dynamo, though there is a certain amount of self-righting effect (due to part of the excess current being diverted from the series winding of the overloaded machine to those of the other machines by the equalising lead), it is much smaller than in the shunt machine. The result is that a given rise in speed on one of the machines produces a much greater overloading of that machine if it is compound than if it is shunt wound. Any advantage on the side of the compound dynamo in the way of self-regulation is further discounted when it is remembered that even if the machine is wound to compound exactly level when warm, it will compound down to an appreciable extent when cold at first starting up. On this account a resistance in the shunt for hand regulation is still a necessity, almost as much as in the case of the shunt machine.

The advantages and disadvantages of a compound dynamo may, then, be shortly stated as follows:

Advantages.—(1) They serve to maintain the supply voltage more steady under large and sudden load variations,

Digitized by Google

when these occur; (2) they require little or no hand regulation as the load increases.

Disadvantages.—(1) Practical experience has shown that there is more liability to disproportionate loading of the various machines in parallel due to unavoidable speed variations; (2) though the characteristic curve may be level at a given temperature of the field coils, its shape is sure to change when they are either cooler or hotter than this, and hand regulation must then be resorted to, just as in the case of the shunt machine; (3) the shapes of the characteristic curves of the different machines in parallel must closely resemble one another for satisfactory work, and this condition, as well as the condition that the resistances of the series windings should be in inverse proportion to the outputs of the respective machine, are often difficult to fulfil when installing new machines of various makes.—Q.

Answer to No. 319 *(awarded* 5*s.).*—The reason compound-wound dynamos have not come into general use in electric lighting stations appears to be due to one or more of the following disadvantages; (*a*) complication of switch gear; (*b*) greater liability to accidents when changing the machines about; (*c*) extra cost.

Referring to (*a*) it will only be necessary to carefully examine the connections involved, when, say, a set of six machines are required to be run in parallel, in order to see the extra switch gear required over and above that used for simple shunt machines, and also the fact that this requires very careful manipulation, or very serious things will happen. Should a breakdown occur at one of the engines a very serious short-circuit would result unless the automatic cut-out came out to time, and in some cases reversal of polarity has resulted from the series coil overpowering that of the shunt due to the latter failing or the engine failing. In the case of the shunt machine it is not possible to reverse the polarity should the engine fail, because the direction of the current round the field coils of a shunt machine is the same when giving out current or receiving current as a motor, so that should the pressure of the shunt machine fall a little below that of the rest in parallel with it the machine would tend to draw the engine round; but with the compound dynamos the case is very different, as pointed out above, for should this reversal of current round the series coil overpower the shunt a reversal of polarity follows, and unless careful precaution is taken a consequent short-circuiting of the rest of the machines, hence a very reliable zero cut-out must be used.

From the point of view (*b*) it may be well said that the compound machine is not so easily handled as the shunt machine, and simplicity is everything in central-station working, especially where a great number of units are already installed; and I think it may be said that if the shunt machine is well designed, and fitted with a good field control, and the machine coupled to an engine having good expansion gear or simply a reliable throttle governor, that for a general lighting supply it is all that is required, without going to extra expense and complication.

Dealing with the latter part of the question, there is no doubt that the use of compound machines on a supply having a good number of heavy motors would be helpful, especially if these are constantly varying in load. Then the compound machine can better deal with this class of supply, which brings us practically down to the tramway supply, for which the latter machines are best suited, but, generally speaking, the average station's motor load is small, and not of so varying a nature as that of a traction station. In one or two larger stations I believe compound machines are used on a lighting supply, but it is only in one or two instances, and no doubt the loads are subject to great variation in these particular stations—as in Glasgow, for instance.

In cases of combined lighting and traction stations the modern practice tends towards the employment of compound dynamos, with a switchboard arranged for each source of supply, so that the generators may be used on either lighting circuit or tramway supply, but in most cases the dynamos are so arranged that when the leads are plugged up to the lighting mains the field series coils are cut out, leaving the machine to do duty as a simple shunt machine.—A. H.

Question No. 320.—In an alternate-current station where accumulators are charged by means of a direct-current dynamo driven by a synchronous alternate-current motor, what will be the increase in the cost per unit supplied due to the conversion and storage of the electrical energy and to capital charges on the additional plant?

Best Answer to No. 320 *(awarded* 10*s.).*—The increase of cost per converted unit will very greatly depend upon the number of units so converted, upon the maximum demand at any one time, and upon several points on which no data are furnished. The question may, however, be investigated in general terms, and an expression obtained from which the actual increase of cost may readily be found.

Let p = cost of each alternating unit;
H = price of alternating motor and continuous-current generator;
B = price of battery and accessories;
η = efficiency of combined motor and generator;
ζ = efficiency of battery under average conditions;
α = rate of interest per cent. on capital sunk;
β = allowance per cent. for depreciation of machinery;
γ = allowance per cent. for depreciation of battery;
C = annual extra expense for attendance, oil, etc.;
N = number of units converted per annum.

Then the cost of each converted unit is

$$\frac{10{,}000\,p}{\eta \times \zeta} + \frac{\alpha\,(B + H) + \beta H + \gamma B}{100\,N} + \frac{C}{N}.$$

The extra cost thus consists of three parts: (1) making up the loss of energy in converting; (2) covering interest and depreciation; (3) covering extra attendance and expense. As an example in the application of this expression, let the case of a converting plant and battery for 500 ampere-hours be considered. The accumulators will cost about £220, the machinery, supposing conditions permit of 10 hours for charging, would probably be about £120; the combined efficiency of motor and generator we may take as 80 per cent. That of the battery depends largely on the rate of discharge, but may here be taken as 85 per cent.; allowance for depreciation of machinery would be 10 per cent., that for the battery nearer 20 per cent.; the rate of interest is taken as 3 per cent.; extra attendance, etc., amount, say, to £80 per annum. Now, if 175 units be converted in the year, and the cost of producing the alternating unit is 1·5d., the cost per converted unit is

$$\frac{10{,}000 \times 1\,5}{85 \times 80} + \frac{3\,(340) + 10\,(120) + 20\,(220)}{100 \times 175} + \frac{80}{175},$$

which comes out to 2·805d. It will be noted that the greater part of the extra cost is due to the loss of energy in conversion. The exact proportion, however, in which it comes under each of the three terms depends upon capacity, maximum current, etc.—ZERO.

SHEFFIELD CORPORATION ELECTRIC SUPPLY DEPARTMENT.

The following is the report on Continental electrical machinery, by Mr. S. E. Fedden, chief engineer and manager of the Sheffield electric supply department, to the chairman and members of the Electric Light Committee of the Sheffield Corporation:

GENTLEMEN,—In response to your instructions, I visited France and Germany in order to gain information with regard to Continental practice in single-phase and polyphase alternating systems, and have pleasure herewith in reporting on my observations. Before starting on the Continent, I obtained introductions and pass-cards for permission to visit the electricity works, and I must take this opportunity to thank Mr. Robert Hammond for his kind assistance in this direction. The firms through whom I obtained these permissions had, in addition to exhibits at the Paris Exhibition, carried out the complete contracts for the several stations which I visited, and I received every courtesy and assistance in obtaining information from their representatives.

The city of Paris, as London, is divided into numerous districts, and supplied by different companies; some supply

Digitized by Google

continuous current and some alternating. The stations in the city, however, very soon became loaded up, and it was then found necessary to go outside Paris and generate electric energy on a large scale. A big station was therefore erected about six miles down the River Seine, and I was informed that they already had 12,000 h.p. of polyphase machinery, working at 3,500 volts, installed. So strict were they, however, about admitting anyone into the station that I was not allowed in, although I took a letter of introduction from a prominent consulting engineer in Paris to the manager, who was a personal friend of his. At the Exhibition I had very great difficulty in getting about, as on the four days I was there the President was entertaining the mayors of the whole country, and as a consequence there were half a million of people in the Exhibition. However, I saw a large number of very fine engines and alternators, more especially in the German section. The Germans have made a very great advance in all electrical machinery during the past few years, and, as a rule, the design of the five large manufacturing firms is very similar. It is also similar to American practice, but the finish on the work of the German machinery is far superior to that of the American. There were three large vertical engines in the German group—combined triple-expansion three-cylinder and triple-expansion four-cylinder. These engines were 1,500 h.p., 2,000 h.p., and 2,500 h.p. respectively. One was direct-coupled to a polyphase 2,200-volt generator by Siemens and Halske. The next engine was built by the Consolidated Augsburg and Nuremburg Company, giving an output of 2,000 h.p. at 83 revolutions per minute. The Augsburg Company make a speciality of horizontal engines, whilst the Nuremburg Company have built more of the vertical type. On one of the Augsburg engines was connected a 1,060-kw. Helios alternator of very fine design, running at 70 revolutions per minute, and furnishing either polyphase or single-phase current. The French company (Anciens Etablissements Cail) had a large vertical compound Reynold-Corliss engine coupled to three-phase 5,500-volt alternator of the French Thomson-Houston Company. The French company also had numerous other steam alternators of varying power from 1,000 h.p. to 2,000 h.p., connected mostly to polyphase alternators. The ruling periodicity is 50 per second, although some companies vary a few periods either one side or the other from this. (You will, no doubt, remember that this is the periodicity which it was decided our new machinery should be constructed for and our present machinery be lowered to.) The alternators are insulated for any voltage that may be required, according to the distance of transmission, and are direct-coupled to the engines. The speeds are all low, from 80 to 125 revolutions per minute. The largest polyphase alternators on exhibition had been manufactured by the Allgemeine Elektricitats-Gesellschaft. This was 3,000 kw. The engine, however, had not been completed in time for the Exhibition, therefore a motor had been connected up to show it running round. I saw polyphase motors at work for all purposes, from ¼ h.p. up to 135 h.p. Alternating motors were also working spinning and printing machinery, cranes, elevators, and the moving staircases, and, in fact, almost everything imaginable where clean and easily accessible power might be required. One polyphase motor of 125 b.h.p. takes its energy direct from the mains at 3,500 volts, and is belted to the centrifugal pump for supplying the water to all the fountains round the Trocadero building. It was working under most exceptionally trying conditions on account of the wet place in which it was erected, but the attendant informed me that it went along regularly almost day and night, and no trouble had been experienced on account of the high voltage or otherwise. The new liquid air machine was also being worked by an electric motor. There were also a few single-phase motors working, but the proportion was small compared with the polyphase.

The Nernst Lamp Company had a very fine display of electric incandescent lighting. This company has a new incandescent lamp which takes only 1·5 watts per candle, as compared with 3·5 to 4 watts per candle used by our present type of lamps. It is a new patent, is at present very costly to make, and the lamps only last from 200 to 300 hours. It, however, gives a very brilliant white light, and as soon as the company are in a position to place it on the market as a reliable article I have no doubt electric lighting will have an enormous boom. The general illumination at the Exhibition is quite beyond description, and it must be seen to be appreciated. It comprises incandescent and acetylene gas, and a most lavish display of arc and incandescent lighting. The electrically-illuminated fountains, at the end of the Champs de Mars, are one of the features of the Exhibition. The Bremer arc lamp is also another improvement in arc lighting, and a decided advance both in the cost and power for street-lighting may be expected if the experiments now being carried out by Herr Bremer fulfil his expectations. The carbons are prepared with 20 to 50 per cent. of non-conducting salts of metals, such as calcium, silicon, and magnesia, and experiments at present show that by this new method light can be generated at an expenditure of about ·1 watt per candle, as against ·4 to ·5 watt per candle as is at present the practice. The new lamp, therefore, is three times as efficient as the best of the old ones, and I was informed that the regulating mechanism was exceedingly simple, but the details have not yet been disclosed. The reason why this lamp gives so much more light than our present arc lamp is that the arc itself furnishes considerable light, and so makes a more even distribution of illumination, whereas in the present ordinary lamps most of the illumination comes from the glowing carbons. I have considerable hopes of this lamp, and trust that it will be placed upon the market in a practical form in time to be considered when the question of the arc lighting of the streets of Sheffield is gone into. The street arc lighting in Paris is not very good, because the arcs have been surrounded with very small globes. Each lamp has its own transformers at the foot of the pole to transform the alternating current from 3,000 volts to 35 volts; and, on enquiry from the lamp-trimmers, I found that two men attended to 60 lamps per day. I visited the Paris Municipal Buildings, which are most lavishly decorated, and there observed that the incandescent gas lighting, which had been installed on a very elaborate scale, was being replaced by the electric light.

Strassburg (Population, 150,000).—At Strassburg, the first thing I noticed was a polyphase motor working in the pouring rain, without a cover of any sort over it. It was down by the riverside screening builders' sand and gravel. On enquiry, I found it was not unusual to use these motors wherever they might be required, either on new buildings for working mortar mills, or for lifting the material to practically any height. The man in charge of this motor simply knew how to switch it on and off at meal times, and otherwise took no notice of it. The parks and public gardens at Strassburg are all brilliantly lighted by arc lamps. I visited the electric lighting station, and made the following notes. The plant installed comprised four 900-kw., one 265-kw., and two 280-kw. steam alternators (polyphase), 3,000 volts; two 600-kw. and two 300-kw. steam dynamos for tramways, continuous current, 500 volts; two 200 and one 400 ampere polyphase motor-driven exciters, 70 volts; one 200-ampere steam-engine exciter. A large set of accumulators are also installed as a stand-by for the tramways, and also for exciting the alternators in case of breakdown of the mechanical exciters. Compressed air is laid on throughout the station for cleaning the running machinery, and the Westinghouse air-compressor is run by a motor. One of the boilers is fitted with a new kind of automatic stoker, similar to the Bennis stoker now in use at the Sheffield station, except that the shovels are arranged to throw the coal to three different distances in the furnace. There are 170 arc lamps in the streets, of the alternating type, and many hundreds of motors from ¼ h.p. to 100 h.p., one factory alone taking 300 h.p. from 6 a.m. to 6 p.m. This is in a city of only 150,000 people (as stated above). The charge for energy for lighting is between 6d. and 7d. per unit; for power, 2½d. per unit. Coal in Strassburg is very expensive, and the cost per unit at the works, notwithstanding the advantage of the heavy day motor load, came out at 1·43d., which leaves a very small margin for profit on the price of the power when other costs are taken into account. The capital expended in the works came out at about £92 per kilowatt installed, as against about £150 per kilowatt installed in Sheffield. There are numerous other important points of a technical nature with regard to the laying out of the engine-house and the working of the condensers, etc., which I carefully noted.

Nuremburg (Population, 160,000).—At Nuremburg I spent several hours in the factory of the Schuckert Electrical Company, where 8,000 men are employed. These works are divided into two sections, one for the manufacture of continuous and the other of alternating machinery. In the continuous-current section the power for all machines, cranes, lifts, etc., is supplied from its own continuous-current central station, and in the alternating-current section all the power is supplied from its own alternating-current station. This gave me an excellent opportunity of comparing the two systems side by side, and I must confess there was very little to choose between the adaptability and working of the two methods, except that the alternating-current motors could stand very much more rough usage and did not require so much looking after as those run by continuous current. Portable tools, worked by motors, were carried about the shops to all heavy work, instead of moving heavy work to the tools. In each power station was erected a connecting link between the two systems, in the form of a motor-generator and rotary converter, so that if there was not sufficient demand for both sections at night to run the two stations, one only was run, and the alternating current was converted to continuous for the continuous-current shop or *vice versâ*. In these shops I saw much two-phase machinery in the course of construction, and one large generator of special interest, to work direct with 20,000 volts, for a transmission scheme. I thoroughly examined and was much impressed with the satisfactory way in which the work was being executed. From the Schuckert Company I proceeded to the Nuremburg electricity station, and found there installed four 300-kw. steam alternators, 2,000 volts, 125 revolutions per minute, and two 650-kw., 2,000 volts, 94 revolutions per minute. This

Digitized by Google

station is single-phase, alternating, 50 periods. More than half the total load of this station is motors, there being no less than 1,100 h.p. of motors connected to the mains, the majority of which run from 6 a.m. to 6 p.m. The motors vary from ½ h.p. to 50 h.p., and are said to be most satisfactory and to start well. All motors are fitted with properly-designed starting switches. From enquiries I made here, the consumers seem to be very well satisfied with their single-phase motors, and I was further informed that there had been no call for continuous-current motors, as it is found that the single-phase alternating-current motors will do all that is required of them. The Schuckert Company also informed me that they had lately taken out a patent for an automatic cut-in and cut-out switch for all transformers, so as to minimise the light-load losses caused by the continual magnetisation of the transformers. They promised to send me full particulars about this patent switch. I was much struck with the simplicity of the switchboard in the Nuremburg station, and with the ample space—which indeed was a large room behind the switchboard—for bringing in the feeders from the street and also for making connections. I examined the pressure curves to see to what extent this large motor load varied the pressure on the mains, and found that the variation from the normal was very slight, except at 6 a.m., when all the motors were being started up. The price for lighting in Nuremburg is 8d. to 9d. per unit; for power 2½d. per unit, with discounts up to 50 per cent. if the bill amounts to £1,750 per annum. I was informed that the works' cost of coal came out at 1d. per unit. The street-lighting in Nuremburg is excellent, and nearly all the main streets are lighted by alternating arc lamps. The lamps are only of small power (420 watts) and have each their own transformer, as at Strassburg, with a ratio of 2,000 to 110 and choking coil from 110 to 35 volts. I watched these lamps for some time in a great many streets, and did not detect a single flicker or any variation whatever in the light. They are fitted with a big reflector over the arc, and also a large reflecting hood over the globe, which throws down the rays of light which are usually projected upwards by the alternating arc lamps. Half of these lamps are switched out at 11 o'clock at night, and the remaining lamps are ample for illuminating the streets after that hour. The lamp-posts are spaced from 50 to 70 yards apart, and a number of the lamps were suspended in the centre of the street from wires fixed to the houses. This system of lighting a street is very effective, but considerable trouble is experienced in trimming the lamps, especially where there is much traffic, or where there is a trolley wire in existence.

Mannheim (Population, 150,000).—Here I visited the works of Brown, Boveri, and Co., which have lately been erected. There is no steam power of any sort or kind at these works, hence the absence of coal and its attendant dirt. The result is that everything is spotlessly clean. All power is obtained from the town's electricity mains. Overhead travelling cranes are driven by polyphase motors, also all shaftings on which tools are grouped, and, in addition, all isolated machines on which it is advisable to couple a motor direct. The 20-h.p. and 30-h.p. motors were just bolted to the side columns or roofs of the shops, and from here they were belted to the shafting. They therefore took up no floor space, and, on account of their requiring so little attention, it was possible to put them quite out of reach. These motors started up on full load without any sparking on the collector rings, or on the starting resistance. One speciality of this firm's manufacture is that after starting the motors the collector rings are short-circuited, and the brush is lifted. For some years past I have been asked by manufacturers who use steam hammers when it will be practicable to actuate hammers of this class by electric power, and prior to my visit to these works I was unable to answer this question, but I am now able to say that I have actually seen such hammers working by electricity. The hammer itself is worked by compressed air, and on to the compressor is geared a polyphase motor, which is not started up until the man is ready to start using the hammer. When the latter is required, he simply walks over and puts on the switch, and by the time he gets back to the fire and gets out the metal, everything is ready to start hammering. I was told they obtained much finer adjustments with this hammer than that which is obtained when working by steam. Polyphase motors in this workshop were being turned out wholesale (of all sizes), and I saw a very large order for small motors being executed for spinning machines. At the electric generating station at Mannheim I made the following notes: The population is about 150,000, and in the first year they expended £100,000 on their works. There were installed three 1,500-h.p. Sulzer engines, coupled direct to polyphase generators running at 90 revolutions per minute; six boilers with superheaters similar to the Lancashire type made in this country, water purifiers, and a good workshop. The ash arrangements, underneath the boiler-house floor, are most complete, and consequently the boiler-house is entirely free from dirt. The switchboard and the switchroom, behind the board, are of the very latest type, manufactured by the firm of Brown, Boveri, and Co. No high-tension connections of any sort are brought out to the face of the board. All the high-tension cables and connections are in the commodious switch-room, the floor of which is raised on dry wood, and covered with heavy rubber mats. Although this generating station is only a year old, there are already 200 h.p. of motors in small sizes connected to it, besides the works of Brown, Boveri, and Co. There is also at Mannheim a converter station for changing the polyphase current into continuous current. The total capacity of this converter station is over 2,200 h.p., but at present there are only installed three motor-generators of 750 h.p., which supply continuous current to the tramways. The charge for energy is 7d. for lighting and 2½d. for power. At Mannheim I also took particular notice of one or two different types of alternating arc lamps, and find they are now manufacturing them on the Continent so as to run practically noiselessly.

Frankfort (Population, 250,000).—I visited the Frankfort-on-the-Maine electricity supply works. The system here is single-phase alternating current. The capacity of the central station is 9,000 h.p., consisting of four units of 750 h.p. and four units of 1,500 h.p., all direct-coupled to horizontal engines. Besides lighting there is power distribution of about 4,000 h.p. by means of single-phase motors with capacity ranging 1/5 h.p. to 150 h.p. The voltage at this station in the primary mains is 3,000, and at the city pumping station there are three 130-h.p. induction motors, taking their current directly from the mains at 3,000 volts. These pumps work night and day, and supply a section of the city with water. The pumping motors get their current at 1¼d. per unit. These electricity supply works also provide power for the Frankfort tramways. It is converted from alternating to continuous current by motor-generators at a converter station, of ample dimensions, built under a public playground. Its capacity is of 4,700 h.p., and there are at present installed three 750-h.p. motor-generators, all of which are made up of high-tension single-phase alternating-current motors, direct-coupled to the continuous-current dynamos which supply current for the large tramway system in Frankfort. The efficiency of these motor-generators is 90 per cent. There is also installed at this sub-station a large set of accumulators of 276 cells, which will discharge 920 amperes for one hour or 1,800 amperes on emergency for a short time. The charge for energy for the tramway purposes is 1¼d. per unit on the alternating side, or 1½d. per unit on the continuous-current side. Whilst in Frankfort I visited a large warehouse where a single-phase motor elevator was in use. This elevator was used only intermittently, therefore the motor was not kept running continuously. Anyone wishing to use the elevator could start the motor (which was in the basement) from any floor by a starting device patented by Brown, Boveri, and Co. I timed the starting-up of this motor twice, and found it was under 20 seconds before it ran up to speed and automatically synchronised. The elevator was then worked in the ordinary way, and as soon as it was not required further the current was switched off. I was exceedingly impressed with this, and consider that it is practically as good as any continuous-current motor I have seen. I then visited the Pariser Hotel in Frankfort. At this hotel they formerly had a hydraulic elevator worked by steam power, but this has now been discarded and a 10-h.p. single-phase motor put in its place. This motor is used for pumping the water used by the lift to a certain pressure. When the pressure gets to 12 atmospheres the motor automatically cuts out. After the elevator has been used for some time the pressure naturally falls, and as soon as it falls to six atmospheres the motor automatically switches in again, and commences pumping water until the pressure again reaches 12 atmospheres, when the motor again switches itself off. The arrangements for this are most ingenious, as all the starting switches are switched in and out automatically. It is worthy of mention that the space occupied by this motor is about one-tenth of that formerly taken up the engine and boiler. At the Frankfort newspaper office I saw working three 30-h.p. single-phase motors operating printing machinery, one 2-h.p. for a smaller printing machine, and one 3½-h.p. for an electric elevator. So satisfied are the proprietors with the working of these motors that another 30-h.p. is being installed. I then visited the Hotel Fustenhof, where is installed a 25-h.p. single-phase motor-generator for converting the alternating to continuous current. This is used for charging a large set of accumulators during the hours of light load at the station. Customers of this class obtain their current for 1¾d. per unit if they only use their motor-generators during certain hours of the day. If they use them at the time of heavy demand, they are charged the full lighting rates. A patent change-over meter is employed at this hotel, which is arranged to change over from one dial to another at certain hours of the day, so that the accounts can be charged at the different rates by the readings of the different dials. A similar arrangement for storing electrical energy is in vogue at the recreation ground called the Palmengarten, where a very large amount of light is used at night. Here are installed three 25-kw. single-phase motor-generators for converting alternating to continuous current, and a large set of accumulators, and the rates charged are similar to those charged to the above hotel.

Digitized by Google

In this Palmengarten the whole of the grounds are most lavishly lighted with incandescent lights, and also with arc lamps. A band plays in the evenings, and there are 12 lawn-tennis courts. These lawn-tennis courts are banked for flooding in the winter, when they are used for skating purposes. Arc lamps surround the whole of these, so that the people, who here work very long hours, may take their recreation at night by artificial light. The large piece of ground in the Endcliffe Woods would be an ideal spot for making similar arrangements. All the conservatories and museums are brilliantly lighted by electric light, and in the concert-room in this park there are two magnificent electroliers, each containing 20 clusters of nine lamps each. The roof of this building, which is elaborately decorated, is lighted by means of arc lamps, which are hung in four cut-glass wells, and the effect is very beautiful. I was informed upon a number of occasions that the alternating arc lamps were preferred to the continuous current on account of the better diffusion of light. In the Kaiserstrasse, in Frankfort, the arc lamps are placed on the top of the poles which support the span wire for the trolley wire, and the effect of this is that every car passing causes the lamps to jump in succession all the way down the street. The conclusion I came to, therefore, is that it would not be advisable to place arc lamps on any poles which will have vibration from the trolley wire.

Cologne (Population, 290,000).—In Cologne I visited the manufactory of the Helios Company. They kindly showed me round their works, and there I saw a large number of polyphase generators and motors being constructed for all voltages. I also had an opportunity of seeing four different 30-h.p. polyphase motors, which were connected to large tools, stopped and started up on full load. This most conclusively proved to me that these motors are quite as capable of starting on full load as the continuous-current motors. In fact, they started up without any sign of sparking at all with about twice the normal full load current. Two 25-h.p. polyphase motors were also connected to pumps for supplying the boilers with water. I also saw some two-phase motors being built here for 5,000 volts. All the machinery in these works, including the travelling cranes, is worked by polyphase motors. It is this company's practice to wind the rotors—that is, the revolving part of all their motors—whether single, two, or three phase, with three-phase windings, thus making them standard. They then wind the armatures for any phase that may be ordered. I am informed at these works that they still make some continuous-current machinery for moderate sized towns and for repeat orders, but the majority of their new work is polyphase. I inspected the Cologne electricity stations, which are at present single-phase. The old station contains four 600-h.p. steam alternators, and the new station, which is close to the other, now contains two 1,500-h.p. steam alternators. In this new station are also installed separate motor-generators for converting alternating to continuous current, for exciting the alternators, and also a set of accumulators as a stand-by to these exciters. There are about 1,000 h.p. of motors connected to the mains. A very fine switchboard, manufactured by the Helios Company, is in use in the new station. The new project is to place a large polyphase station outside the city, and to convey the current to sub-stations, to be there transformed to continuous current by rotary converters for the tramways, and by static transformers for helping the present supply stations, which will shortly be loaded up. Three hundred alternating arc lamps are connected to the mains of the Helios type, and these lamps give a most excellent light. They are of very simple construction. The railway station at Cologne is lighted off private plant with continuous-current arc lighting; and after comparing the two lamps at night, I came to the conclusion that the alternating arc lamps certainly gave a far superior light to those lighted by continuous current. The two electricity stations at Cologne are unable to run in parallel, on account of the different wave forms of the alternators. One station is, therefore, held as a reserve in case of breakdown in the other. I beg to report that throughout Germany I found that a very large number of small villages, from about 300 inhabitants upwards, are supplied with electric light. All the goods yards at the railway stations are brilliantly lighted by arc lamps. The cattle markets and nearly all the principal markets are also similarly lighted, and in many towns where gas is used in the streets I found, on enquiry, that they are only waiting for the concessions to expire in order to carry out the street-lighting by means of arc lamps. These streets, however, are now well lighted by incandescent mantles of large dimensions.

General Conclusions and Remarks.

The employment of high-pressure alternating currents, preferably of the polyphase type, have given a tremendous impetus to the growth of electrical undertakings for the transmission of power over large areas throughout the Continent. Alternating currents are successfully generated and transmitted at high voltages without the use of step-up transformers, as has been usual in American practice. Alternating currents are now employed for work which a short time ago was considered to be totally impossible. Polyphase machinery is long lived on account of the simple and solid construction of the type of generators and motors. Owing to the great development of high-tension alternating current the switching and controlling gear has been completely remodelled and greatly improved within the last few years, in order to meet the severe demands made upon it, without risk of breakdown or danger to attendants. Polyphase motors will in particular be used in preference to continuous current in mines and foundries, and other places of similar description, on account of the rough treatment and heavy duty which they can withstand, and also because no skilled attendance is required. Polyphase motors are now being used on the Continent for driving jib cranes, travelling cranes, traversers, rolling-mills, turntables, plunger pumps, rotary pumps, centrifugal machines, lifts, and elevators. They are also adapted to all kinds of ventilators, ring spinning frames, weaving looms, and, in fact, almost every type of machinery. I made numerous enquiries at the different factories I visited with regard to the use of two and three phase current, and was informed that they were practically the same as regards efficiency, duty, and starting torque. The old apparent benefit of three-phase over two-phase is in the saving of copper in the mains for long-distance transmission. This is not material in Sheffield, as we already have many miles of mains laid which cannot be suitably converted to the uses of three-phase, but which can be converted to two-phase. There are a large number of installations on the Continent which are most successfully run by two-phase alternators. The largest two-phase induction motor which, I believe, has ever been made is that manufactured by the Brown-Boveri Company. It is 1,000 h.p., taking 5,000 volts direct, and is connected to a centrifugal pump running at 455 revolutions per minute. This set is used at the Geneva Waterworks for pumping water to a height of 460ft. Not the least remarkable feature of this combination is that a centrifugal pump should be employed for throwing water to so great a height. Polyphase traction is now being used on the Continent for a number of mountain railroads, and I quite expect that within a few years it will become general for light railway work. The electricity supply works of the later construction are designed and built sufficiently capacious for the reception of machinery that may be required for some years to come, although this places a rather heavy burden on the starting of a new undertaking. They are generally well designed, spacious, lofty, and well ventilated. The walls are all faced with enamelled brick, and the floors are handsomely tiled. In most cases no pipes of any sort are above ground, ample space being provided underneath the floors for the reception of all steam, exhaust, water, and compressed-air pipes, and all the necessary cables. The condensers are also placed underground. There is also every convenience for the comfort and welfare of the people connected with the undertakings. The chief engineer, his assistant, and the leading hands are usually provided with good house accommodation on the premises, and in most cases superannuation funds are in existence to provide for the members of the staffs after a number of years of service. I was very much struck with the comprehensive way in which these undertakings are generally organised and carried out, and although I am loth to say so, I must confess that in the matter of central-station practice generally we have many lessons to learn from the Continent. The result of this trip on the Continent convinced me that my late report as to the future system of supply for Sheffield was based on the right lines, and I have every confidence in proceeding with the work of changing over our present monophase system to polyphase. Further, I have every reason to be satisfied that I am conforming to the latest up-to-date practice in laying down a new polyphase power station and converting the old one, and I trust that what I have reported will lead you to share with me the confidence I have in these proposals. Finally, I have to express my cordial thanks to all the officials of both the public and private undertakings I have visited for the very courteous attention and consideration shown to me.

COMPANIES' MEETINGS AND REPORTS.

WEST INDIA AND PANAMA TELEGRAPH.

The ordinary general meeting took place on Wednesday at Winchester House.

Mr. William Andrews, the chairman, in moving the adoption of the report, referred to the line competing with them, which he said worked at artificially low rates The object of the aid solicited by them from the Colonial Office was really and in practical effect aid to the West Indies. The Treasury regarded with disfavour applications for aid. The directors were pleased to see of late that prospects were held out of a revival of West India trade and commerce and they would like to see extended to this Company a little of the liberality which had been exhibited in the direction of Messrs. Elder-Dempster's steamers.

Mr. Henry Holmes seconded the resolution, which was carried.

Digitized by Google

CAPE ELECTRIC TRAMWAYS.

The ordinary general meeting of this Company was held on Wednesday at Winchester House. Sir Charles Euan-Smith presided.

The **Chairman** referred to the fact that two interim dividends, making together 9 per cent., had been paid, as compared with 6½ per cent. in the preceding year. The sum of £20,000 had been carried to the credit of reserve, against £8,000 last year, and it was now proposed to make a further payment of 3 per cent. on the share capital, leaving £12,000 to be carried forward.

The report was adopted and the bonus approved, and the following resolution was unanimously agreed to: "That the capital of the Company be increased by the creation of 100,000 additional ordinary shares of £1 each, ranking for dividend and in all other respects *pari passu* with the existing ordinary shares of the Company, and that the directors be empowered to dispose of such shares to such persons and on such terms as the Board may think fit."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ilford.—The Urban District Council invite tenders for the supply of lamp columns in quantities of about 50 at a time. Tenders by Nov. 26.

Kendal.—The Corporation invite tenders for the supply and erection of various plant. Tenders by Dec. 1. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for electric travelling crane and condensing plant. Tenders by Nov. 22. Details in our advertisement columns.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads. Tenders by Dec. 13. Details in our advertisement columns.

Halifax.—The Tramways Committee invite tenders for tramcars, trucks, motors, and electrical equipment for same. Tenders by Nov. 27. Details in our advertisement columns.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for arc lamp cables, telephone and pilot wires. Tenders by Nov. 21. Details in our advertisement columns.

Newcastle-upon-Tyne.—The New Tramways Committee of the Corporation invite tenders for arc lamps and accessories. Tenders by 21st inst. Details in our advertisement columns.

Cuevas (Spain).—Applications are invited by the Municipality for electric lighting of the town for 20 years. Tenders by Nov. 30. Specification, etc., may be seen at the office of this paper.

Bermondsey.—The Vestry invite tenders for arc lamp columns, arc and incandescent lamps, automatic switches, and fittings. Tenders by Dec. 3. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by Dec. 31. Details in our advertisement columns.

Belfast.—The Gas and Electric Committee invite tenders for switchboard extensions. Specifications, etc., may be obtained on application to Mr. Victor A. H. McCowen, city electrical engineer. Tenders by Nov. 23.

Nottingham.—Tenders are invited for the installation of an electric lighting plant at the new workhouse. Specifications may be obtained from Mr. G. Muncaster Howard, clerk, Poor-Law Offices, Nottingham.

West Bromwich.—The Corporation invite tenders for the supply of wiring materials, motors, and labour in wiring for lighting and power installations. Tenders by Nov. 17. Details in our advertisement columns.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection of an extension switchboard for supplying current for the tramways. Tenders by Nov. 27. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for the following: (Section 4) 75-kw. motor-generator and Tudor storage battery; (5) lead-covered cables; (6) 20-ton travelling crane. Tenders by Nov. 28. Details in our advertisement columns.

Oldham.—The Tramways Committee invite tenders for the erection of a tramway car depot at Wallshaw, within the borough. Specifications, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by Dec. 5.

Wolverhampton.—The Tramways Committee invite tenders for erection of car depôt, paint and repair shops, etc., at Cleveland-road. Plans, etc., may be seen at the office of Mr. J. W. Bradley, C.E., M.I.M.E., borough engineer, Wolverhampton. Tenders by Nov. 19.

Brighton.—The Council invite tenders for the supply and delivery of the following: points, crossings, etc., soleplates, manhole covers with frames, gully grates with frames, tie-bars, fish-bolts, and other bolts for fastenings, etc. Tenders by Dec. 6. Details in our advertisement columns.

Greenwich.—The Guardians invite tenders for proposed electric lighting installation at the new workhouse, Grove Park, S.E., now in course of erection. Specification, etc., may be obtained and plans seen at the Greenwich offices of the architect, Mr. Thomas Dinwiddy, F.R.I.B.A. Tenders by Nov. 22.

Leeds.—The Corporation invite tenders for the various works required in erection and completion of buildings in extension of the present electric lighting works in Whitehall-road. Plans, etc., may be obtained from Mr. H. Dickinson manager, Electric Lighting Works 1, Whitehall-road, Leeds. Tenders by Nov. 27.

Oldham.—The Tramways Committee invite tenders for the supply and erection of the iron and steel work required in the completion of a car depot at Wallshaw, within the borough. Specification, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by Dec. 5.

Stockport.—The Tramways Committee invite tenders for the supply and delivery of about 1,050 tons of grooved steel girder tramway rails, fishplates, tiebars, bolts and nuts, points, and crossings. Plans, etc., may be obtained (£3. 3s.) from Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Shoreditch.—The Vestry invite tenders for the supply of various plant for the new generating station at Whiston-street, including direct-connected direct-current generators of an output of about 800 kw. each set. Specifications, etc., may be obtained at the office of the Vestry's electrical engineer, Mr. C. Newton Russell, Electric Light Station, Coronet-street, Hoxton, N. Tenders by Nov. 20.

Stockport.—The Tramways Committee invite tenders for the overhead equipment and supply of rail bonds for six sections of their electric tramways, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Specifications, etc., may be obtained from Mr. A. J. H. Carter, electrical engineer, or Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Stockport.—The Tramways Committee invite tenders for the laying of the permanent way of their electric tramways, including concrete foundation, but excluding bonding and paving, in six sections, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Plans, etc., may be obtained on application to Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Alteerig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

RESULTS OF TENDERS.

Worthing.—The Electric Lighting Committee have accepted the tender of Messrs. Oliver and Co. for Contract No. 8 (arc lamps), at £850. 17s.

Avonbank (Bristol).—The Electrical Committee have accepted the tender of E. Nuttal, Manchester, for the erection of a power station at Avonbank.

Walsall.—The Electric Lighting Committee have accepted the tender of Mr. A. Lynex for erecting the timber required for a temporary switchboard for £6. 17s. 6d.

Cardiff.—The tender for 1,000 tons of steel rails for the relaying of the tramway track for electric traction in Cardiff has been secured by Messrs. Dick, Kerr, and Co., of Glasgow.

Bermondsey.—The following tenders have been accepted: Thames Ironworks Company, engines, electric generators, etc., £4,334; J. Spencer, Limited, pipes, pumps, etc., £2 672. 10s.

Sheffield.—The Corporation have accepted the tender of the Electric Construction Company, Wolverhampton, for two two-phase steam alternators (600 kw.), and for alterations to present single-phase plant, at schedule rates

Aberdeen.—The Tramway Committee have accepted the tender of the British Westinghouse Company, Limited, Westinghouse-buildings, Norfolk-street, Strand, W.C., for the manufacture and supply of 12 electrical tramcars, and equipments for six horse cars about to be converted.

Bedford.—The Electric Light and Traction Committee have accepted a contract with the Midland Railway Company to carry a conduit containing cable over, and erection of lamps upon, the Kempston-road bridge. The committee have also accepted the tender of Mr. W. Laughton to build two underground sub-stations, at £33. 10s. each.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Bedford.—Several extensions of cable have been agreed to.

Lichfield.—The City Council propose to apply for a provisional electric lighting order.

Finchley.—The School Board are favourable to electric lighting, and in all probability will use it.

Aylesbury.—A special report of the Lighting Committee has been before the Council in committee.

Accrington.—The electricity works are practically completed. Current was turned on for the first time on Friday.

Digitized by Google

East Grinstead.—The Urban District Council have decided to apply to the Board of Trade for a provisional order for electric light.

Hereford.—The Town Council have decided to apply for sanction to borrow an additional amount for electric light extensions.

Trowbridge.—Two schemes, estimated to cost £17,000 and £28,000 respectively, are recommended to the District Council for electric lighting.

Worksop.—The Council have concluded a loan of £5,000 (part of £30,000 proposed to be raised for the purpose of electric lighting) at 3½ per cent.

East Ham.—The District Council have agreed to an extension of arc lamp lighting at a cost of £557. The annual charge per lamp is stated at £18.

Electrical Power Distribution Co.—Letters of allotment for the recent issue of shares by the Electrical Power Distribution Company have been posted.

Potteries.—The Potteries Electric Traction Company propose to apply to the Board of Trade for powers to improve and extend their system in North Staffordshire.

Keswick.—The resolution previously passed by the Urban District Council refusing to allow the Postmaster-General to fix telephone wires and poles in the streets has now been rescinded.

African Telegraphs.—With the completion of the telegraph from Brazzaville to Libreville, in the French Congo, the district of Stanley Pool is now brought into direct communication with Europe.

Gosport.—The Council have assented to the application of the Portsmouth Town Council for a municipal telephone exchange, subject to the Council being consulted as to the breaking-up of their roads.

Ilford.—The charge for electricity has been fixed at the rate of 8d. per unit for the first hour per diem on the maximum demand, and a rate of 2d. per unit per diem for all current consumed after.

Norton.—The Rural District Council have formally consented to the obtaining by the Sheffield Corporation of the power to construct an extension of the Woodseats tramway from Woodseats to Abbeydale, *vid* Abbey-lane.

Oban.—At a recent meeting of the ratepayers a resolution was passed approving of the resolution of the Town Council to apply for a provisional order to supply electrical energy for public and private purposes within the burgh of Oban.

Arbroath.—The Government intend to erect a telegraph wire between Arbroath and the coastguard station near Auchmithie, in order to facilitate communication between the coastguard station and the town in case of wrecks off the coast.

Walsall Telephones.—The Chamber of Commerce recently decided to communicate with the chambers of commerce in other towns of about the same size as Walsall in order to ascertain whether the telephonic system is as bad in those towns as it is in Walsall.

East Barnet.—The Urban District Council have decided to oppose the North Metropolitan Electrical Power Distribution Company's application for a provisional order to supply electrical power in the Council's district under the Electric Lighting Acts, 1889-1892.

Saltburn.—At the November meeting of the Urban Council the question of purchasing the electric lighting station plant, etc., from the Assets Company was discussed, and it was decided to ask the Assets Company if they were prepared to entertain an offer of £8,000.

Rathmines.—The Urban District Council have agreed, owing to the numerous applications for electric lighting, that additional generating plant should be obtained at an estimated cost of £7,500. Mr. Hammond has been instructed to prepare specifications and invite tenders.

Southgate.—The Urban District Council have received from Mr. Carpenter a report on the proposed joint scheme for electric lighting, and afterwards sealed the agreement between Edmonton, Tottenham, Southgate, Enfield, and Wood Green for the promotion of a joint Bill in Parliament.

Worcester.—It is proposed to purchase, at a cost of £3 750, a site in the Hylton-road whereupon to erect a supplemental electricity generating station, in view of the conversion of the city tramways for electrical traction and their extension as light railways in the surrounding districts.

Foots Cray.—Application is to be made to the Board of Trade for a provisional order for public and private lighting within the parish of Foots Cray, and within that portion of the parish of Chislehurst known as the lower borough, in the district of the Urban District Council of Chislehurst.

Romford.—In reply to a letter from the Board of Trade, with an application by Messrs. Ind, Coope, and Co., Limited, for exemption from the operation of the by-laws proposed to be made in respect of the electric light cable across South-street, the Board of Trade will be asked that no exceptions be made.

Taunton.—The Electric Light Committee of the Town Council in their last report state that they are in communication with the British Electric Traction Company as to the terms agreed upon by the Council for the supply of current for the trams, and hope to report further upon the matter at the December meeting.

Stoke Newington.—A special meeting of the new Council was held last night to consider report of special committee *re* site for electric light works, etc., as to obtaining parliamentary powers for the compulsory purchase of a site under Section 5 (2) of the London Government Act, 1899, and Section 65 of the Local Government Act, 1888.

Shoreham.—The Harbour Trustees have agreed to the plans for the Brighton Corporation's generating station, and have decided that in consideration of the diminution of the Trustees' water rights by the erection of the proposed new electricity works on Shoreham Harbour, a claim of £200 be made on the Brighton Corporation in respect of the same.

Recording Telegraphs.—In the Companies' Winding-up Court on Wednesday, Mr. Justice Wright had before him a petition for the compulsory winding-up of Recording Telegraphs, Limited, presented by Messrs. Segrue and Co., Limited. The matter was allowed to stand over for a week, so that copies of the affidavits might be prepared for all the parties concerned.

Brighton Telephones.—With regard to the municipal telephone scheme which Mr. Bennett is preparing, we learn that provision is being made in the specification for the tramways for the necessary conduits for laying the underground telephone wires, such conduits being stoneware pipes of the same description as those to be used in connection with the tramways.

Walsall.—The total number of consumers supplied on Oct. 31 last was 168. An application has been made by the Hospital Bazaar Committee for a gratuitous supply of electric current during the holding of the forthcoming bazaar, but as it would be creating a precedent which might cause difficulty in the future, the committee were unable to accede to the request.

Football.—On Saturday last Glover's Cables met and defeated Royce's Dynamos by three volts to two. The scores fairly represented the play, and Royce's are to be congratulated on playing such a good game against the premier Manchester electrical football club. We have been asked to state that Glover's still have some dates open for matches against similar organisations.

Whitehaven.—The borough engineer's report states that more satisfactory progress has been made in the work of extension at the electric lighting station. The Town Council have informed Messrs. Raybould that they had given the Water and Lighting Committee power to cancel their contract, but they had decided to postpone any action to see what progress was being made.

Manchester.—Mr. C. H. Wordingham, the chief engineer at the electric light works, has intimated to the Electricity Committee of the Corporation that he will not renew his engagement at the expiration of his agreement on March 31. He has been with the Corporation about seven years, during which time he has had charge of the rapid developments of the electricity undertaking.

Inverness.—Mr. Craven, engineer of the abandoned electric lighting scheme for the town, has accepted the Town Council's offer of commission at the rate of 2½ per cent. on £27,000, the amount stated in his account as the total cost of the scheme, under deduction of the sum of £300 already paid to account of commission. A special meeting of the Council has been called for Nov. 15.

Sale.—The Electric Lighting Committee of the District Council will at their next meeting decide as to whether the provisional order made by the Local Government Board should be put into operation. In the meantime, the chairman has been requested to interview the chairman of the Stretford District Council, and ask as to whether it was probable that Stretford would be supplied by Manchester.

Northfleet.—The District Council have come to a very practical resolution—viz: "That the railway company be invited to consider the advantage of having the telephone in the office of their goods station, so that on the first arrival of the goods an intimation may be given to those consignees on the telephone service of the arrival of their goods, and requesting that they may be removed in the course of the day."

King's Lynn.—The engineer's last report states that there are now 226 applications for the supply of current, representing 7,244 lamps of 8 c.p., an increase of 308 during the month. The new feeder mains have been delivered by Messrs. Callender, and are now in daily use. The first engine and dynamo and new boiler are expected to be delivered in contract time. The last set of new exhaust boxes has been fixed.

Canterbury.—Mr. R Hammond has been instructed to prepare specifications and obtain tenders (subject to the consent of the Local Government Board) for an extension of the lighting plant, consisting of extensions of boiler and engine house plant, steam-pipe work, accumulators, switchboard, instruments and buildings, and foundations for plant. The resident engineer is about to prepare a scheme for main extensions.

Normanton.—A conference was held on Wednesday to discuss the advisability of sanctioning the carrying out of the electric lighting and an electric tramway scheme by the United Kingdom Electrical Association. The following Councils were represented: Featherstone, Pontefract, Castleford, Whitwood, Warmfield, and Syndale. A sub committee, consisting of two from each Council, is to be appointed to further investigate the matter.

Limerick.—Consequent on the refusal of the Local Government Board to sanction at present the loan of £20 000 for the carrying out of an electric lighting scheme, the Board of Trade have decided to defer consideration of the question of revoking the order for 12 months from Nov 9, 1900. A deputation from the Corporation will wait on the Local Government Board in Dublin this week with a view to the loan in question being granted.

Sleaford.—At the last meeting of the Urban District Council several applications for gas lamps for street-lighting were held

Digitized by Google

over until the Local Government Board had forwarded their decision as to the application for a loan of £7,000 to provide an installation of electric light for Sleaford, under the control of the Council. Complaints were received from various sources of a nuisance caused by offensive odours emanating from the town gasworks.

London Electrical Cab.—This matter, which had been before Mr. Justice Wright in the Companies' Winding-up Court on previous occasions on a petition for a compulsory winding-up, was mentioned last week. The petitioners, having consented to his Lordship's suggestion that a provisional liquidator should be appointed, an order was made that the official receiver should be appointed provisional liquidator. The question of costs was left over.

Bournemouth.—The Guardians have received a letter from the Local Government Board enclosing a copy of an extract from a report made by their architect, Mr. Gordon Smith, with reference to the proposed installation of electric lighting at the workhouse and cottage homes. The matter has been referred to the Buildings Committee, and Mr. Peers (the engineer who has advised the Board with respect to the scheme) has been asked to attend the meeting of the committee.

Thornhill.—At the last meeting of the District Council a circular was read from Messrs. Bennett and Ward-Thomas, electrical engineers, drawing the attention of the Council to the fact that a syndicate intended to apply to Parliament for an Electric Power Bill to supply the district of Thornhill, along with others. They suggested that districts should combine in opposing private companies, and to promote an alternative scheme, and proposed to send one of their representatives to meet the Council. It was agreed to confer with such representative.

Ashton.—At Friday's meeting of the Town Council Mr. Vincent tendered his resignation, he having obtained an appointment under the Bermondsey Vestry. It was resolved that Mr. Vincent's resignation be accepted with sincere regret. Mr. Bruton, the second engineer, is to take charge of the work between the time of Mr. Vincent leaving and the appointment of his successor. It was also resolved that the whole of the existing disconnecting boxes laid under the footpaths be bricked in at once, and that all additional boxes be laid in the same manner.

Sheffield.—At Friday's meeting of the Town Council the Town Clerk read a communication from the Yorkshire Electric Power Syndicate, which, he said, proposed to apply for parliamentary powers to supply electricity in bulk to local authorities, and also to supply it to manufacturers who desired it. As the latter proposal would be a distinct interference with the privilege of the Corporation, he suggested that the communication be referred to committee. It was decided to refer the matter jointly to the Parliamentary and Electric Light Committees.

Middlesbrough.—Applications have just been granted for 615 lights from different consumers short distances from the cables, requiring the purchase of a quarter of a mile of cable. The North Ormskirk Urban District Council have been enquiring if the Middlesbrough Corporation could supply electric power in bulk. A Bill is to be promoted next session for powers to supply electricity to the whole of Cleveland, Middlesbrough, and Hartlepool. The Council will probably oppose this measure. The works being practically finished, supply will be started some time in December.

London County Council.—At the meeting of the Council on Tuesday tenders for the supply of arc lamps for the Victoria-embankment and Westminster Bridge were received, and referred at once to the Highways Committee for report. Upon the recommendation of the Finance Committee it was agreed to lend the Hampstead Guardians £2 005 for erection and equipment of laundry and boiler-house, and for the installation of electric light at their workhouse. The fee for telephonic communication with the fire brigade stations was reduced from £5 to £2. 2s. per annum.

Whitby.—Two plans have been prepared for a new opening bridge at Whitby on a much larger scale than the existing one. One plan provides for an ordinary swingbridge with an opening span of 60ft. for boats, and two side spans of 30ft. and 40ft. respectively, at a cost of about £15,000, and a temporary bridge for the same £3 500, making a total cost of £18,500. This plan would be worked by electricity, and in this case the Council could use some of their surplus power at the electric light works. The matter has now been referred to the Highways and Sanitary Committee.

Appointments Vacant.—The Brighton Corporation require a junior assistant in their testing department, to assist with meter and dynamo indicator testing.—The Gas and Electric Committee of Belfast are prepared to receive applications for junior assistant in the mains department and an improver.—The electricity department of West Ham require the services of a first-rate cable jointer. Full particulars of these vacancies appear in our advertisement columns.—The Whitehaven Electric Lighting Committee will advertise shortly for a mains foreman at a commencing salary of 35s. per week.

Paignton.—The District Council have had under consideration the lighting the town with electricity, but they have been unable to take any active steps owing to the initial cost, and the fact that they already have their hands full of big schemes. Mr. Paris Singer has come forward and has offered to undertake the whole cost of lighting the central part of the town with electricity, and to give the town the option of purchase within any reasonable time for exactly the same sum that the works cost him. The Lighting Committee have been instructed to meet Mr. Singer and go into the matter with him.

London Gazette.—Notices of intention to apply for provisional orders have appeared in the *Gazette* as follows: Whitley and Monkseaton electric lighting (A. G. Robson and others), Alfreton (Urban District Council), Hindley (Urban District Council), Roundhay and district (Roundhay and District Electric Lighting Company). Application is to be made to the Light Railway Commissioners by the London and South Western Railway for the construction of a light railway between Ratfyn and Shrewton, Wilts. The liquidators in the estate of the Chitty Dynamo and Motor Company, Limited, 4, Hythe-road, Willesden, have been discharged (Nov. 10).

"English Illustrated Magazine."—The November number of this bright magazine is unusually interesting. This month's instalment of the adventures of Mr. Archibald Batts brings sport up to date by means of electric appliances provided by the thinly-disguised firm of Gaskelyne and Brooks. Mr. Halliwell Sutcliffe has a vigorous tale to tell of the time when Mary queened the Scots, and Mr. Hamilton Drummond is adding to his reputation by showing how Diego Roseas cheated the *oubliette*. There are many other good things provided—in fact, the shorts are all the best of their kind, and the more instructive essays are well worth reading, and are beautifully illustrated.

Morley.—The chairman of the Electric Lighting Committee and the engineer have been empowered to advertise and appoint a successor to Mr. Ely as electrician-in-charge. Enquiries are being made as to charges made elsewhere for current supplied through penny-in-the-slot meters, and as to wiring of premises either by the Corporation or the free wiring companies. The engineer is preparing an estimate of the capital expenditure for the next five years, and application is to be made to the Local Government Board for sanction to the necessary loan. Steps are being taken to extend the cables to Bank-street, Rooms-lane, and Barfield-terrace, and new meters are required.

Kensington.—The Special Electric Lighting Committee recommended at the last meeting of the Guardians that the workhouse, infirmary, and offices in the Marloes-road be lighted with electricity, to be manufactured on the premises, and that Prof. Robinson be instructed to prepare the necessary plans and specifications for the works required at an estimated cost of £12,500. The Clerk read a lengthy report from Prof. Robinson, in which he showed that both for economy and convenience the Guardians should manufacture their own supply of electricity. Decision was deferred until this report had been printed and issued to the members. It appears, however, that the majority of the committee were in favour of having their own plant.

Walker and Wallsend Union Gas Co.—An extraordinary general meeting of the shareholders was held in the Company's offices, Mitchell-street, Walker, on the 9th inst., at which the following resolution was adopted: "That the Company create and issue the whole of the ordinary shares remaining unissued in the electricity capital of the Company, authorised by the Walker and Wallsend Union Gas Company's Electric Lighting Act, 1899, and raise £25,000, part of the additional capital authorised by the Walker and Wallsend Union Gas Company's Electrical Capital Act, 1900, by the creation and issue of new ordinary or preference shares of the nominal amount of £10 each, or of new ordinary preference stock as the directors may from time to time determine, and that the directors be hereby authorised from time to time to dispose of such shares or stock in such manner as the directors shall think advantageous to the Company.'

"The Practical Engineer Pocket-Book."—We have received from the Technical Publishing Company, of 31, Whitworth-street, Manchester, a copy of the edition of the "Practical Engineer Pocket-Book" for 1901. In this new edition great care appears to have been taken to bring it up to the usual high standard to which it attains. The book is now in its twelfth edition, and is kept thoroughly up to date. Amongst the additions to the volume we notice the recommendation of the Institution of Civil Engineers upon the best standard of efficiency for steam engines. The steam-engine has received much attention in the book this year, there being extra tables added for the finding of steam pressures, etc. We are sorry to see that electrical engineering has but a small place in the practical engineer's estimation, as even if the ordinary engineer does not have much to do with electricity there are times when a little information on another branch of engineering may prove very useful. At the end of the pocket-book is a diary, the pages of which are square ruled, which should be very convenient to the engineer wishing to make notes to scale.

Fatal Shocks.—A fatal accident occurred on Monday afternoon at the Corporation electricity works at Newport, Monmouth. Mr. T. W. Griffiths, an assistant engineer, while on duty at the switch-board, received a shock which resulted in his death. The inquest on the deceased was formally opened on Wednesday and adjourned until to-day (Friday). The result of the post-mortem is, up to the time of writing, not known. The accident, which is very regrettable, is the first of the kind which has happened at the Newport works. It is suggested that the deceased was engaged at the time of the accident in screwing up a nut on a portion of the apparatus, and was in a stooping attitude whilst using the spanner on the nut. The spanner is then thought to have thrown deceased's left knee against a live portion of the apparatus, there being a slight burning mark on the knee-cap.—Another case of fatal shock is reported from Cheltenham, where a young man named Richard Edwards, in the employ of the Corporation, was on Tuesday afternoon killed by an electric shock while at work on a cable junction.

Stock Exchange.—The Stock Exchange Committee have appointed Nov. 28 as a special settling day for the British Electric

Digitized by Google

Traction Company, Limited, further issue of 10,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 110,001 to 120 000; and 15,000 ordinary shares of £10 each, fully paid, Nos 75,001 to 90,000, and have ordered them to be quoted in the official list. The committee have also ordered the undermentioned securities to be quoted in the official list: City of Buenos Ayres Tramways Company, Limited, further issue of 20 000 shares of £5 each, fully paid, Nos. 135,001 to 155,000; Willans and Robinson, Limited, further issue of 10 000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 60,001 to 70 000. Applications have been made to the committee to appoint a special settling day in and to grant a quotation to the Blackheath and Greenwich District Electric Light Company, Limited, provisional certificates for £100,000 4½ per cent. first debenture stock, and to the Notting Hill Electric Lighting Company, Limited, further issue of 2,200 ordinary shares of £10 each, fully paid, Nos. 10,001 to 12 200.

Partnership.—Mr. Alfred H. Gibbings writes to inform us that he has taken into partnership in his consulting practice Mr. C. A. Baker, M.I.E.E. The firm will in future be known as Messrs. Gibbings and Baker. As much of Mr. Baker's experience has been gained on the Continent, a brief *résumé* of it will be of interest as showing the strength he will add to the new firm. After a course at the Hanover-square School of Electrical Engineering, and some experience with a contracting firm in this country, Mr. Baker was appointed assistant engineer to the electric lighting station in Milan, at that time the largest in Europe. This station has always maintained a foremost place, being owned and worked by the Italian Edison Company, who generated electricity on the low and high tension systems for electric traction, power, and lighting purposes. Mr. Baker was responsible for the erection of a complete central station for electric lighting at Pallanza, on Lake Maggiore, and the subsequent working of this station for a considerable period. On returning to England, Messrs. Callender's Cable Company, Limited, appointed Mr. Baker their resident engineer, with sole responsibility for carrying out a large contract in the city of London, during which time upwards of 200 men were working under his supervision, the difficulties of executing this work in crowded thoroughfares with a system of distribution requiring the most careful and prompt attention. On the completion of this contract Mr. Baker was employed by the same firm to carry out contracts for them in the Strand district of London, in Huddersfield, Sheffield, and Hull. After working for about three years in the South Wales district with Messrs. J. C. Howell and Co., where some extensive collieries and manufactories were equipped with electrical pumping, hauling, and lighting plants, Mr. Baker accepted a position at St. Petersburg. The Telegraph Manufacturing Company, Limited, of Helsby, arranged with him to go out to prepare plans and specifications for them in connection with a central electric generating station of 10,000 h.p. that it was proposed to equip there on the high-tension alternating system by a Belgian engineering firm. A contract for the manufacture, laying, and operation of the whole of the distributing system was arranged with the English firm, and Mr. Baker was appointed by them to act as their engineer and representative for the North of Russia, advising generally on all electrical matters in connection with the equipment of the new generating station. As many as 700 men were employed under Mr. Baker's direct supervision in the execution of the work entailed under this contract, which was satisfactorily completed and handed over in working order to the Russian authorities. Mr. Baker's appointment as representative of the Telegraph Manufacturing Company, Limited, necessitated his travelling considerably through Russia and Finland, thus extending his knowledge of men and things. We wish this new firm a successful career.

Brighton.—Application is so be made for a loan of £6 440—cost of lighting the tramway routes with 117 arc lamps, the maintenance of which is estimated at £20. 13s. 2d. each per annum. On Friday the Council adopted a report from the resident engineer as to the advisability of making a special tariff for the supply of electricity to churches. The engineer was of opinion that if churches held meetings and used light on weeknights, they could not in fairness expect any better terms than any other class of consumer. It was different, however, if they used more light on Sundays than weeknights (which was most probable), as they were then in a position to meet their requirements without in any way clashing their Sunday maximum demand with the ordinary weekday maximum load on the station. This also applied to other classes of consumers who were willing to use their demand at other hours throughout the week than the usual lighting hours. He suggested that all churches which agreed to pay an increased meter rental at £1 per annum might have their demand indicators short-circuited on Sundays, and thus have their accounts based on the weekday maximum demand, which in all probability would be so much less than their Sunday maximum as to make a very material difference in their annual accounts. This principle, if they would accept it, ought also to be extended to all other classes of consumer who on weekdays were willing or likely to only take a supply at other than the ordinary hours of lighting. Such an arrangement would meet perfectly the requirements of printing offices of morning dailies and such like, and those who agree to this method of obtaining their supply would, for an extra rental of £1 per annum, be provided with a time switch which would automatically prevent the demand being registered except during the usual lighting hours. The advantage of the above suggestion was that, while strictly adhering to correct principle of maximum-demand system of charging, it fully met the requirements of churches, midnight and daily users of electrical energy. In conclusion, therefore, he would strongly advise no departure from the present system of charging, except on lines similar to those he had indicated above. The committee approved the recommendation contained in the report, and that all consumers agreeing to pay an extra charge of £1 per annum for an automatic cut-out might have their demand indicator cut out all day on Sundays and on weekdays, except during the ordinary hours of lighting—viz., from dusk to 10 p.m. A letter was read from Mr. Christie, forwarding a letter from the Westminster Supply Company requesting the support of the committee to the application of the company for an alteration to the proviso to Clause 6, Section B, of the Board of Trade regulations of March 4, 1896. It was resolved that the town clerk should write to the Board of Trade in support of the application, so as to provide for an appeal to the Board in cases in which an alteration of the standard pressure in a whole district was prevented by the refusal of consent by a small proportion of the consumers in such district.

TRACTION.

Bowness.—The Urban District Council are in favour of a tramway scheme.

Personal. — Mr. Norman Thompson has been appointed secretary of the Tramways and Light Railways Association.

Paisley.—A strong endeavour is being made locally to form a company with a view to making application to Parliament for a tramways provisional order.

Port Glasgow.—The Town Council have received a formal undertaking from the tramways company binding themselves to apply for a provisional order for power to extend the tramways to Blackstone-buildings.

Dublin United Tramways Co.—The mileage worked by the Company is now 44 miles electrically and one mile by horses, as against 35 miles electrically and nine miles by horses for corresponding period last year.

Willington.—A local syndicate proposes to endeavour to obtain a Bill sanctioning the construction of certain electrical tramways on the north of the Tyne, including the district under the control of the Willington Urban Council.

Bolton.—The new electric tramways will, it is expected, shew a yearly profit of £20 000, and the Corporation have decided to promote a Bill in the next parliamentary session extending the roads and widening the principal thoroughfares of the town.

Colchester.—Messrs. Massey and Allpress have been engaged to carry out the preliminary engineering and other works connected with the Council's application for a provisional order authorising them to construct and work tramways in the borough.

Bath.—The company promoting the electric tramway scheme in Bath have agreed so conform to the wishes of the Rural District Council provided they pass over their roads. Certain conditions as to fares and routes suggested by them have been accepted by the Council.

Sheffield.—The Tramways Committee have instructed the tramways manager and the city surveyor to report upon the facilities of the Fitzalan Market as a site for a central station, and it has also been decided to obtain parliamentary powers to use the site of the market for this purpose.

Newport.—The Corporation discussed at some length on Friday the question of leasing the new electric tramlines or running the traffic directly under the control of the Corporation. The Traffic Committee's recommendation that at the expiration of Mr. S. Andrews's lease in July next, the tramway system be worked direct by the Corporation, was adopted.

Scarborough.—The New General Traction Company, Limited, have promoted a company, styled the Scarborough Electric Tramway Company, with a capital of about £150,000, which, it is understood, is practically already assured. The scheme which the company proposes for Scarborough is a comprehensive one, and is estimated to involve an outlay of £120,000.

Cleator Moor.—A proposal of a syndicate who intend to ask for power for the construction and equipment of a tramway from Cleator Moor to Maryport, and who desire to come to terms with the various authorities if possible, suggesting that the town clerks of Whitehaven, Maryport, and Workington should discuss their proposals, is before the Works Committee of the Urban District Council.

Dundee.—A new proposal has been brought forward by the burgh engineer with a view to avoid the steep gradient in Constitution-road. This has been favourably considered by the Tramway Committee, and is to be brought before the Council with the view of it being substituted for the route by Barrack-road. The proposed new route is both shorter and cheaper than the one formerly adopted.

Beetle.—The consideration of a proposal from the general manager of the Liverpool Corporation tramways to construct a tramway from Litherland to Rimrose Bridge through Seaforth Village, has again been deferred. A memorial protesting against the construction of this tramway along Seaforth-road has been referred to the Tramway Committee, and it has been pointed out that if a tramway was laid they must leave sufficient space, which would probably necessitate the pulling down and setting back of the houses, so that if the road was widened by that means it would dispose of a good many of the objections.

Digitized by Google

Erdington.—The Council have passed the following resolution: "That in the opinion of this Council the time had arrived when it would be to the advantage, convenience, and benefit of the inhabitants at large to have a system of tramways properly equipped and of an up-to-date character for the district; and that accordingly a committee be appointed to consider and report upon what in their opinion was the best system of tramways to be constructed, and to the roads along which they should be laid."

Gosport.—A small committee has been appointed to settle in a final interview with the companies' representatives in London the various tramway matters under discussion. The two agreements submitted by the Electrical Power Distribution Company and the British Electric Traction Company have been revised by the Council, and their alterations have been considered by the companies. The transfer of the existing system to the Corporation will take place on the last day of the year, and on the first day of the new century it is hoped to make a start with the relaying of the lines for the introduction of electric traction.

Northampton.—Application is to be made to the Board of Trade on or before Dec. 22 next for a provisional order under the Tramways Act, 1870 (to be confirmed by Parliament in the ensuing session), to authorise the Corporation to construct tramways in extension of the existing tramways in Kettering-road (as far as the Church of St. Matthew in Phippsville), and in Wellingborough-road, as far as the gates of Abington Park; to empower the Corporation to work any tramways for the time being belonging to them; to double the lines of such tramways where expedient; and to employ electrical or other mechanical motive power; and to make further and better provision in regard to the tramway undertaking for the time being belonging to the Corporation.

Bournemouth.—Mr. A. P. Trotter has held an enquiry into the application of the Corporation for sanction to borrow £174,750 for the construction and electrical equipment of a tramway authorised by the Corporation Tramways Order. 1900 The Town Clerk pointed out that the Poole and District Electric Traction Company had a light railway order to construct a tramway from Bournemouth to Poole, which was now being laid, and the Christchurch and Bournemouth Company had powers in their order of last session to construct a tramway between the two towns. They had running powers over the Bournemouth East line from east to west. The Town Council will now proceed with the application for the Bill for the tramways extensions, street widening, and other objects resolved upon.

Cleckheaton.—The Council have signed an agreement with the British Electric Traction Company, based on the arrangement made at the recent enquiry in Leeds, whereby the company undertake to pay half the cost of three widenings in Westgate in connection with their electric tramway scheme—viz., at the Square, at Victoria Mills, and at Moorbottom, near St. Luke's Church and Messrs. Umpleby's boiler works. The Council do not pledge themselves by the agreement to carry out any of the works, but whatever they did the Traction Company pledged themselves to pay half the cost at any time during the next three years. The expenses would include the cost of the acquisition of necessary properties, and the Council are entitled to call for payment of the half cost as soon as the works or any of them were completed.

Burton.—The tramway scheme adopted by the Council consists of six lines, and contains the following proviso: "That the carriages and trucks on the said tramways be moved by animal, mechanical, or electrical power, as the Town Council may from time to time determine." The promoters of the proposed Woodville and Burton tramways are to be informed of the tramways which the Council are seeking powers to construct, work, and maintain, and that the Council will consider any proposition as to running powers over that portion of the tramways between the borough boundary on the Stanton-road and Stapenhill-green which the promoters may desire to make, and that the clauses necessary for or relating to the carrying out the foregoing objects and incidental thereto be forthwith prepared and inserted in the draft Bill to be introduced by the Council into Parliament next session for the consideration of the Town Council.

Warrington.—At the last meeting of the Rural District Council a letter was read from the South Lancashire Tramways Company to the effect that the company were applying this year to Parliament for an extension of their tramway system from Newton, through the Warrington rural district, to the boundary of the borough of Warrington. The company obtained powers last session to construct certain tramways through St. Helens, Earlestown, Newton, Atherton, Leigh, and Bolton, with branches connecting these places with Haydock, Ashton, Abram, Hindley, Westhoughton, Little Hulton, Walkden, Swinton, Atherton, with Tyldesley and Worsley. It was proposed to make the extension to Warrington, in pursuance of the request of one or two local authorities last year. If the Council approved of the extension the company desired them to pass a resolution consenting to it. The matter was adjourned pending enquiries by the surveyor.

Baker-street and Waterloo Railway.—We refer elsewhere to the issue at par of 66 000 4 per cent. preference shares and 172,500 ordinary shares of £10 each which is just being made in this Company. Interest during construction will be paid half yearly at the rate of 3 per cent. per annum. The directors are Mr. Theodore Julius Hare (chairman), the Marquis of Dufferin and Ava, K.P., G.C.B., G.C.M.G., etc., Mr. Quintin Hogg, Major-General C. S. Hutchinson, C.B., late R.E., and the Right Hon. Sir Algernon West, K.C.B. The Baker-street and Waterloo Railway as authorised is five miles two furlongs in length, or thereabout, and will be formed by the construction of two separate parallel tunnels throughout its entire length on the Greathead system. Starting at the Elephant and Castle, on the south, it passes Waterloo Station, thence under the river, up Northumberland-avenue, Charing Cross, the Haymarket, Regent-street, Portland-place, Regent's Park, Baker-street, Marylebone Station (the terminus of the Great Central Railway), and Edgware-road, to Paddington Station. The site for the necessary depôt and generating station is about a quarter of a mile to the south of Waterloo Station. The stations will be placed at or near the following points—viz., Elephant and Castle, Waterloo, Thames Embankment, Charing Cross, Piccadilly-circus, Oxford-circus, Baker-street, Marylebone, Edgware-road, and Paddington. The line will thus form a connecting link between the District and Metropolitan, the Central London, the City and South London, the Waterloo and City, the South-Western Railway, South-Eastern Railway, Great Western Railway, London, Chatham, and Dover Railway, and the Great Central Railway. The works between Waterloo and Baker-street, which are being constructed by Messrs. Perry and Co., the well-known firm of contractors, are in full operation, and this section will be completed and opened for traffic independently of the rest of the line. From the river stage northward the western or down tunnel (towards Baker-street) has been driven beyond Piccadilly and up Regent street as far as the western end of Messrs. Swan and Edgar's premises. The up tunnel has been completed between the river stage and the statue of King Charles at Charing Cross, and between Swan and Edgar's and a point in the Haymarket opposite Her Majesty's Theatre. The tunnels at Baker-street have been driven under the St. John's Wood Railway, and underneath the Regent's Park; the down tunnel to the north side of the Park-square-gardens, and the up tunnel to the western side of the Outer Circle road. Southward of the river stage the down tunnel has been constructed nearly across the river, and the difficult operation of driving through the water-bearing gravel in the bed of the Thames has been successfully accomplished. The permanent shafts for the reception of the lifts have been sunk at Baker-street and Piccadilly, and one of the shafts is in progress at Waterloo. The up-station tunnel at Baker street has been completed. Both station tunnels at Piccadilly-circus are finished, and at Charing Cross one tunnel is completed and the other is in progress. At the Thames Embankment station the up tunnel is finished. An ample supply of shields and plant of all descriptions having now been provided, the works will proceed more rapidly than heretofore, and should be completed in two years from this date. It is needless to say that the motive power will be electricity, and it is anticipated that the entire distance will be covered in 25 minutes. The engineers are Sir Benjamin Baker, K.C.B., Mr. W. R. Galbraith, C.E., and Mr. R. F. Church, C.E.

LEGAL INTELLIGENCE.

LONDON COUNTY COUNCIL v. THE NATIONAL TELEPHONE COMPANY.

In the Queen's Bench Division on Monday last Mr. Justice Wills and a special jury commenced the hearing of the action by the London County Council against the National Telephone Company. The action raised an important question as to the right of the National Telephone Company to lay wires under the streets. The action was brought to restrain the defendants from breaking-up streets in the county of London to lay their telephone wires underground without the consent of the London County Council. The case was put in two ways: first, that under the Telegraphs Act the defendants had no right to do what they had done; and, secondly, they were creating obstruction by breaking-up the streets. The defendants said they were not acting under the Telegraphs Act at all, and that they had created no obstruction. The plaintiffs, in reply, joined issue.

Mr. Dickens, Q.C., and Mr. Daldy appeared for the London County Council, and Sir Edward Clarke, Q.C., Mr. Joseph Walton, Q.C., and Mr. Roskill represented the Telephone Company.

Sir Edward Clarke asked for permission before the case was opened to called his Lordship's attention to some correspondence which had taken place between the solicitors of the National Telephone Company and the solicitors of the London County Council. This was one of two sets of proceedings which were brought against the National Telephone Company. One was brought by the Attorney General at the relation of the Postmaster General, and the other by the London County Council, and they substantially involved the same questions, as to whether an injunction should be granted, whether there had been an interference with public right, and so on. Both matters involved serious questions of law, as well as very complicated questions of fact. The information of the Crown came on first, and in that proceeding, which was before one of the Queen's Bench Courts in July, the National Telephone Company submitted to terms under which they were restrained, as between the Government and themselves, from doing any work for extending the existing system of the Telephone Company under the streets of London, and the whole object that could be achieved by going into the litigation which was then before his Lordship was, he thought, completely fulfilled by the terms which were arrived at in the former action. Under those circumstances his clients had written an open letter, to be used in the Court, to the plaintiffs' solicitors, and he asked that he might be allowed to read it. The letter was as follows: "As the trial of this action will shortly be reached, it is worth while considering the position as between the parties. As you are

Digitized by Google

no doubt aware, an information by the Attorney-General, at the instance of the Postmaster-General, was laid against the company with a similar object to that sought by the County Council in the present action, and the Crown action has been disposed of by an order which declares the law and restrains the company from breaking the surface of any street within the county of London for the purpose of extending its underground pipes without obtaining the authority of the Postmaster-General and the consent of the London County Council, as required by the Telegraphs Act of 1892." He thought that put the Telephone Company in a position which carried out all that the County Council in this litigation could require. The letter went on: "It seems to me to be a useless waste of money to fight out the present action, seeing that the order made in the Crown action secures to the County Council what it requires, and I have, therefore, to suggest that instead of going to trial at present the County Council action should be allowed to stand over *sine die*." The reply of the representatives of the London County Council was that they did not think it desirable that the action should stand over. The solicitor of the County Council wrote: "I have some difficulty in understanding why the Telephone Company, after submitting to judgment in the Post Office information, has nevertheless persisted in defending the present action. The order in the Crown action does not appear to me to secure anything at all to the County Council, for it would be open to the Telephone Company to arrange its differences with the Postmaster General to-morrow, and, therefore, so far as that judgment is concerned, to continue breaking-up the streets. If, however, the Telephone Company will consent to a similar judgment in the present action I am prepared to advise the Council to accept it, and so put an end to the litigation." Sir Edward Clarke proceeded to say that the Telephone Company could not consent to judgment or to anything, or to give an undertaking in this action. His Lordship would understand there were considerations with regard to the position of the parties which would prevent him under any circumstances submitting to a judgment. The case must involve a very long investigation of facts, and on the finding of the jury his Lordship would be asked to deal with questions of law and to exercise his discretion in granting an injunction. The litigation could not in any case stop there. He was very much impressed with the idea that it would be a misfortune if they were to spend several days of public time there to come only to the position of having the material for going into another court when all that could be done in this litigation was already secured by the terms of the judgment in the other action.

Mr. Dickens said there was a difficulty in the way of accepting his friend's suggestion. There were two proceedings, advisedly commenced by the Attorney General on the basis of the interest of the Postmaster General, merely representing the Post Office service in this country, and by the London County Council as representing the public. The two interests were not identical. The defendants submitted to an injunction in the action of the Postmaster General, and they were bound to obtain the consent of the County Council before breaking open the streets. He did not wish to enter into a long litigation in the present case, but he had not seen the members of the Highways Committee, and he would not like to consent to the suggestion of Sir Edward Clarke without consulting them.

Mr. Justice Wills said at the present moment he did not quite appreciate the difficulty of the Telephone Company in giving an undertaking similar to the one given to the Postmaster-General. He supposed it was very likely that the Postmaster-General would allow them, after getting that judgment, to break up the streets without obtaining the consent of the London County Council. On the other hand, the County Council had not got the security as between themselves and the defendants.

Sir Edward Clarke said if his Lordship would look at the pleadings he would find there were serious questions, which made it impossible for the Telephone Company to come under the terms of an injunction or an order. There were important legal questions which they wanted to raise. Precisely the same result might be obtained if the action stood over generally, with leave to apply to restore it; and if the Telephone Company was to do anything in contravention of the injunction, the case might come into the paper the next day. If it were a mere technicality, he would give way.

His Lordship did not think the course proposed by Sir Edward Clarke was an unreasonable one. Probably he would give the plaintiffs an undertaking not to attempt to do anything in contravention of the order obtained by the Postmaster-General without giving the County Council due notice of it.

Sir Edward Clarke said he was quite prepared to agree, and to undertake, on the part of his clients, that no action should be taken in contravention of the Postmaster-General's order without giving notice to the London County Council, so that they could have an opportunity of applying at once.

Mr. Dickens said he was glad that his Lordship had made the observation that the course suggested by Sir Edward Clarke was reasonable. Having regard to the importance of the matter, he would ask that the action might stand over for a fortnight in order that he might put the proposition and his Lordship's suggestion before his clients. If the matter could be arranged, they would only have to come formally before the Court. If the case must go on, the plaintiffs would not be in a worse position than at present.

Mr. Justice Wills thought the best form of order would be that the case should stand over generally to keep its place in the list, with leave to either party to restore it. If any terms were come to, the case could be mentioned without its being put in the paper.

The action was then ordered to stand over generally.

NEW COMMITTEES.

The following Standing Committees have been appointed:

ABERDEEN.—*Streets*: Bailie Brebner (convener); Messrs. Smith, Anderson, and the Provost.

ALLOA.—*Lighting*: Bailies Home-Hay, Duff, and Calder; Messrs. Crawford, Duncanson, and Wilson; Mr. Duncanson, convener.

BACUP.—Five members of the Lighting Committee and five members of the General Works Committee are to be elected by their respective committees to serve on the Electricity Committee for the ensuing year.

BARROW.—*Highways and Lighting*: Alderman Bradshaw; Councillors Ashburner, Barrow, Charles, Dawson, Hardy, Heath, W. Heweteon, Jos. Huarteon, Miller, Neal, Peacock, Stoker, Thompson, Townsend, and Young. *Electricity*: Aldermen Bradshaw, Little, and Townson; Councillors Ashburner, Chapman, Cox, Fisher, Gradwell, Hardy, W. Heweteon, Miller, Postlethwaite, Smith, Peacock, Tootill, and Townsend.

BIRKENHEAD.—*Tramways*: Aldermen Cook, Deakin, B. Jones, Rawcliffe, and Singleton; Councillors Bevis, Edwards, Gamlin, Grice, Hazlehurst, Lilwall, Oates, H. L Pearson, Snape, and Wall. *Electricity*: Aldermen Bloor and Rawcliffe; Councillors Bennett, Dalzell, Dodds, Hazlehurst, Lilwall, McGaul, Moon, H. L. Pearson, T. T. Rees, Tooth, Wall, and C. Williams.

BLACKBURN.—*Electricity and Tramways*: The Mayor; Aldermen Thompson, Baynes, Oddie, Dugdale Heyworth, Law, Billington, and Hoyle; Councillors Lewis, Gregson, Meadowcroft, Crossley, W. H. Law, Hamer, Worswick, and Critchley.

BOLTON.—*Electricity*: The Mayor; Councillors W. Cooper, Young, Preston, J. Edge, J. W. Taylor, Russell Panton, Berry, Rothwell, Rideout, Golding, J. D. Taylor, and Fielding. *Tramways*: The Mayor; Aldermen Nicholson, Miles, and T. Scowcroft; Councillors Battle, Preston, Panton, Howarth, J. Edge, Flitcroft, Smith, Bailey, Wild (Deane), P. Higson, and Harwood.

BRADFORD.—*Electricity*: Aldermen W. E Aykroyd, J. Hustler, and R. Pratt; Messrs J. Akam, T. L Atkinson, T. Clark, F. L Crofts, C. E Dawson, J. Freeman, T. H. Shaw, and T. A. Williamson. *Tramways*: Aldermen Cowgill Holdeworth, and Milner; Messrs. Akam, Atkinson, Crofts, Crossland, Firth, Hartley, Hill, Horsfall, Land, J Moorhouse, North, Pickles, E. Priestley, W. E. B. Priestley, Sowell, P. Smith, Stringer, Watson, Whiteley, Wickham, T. Wilkinson, and Williamson.

BRIGHTON.—*Telephone*: Councillors Allen, Buckwell, Burberry, Carden, Galliers, Halliwell, Holder, Hollis, Jarvis, Kidd, Neale, and Wilson. *Tramways*: Aldermen Reeves and Sendall; Councillors Blaker, Buckwell, Carden, Galliers, Grinstead, Halliwell, Holloway, Swift, Wallis, and Wilson. *Light*: Aldermen Botting and Lowther; Councillors Blaker, Briant, Broadbridge, Buckwell, Butt-Thompson, Carden, Galliers, Halliwell, Holloway, and Swift.

BRISTOL.—*Electrical*: The Lord Mayor; Aldermen Pethick and Pearson; Messrs. Tryon, Hughes, Lloyd, Elkins, Billing, Harris, Chandler, Lowe, and Dr. Cook.

CANTERBURY.—*Lighting*: The Mayor; Aldermen Cross, Collard, and Mason; Councillors Gentry, Godden, Horsley, Hunt, Stone, Pope, and Russell.

DEWSBURY.—*Gas, Electricity, and Water*: The Mayor; Alderman Haley; Councillors Machell, McCann, Newsome, Oldroyd, Pearson, Rhodes, and Yates.

DUNDEE.—*Tramways*: Mr. Brownlee, convener.

EASTBOURNE.—*Electric Light*: The Mayor; Aldermen Skinner, Strange, Pocock, Wenham, and Eden; Councillors Hillman, Martin, Maude, Rowe, Simmons, and Wright.

ECCLES.—*Public Lighting and Electrical Supply*: Aldermen Kendal and Mellor; Councillors Broughton, Hindley, Mort, Nuttall, Oldfield, and Pearson.

FALKIRK.—*Lighting*: Bailie Bogle (convener); Messrs. Weir, Sherburn, Hendry, Mitchell, H. Wilkie, H. Russell, J. G. Russell, and Stevenson.

GLASGOW.—*Electricity*: Bailie Maclay, convener; Bailie M'Cutcheon, sub-convener. *Telephone*: James Alexander, convener; Bailie Stevenson, sub-convener. *Tramways*: Walter Paton, convener; Hugh Alexander, sub-convener. On telephone wire attachments to Corporation property—James Alexander, convener.

GLOUCESTER.—*Electricity Supply*: The Mayor (*ex officio*); Aldermen Estcourt, Matthews, Braine, Mousell, and Woodward; Councillors Karn, Clutterbuck, J. Clarke, Bland, Goddard, Hatton, Gurney, Poole, and Brown. *Street*: The Mayor (*ex officio*); Aldermen Estcourt, Matthews, Braine, Mousell, Ward, and King; Councillors Clutterbuck, Peters, J. Clarke, Goddard, Gurney, Poole, Brown, Estcourt, and Gream.

HOVE.—*Lighting*: Aldermen Clark and Washington; Councillors A. B. S. Fraser, Hollamby, Jupp, Nye, and Singer.

IPSWICH.—*Electric Lighting*: The Mayor; Alderman S. R. Anness; Councillors F. Bennett, E. Catchpole, R. D Fraser, J. Pratt, W. T. Pretty, E. P. Ridley, F. Turner, and Owen Turner.

KEIGHLEY.—*Gasworks and Electricity*: The Mayor; Aldermen Paget and Brigg; Messrs. Pollard, Newton, Snowden, Summerscales, and Walsh.

LEEDS.—*Lighting*: Alderman Lawson's name deleted; Mr. James in place of Mr. F. J. Pickersgill. *Tramways*: Alderman Gordon in place of Alderman Lawson.

Digitized by Google

LEIGH —*Highways and Works*: Aldermen Dennis, Howard, Ingram, and Tolhurst; Councillors Allen, Berry, Browne, Roberts, and Walker. *Light Railways*: Aldermen Brightwell, Burrows, and Dennis; Councillors Allen, Berry, Doody, Hudson, Jones, Martin, Millican, Roberts, and Wilkinson.

MANCHESTER —*Electricity*: The Lord Mayor; Aldermen Bax, Griffin, and Richards; Messrs. Arrandale, Batty, Beastow, Bishop, Bowes, Boyle, Hesketh, Jennison, Johnston, Maben, Phythian, J. Simpson, Smith, Vaudrey, and Wainwright. *Tramways*: The Lord Mayor; Aldermen Bax, Mainwaring, and Tunstall; Messrs. Batty, Bishop, Bowes, Boyle, Brocklehurst, Dearden, Dixon, Fildes, Edwyn Holt, Hodge, Hornby, Johnston, M'Cabe, Ogden, Scott, Sutton, Thompson, Trevor, Wainwright, Whyman, and Wilson.

MORLEY.—*Electric Lighting*: The Mayor; Aldermen Foster Horsfall, Binks, and Ingham; Councillors Watson, Glover, Oakes, Smith, Scholes, Hirst, Tetley, Craven, Rhodes, and Jowett. *Light Railways*: The Mayor; Alderman Glover; Councillors Buttery, Rhodes, Marsden, Scatcherd, Jowett, Tetley, and Smith.

NEWPORT.—*Lighting and Traffic and Electricity*: The Mayor; Aldermen Moses, Parnall, Jones, and Pugsley; Councillors W. J. Lloyd, Dunn, Liscombe, F. Phillips, G. W. White, Gower, M. A. Baker, G. H. Llewellyn, Abrahamson, and Blackburn.

NORTHAMPTON. — *Tramways and Electric Light*: Councillor Wooding (chairman); Aldermen Judge and Wetherell; Councillors Brown, Jackson, Lewis, Martin, J. Perkins, and Tonsley.

RAWTENSTALL. — *Electric Light and Tramways*: Aldermen Compston, Woodcock, Sharples, and Worswick; Councillors Coupe and Schofield.

ROTHERHAM — *Electric Lighting and Tramways*: Aldermen Woodhouse and Hickmott; Councillors Cox, Gichard, Winter, Crank, Hirst, Copley, Jenkinson, and Fieldsend.

SHEFFIELD.—*Electric Light*: Aldermen W. E. Clegg, Styring, and Sir Charles Skelton; Councillors Bennett, Colver, Nowill, Senior, Castle, Harrison, John Maxfield, G. Clark, and Tandy. *Tramways*: Aldermen W. E. Clegg and Styring; Councillors Chambers, Furness, G. Jackson Smith, Bennett, Fenton, A. M. Wilson, Wing, Knowles, Carr, Hobson, John Smith, Tandy, and J. R. Wheatley.

SOUTHAMPTON.— *Tramways*: Messrs. Dunsford, Bencraft, Pearce, Sanders, Tilling, Walton, Willey, Bone, Andrews, Hollis, Burbage, and Garcia. *Electricity*: Messrs. Blakeway, Cawte, Dunsford, M. Emanuel, C. Emanuel, Tilling, Willey, Bone, Le Feuvre, Button, Garcia, and Rowland.

TORQUAY.—*Electric Light*: Aldermen Kerswill and Bovey; Councillors Beavis, Harrison, Taylor, Pickard, R. Smerdon, Greenslade, Bowden, and Pearson.

WALSALL.—*Electric Lighting*: Aldermen Brownhill, Lindop, Marshall, and Newman; Councillors Brownhill, Burt, Cope, Millerchip, Noake, Shore, W. Smith, and Walker. *Tramways*: Aldermen Baker, Clare, and Newman; Councillors Brownhill, Cope, Cotterell, Hughes, Millerchip, Noake, Pearman-Smith, Powell, and Turner.

WORTHING.—*Electric Lighting*: The Mayor (Councillor Ovenden); Aldermen Linfield and Piper; Councillors Butcher, Gravett, Raffety, Tate, and Walter.

PROVISIONAL PATENTS, 1900.

NOVEMBER 5.

19782. Improvements in metal or composition sheathed insulated electricity conductors. David Roberts, 3, Whiston-street, Derby.

19809. An improvement in or in connection with trolley arm standards for electric railways or tramways. Stainer Hutchins and Charles Edmund Fry, Hawthorn Bank, Stamford-road, Altrincham.

19822. An improved conduit for electric cables and the like. Oliver Charles Summers, 82, Malmesbury-road, Bow, London.

19824. Improvements in and relating to printing by telegraphy. John Burry, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

19829. An improvement in electrical locking apparatus for railway signals. George Henry Jelfs, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

19836. Improvements relating to electric call apparatus. Max Joseph Buxbaum, 45, Southampton-buildings, Chancery-lane, London.

19847. Improvements in electric fuses. Oliver Leopold Peard, 24, Southampton-buildings, Chancery-lane, London.

19852. Improvements relating to electric lamps. Willibald Felsch, 27, Chancery-lane, London.

19858 Improvements in electrical switches. William Sumner, 6, Lord-street, Liverpool.

NOVEMBER 6.

19877. Improvements in printing telegraph machines. Alfred Lyster Shepard, 8, West Kensington-gardens, Kensington, London.

19900. Improvements in and connected with electric punkah motors. Heinrich Spühl, 4, Corporation-street, Manchester. (Complete specification.)

19902. Improvements in joint-boxes for distribution of electric current from concentric or other cables. Francis Ernest Hammond, 115, St. Vincent-street, Glasgow.

19910. Improvements in or relating to overhead trolley wires or conductors for electric traction overhead electric cables or the like. Augustus Wyvill Hancock, John Leighton, and Robert Hacking, 111, Hatton-garden, London.

19922. Improvements in overhead electric fittings. Paul Traugott Julius Estler, and Franz Kleinsteuber, 52, Chancery-lane, London.

19934. Improvements relating to the mounting of electric bells. Charles Woittequand, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

19945. Improvements in incandescent electric lamps. William Phillips Thompson, 322, High Holborn, London. (Alf Sinding-Larsen, Norway.) (Complete specification.)

19948. Improvements in and relating to automatic switch systems for telephone lines. Johan Peter Pehrson, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 10, 1900, being date of application in Sweden.)

19951. Improvements in or relating to dry-core cables and the like electric conductors. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

NOVEMBER 7.

19987. An improved electrical connection or bond for application to railway or tramway rails. William Robert Sykes, Arthur Henry Johnson, and Charles Joseph Cooke, Winfrith, The Avenue, Bickley, Kent.

19988. An improved insulating rail joint for railways or tramways which offers considerable resistance to currents of electricity. William Robert Sykes, Arthur Henry Johnson, and Charles Joseph Cooke, Winfrith, The Avenue, Bickley, Kent.

19989. Telephone transmitter of the sounds of rifle fire, Maxim fire, pom pom fire, and Long Tom fire with the noise of its shell in progress and its ultimate bursting. Arthur James Cleland Jackson, Rathmore, Greenisland, co. Antrim.

20016 Improvements in and connected with switches or keys in electric lampholders. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellsch. fo Mix und Genest, Germany.)

20049. Improvements in the manufacture of elements or plates for electrical storage batteries. Jasper Myers Richardson and Harry Ramsbottom, 427, Strand, London.

NOVEMBER 8.

20110. A safety swinging arm for carrying overhead electric wires. Herbert George Thomas, 36, Greenwood road, Hackney, London.

20112 Induction electric telephony and telegraphy. John Robert Quain, Royal Colonial Institute, Northumberland-avenue, London.

20135. Improvements in the control of electrically-propelled vehicles or trains. Edward Henry Tyler and Arnold Greaves Hansard, 15, Kirkstall-road, Streatham-hill, London.

20139. Improvements in automatic telephone switches. Johan Peter Pehrson and Gotthilf Ansgarius Betulander, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 12, 1900, being date of application in Sweden.)

20146. A sound-strengthening appliance for telephone stations. Franz Oprendek and Louis Röder, 4, South-street, Finsbury, London.

NOVEMBER 9.

20152. Improvements in or relating to magneto electric and other ignition devices. John Ridley and George Gibson, 18, Cavendish-street, Birkenhead.

20177. Commutator or collector for electrical purposes. Emile Batault, 21, Ely-place, Holborn-circus, London.

20179. Improved construction of electric arc lamp. Eric Rivers Smith, John James Rathbone, and Charles Bean King, jun., 166, Fleet street, London.

20186. An improvement in air-brakes controlled electrically and by air pressure. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

20197. Improvements in the construction of metal troughs for laying electric mains. Maurice Lachman, 6, Bream's-buildings, Chancery-lane, London.

20200. Improvements in or relating to electrolytic cells. John Hall Noble and Alfred Merry, 6, Lord-street, Liverpool.

20201. Improvements in or connected with apparatus for covering electric conductors with insulation. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

NOVEMBER 10.

20231. Improvements in electrical connections. Robert Frederick Hall, 24, Temple-row, Birmingham.

20255. A new or improved fitting or accessory for electric ceiling roses and the like. William Grimshaw Stones, 55, Market-street, Manchester.

Digitized by Google

20256. Improvements in or relating to swinging brackets for electric lights and the like. Alfred Julius Boult, 111, Hatton-garden, London. (K. M. Seifert und Co., Germany.)

20264. Improvements in connections for electric mains. Charles Douglas Burnet, 24, Southampton-buildings, Chancery-lane, London.

20277. Improved means for supporting the osmium filaments of electric incandescent lamps. Oliver Imray, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London. (The Oesterreichische Gasglühlicht-und Electricitäts-Gesellschaft, Germany.)

20285. Improvements in chains for suspending electroliers, electric lamps, and the like. Edwin Fletcher, 5, Corporation-street, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Dec. 1.

1899.

23753. Maximum electrical current indicators. Rimington.

24459. Electric telegraph apparatus. Dearlove and Brown.

24942. Electric brakes. Tingley. (Date applied for under International Convention, May 18, 1899.)

25299. Electricity meters. Johnson.

1900.

164. Electric incandescent lamps. Stead and Carr.

182. Electric ignition devices for internal-combustion engines. Northey and Electric Motive Power Company, Limited.

630. Method of and apparatus for connecting electric meters in three-wire circuits. Dick and Reason Manufacturing Company, Limited.

659. Electric switches. Gardy.

1704. Electric alarms. Mills. (Vial.)

1906. Electric pendulum clock. Haenichen and Haenichen.

2282. Dynamo-electric machines. Dalén and Hultqvist. (Date applied for under International Convention, July 7, 1899.)

5710. Indicator for storage batteries. Tiddeman.

6261. Electric switches and resistances. Atkinson.

7759. Electrically-operated submarine working devices. De Pauer and de Kutschera.

9751. Switches for electric tramways on sectional conductor and like systems. Eyre.

13966. Roentgen-ray tubes and other vacuum tubes. British Thomson-Houston Company, Limited. (Thomson.)

14104. Electrodes for use in electro-chemical processes. Lauckner. (Vogelsang.)

15721. Telephone systems. Cedergren and Piltz.

16702. Dynamo-electric machines. British Thomson-Houston Company, Limited. (Rice.)

16706. Means for preventing hunting of dynamo-electric machines. British Thomson-Houston Company, Limited. (Buck.)

16945. Electric igniters for explosion motors. Ricard and Gary.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Nov. 11	575	463	+ 112	16,916	14 606
Birmingham Trams.	,, 10	4,490	4,414	+ 76	197,306	187,740
Blackburn Corp'rat'n	,, 3	437	389	+ 48	19,833	17.579
Blackpool Corporatn.	,, 8	253	163	+ 90	26,782	19,732
Blackpool-Fleetwood	,, 10	170	182	- 12	19,256	19,243
Bolton Corporation..	Oct. 28	1,254	—	—	42,293	—
Bradford City Trams	Nov. 11	673	357	+ 316	16,942	12,813
Bristol Tramways Co.	,, 9	2,940	2,997	- 57	—	—
Carlisle Tr'mw'ys Co	,, 11	152	—	—	3,629	—
Central London Ry.	,, 10	5,699	—	—	76,761	—
City & South London	,, 11	1,848	1,082	+ 766	30,242	18,427
Cork E. T. and L. Co.	,, 8	382	374	+ 8	18,643	17,141
Dover Tramways ...	,, 10	185	171	+ 14	9,429	8,990
Dublin & Lucan E.R.	Oct. 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	Nov. 9	3 511	2.728	+ 783	—	—
Dublin S.D. Electric	,, 9	751	710	+ 41	—	—
Glasgow Corporation	,, 10	9,168	8,864	+ 304	—	—
Halifax Corporation	,, 10	677	581	+ 96	25,441	20,093
Hull Corporat'n E.S.	,, 10	1.358	668	+ 690	41,656	—
Liverpool Corporat'n	,, 3	8,555	7,147	+1,408	347.757	302,893
Liverpool Overhead	,, 11	1,541	1,684	- 143	31,996	31,361
St. Helens Tramways.	,, 7	—	—	+ 216	—	—
Sheffield Corporation	,, 11	2,608	—	—	—	—
Southampton Trams	,, 8	693	346	+ 347	—	—
Southport Corporat'n	Oct. 27	374	—	—	2 399	—
Swansea Tramways..	,, 5	447	263	+ 184	7,093	4,462

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-¾
British Insulated Wire, Ord., 1-40,000	5	—	10½-11½
—— 40,001-70,000	5	—	10½-10¾
—— 6 per cent. Cum. Pref., 1-40,000	5	..	6¾-6¾
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	¼-½
—— 4½ per cent. First Mortgage Debentures	103	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures	100	—	110-114
—— Ordinary	5	—	12½-12¾
—— 5 per cent. Pref.	5	—	5-5¼
Crompton and Co.	2	—	2¼-4
—— 5 per cent. Debentures	—	—	99-103
Edison and Swan United, Ordinary	2	—	1¾-2¼
—— 5 per cent. Debentures	5	—	2¾-4¼
—— 6 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	—	96-100
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-12¾
—— 4½ per cent. Preference	5	—	5¼-5¾
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½-21½
—— 4 per cent. Debentures	100	—	99-102
Telegraph Construction and Maintenance	12	—	36 41
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5¼-5¾
Willans and Robinson, Ordinary, 1-30,000	5	—	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-¾
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	102-106
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¾-6¾
Charing Cross and Strand	5	..	9½-10¼
—— 4½ per cent. Cum. Pref.	5	—	5¼-6
Chelsea Electricity Supply	5	—	6-6¼
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	8¼-9½
—— 6 per cent. Cumulative Pref.	10	—	13-13½
—— 5 per cent. Debenture Stock	100	—	125-130
County of London and Brush Provincial, Ordinary	10	—	8¼-9¼
—— 6 per cent. Cum. Pref.	10	—	11-12
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	106-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¾-5
—— 4½ per cent. First Mort. Deb.	100	—	101-104
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¼-6
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10½
London Electric, Ordinary	2	—	1¾ 2¼
—— 6 per cent. Pref.	5	—	4¾-5¼
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-102
Metropolitan, Ordinary	10	—	13¾-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	112-115
—— 5½ per cent. Mortgage Debenture, Red	100	—	97-100
Notting Hill Electric Lighting	10	—	14¾-15¼
Oriental, 1879	1	—	1¾-1¾
—— £5 Shares	5	—	7-7¼
—— £4½ Shares, New	4½	..	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,210	5	..	5¼-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	—	180-200
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	2	—	2¼-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	—	15-16
—— 7 per cent. Pref.	5	—	8-9
—— 3½ per cent. Deb.	100	..	99-101
Westminster, Ordinary	5	—	12-13
—— 30,001-109,437	5	—	11¼-12¼
Electric Railways.—			
Central London, Ordinary	10	..	10¼-10¾
—— Pref. Half-Shares	5	—	5-5¼
—— ,, ,, deferred	5	—	5-5¼
City and South London, Consolidated Ordinary	100	—	54-58
—— Ordinary	10	—	4¼-5¼
—— 4 per cent. Debenture Stock	100	—	118-122
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	12-12¼
Waterloo and City, Ordinary	100	—	92 96
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9¾-10¼
British Electric Traction, Ordinary	10	..	13-14
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-122
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	—	105-108
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9¾-10¼
New General Traction, Ordinary	5	—	2¾ 4
—— 6 per cent. Cum. Pref.	5	—	4¾-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17¼
—— 5 per cent. Cum. Pref.	10	..	10¼-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11-12
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9¾-10¼
—— 4½ per cent. Debenture Stock	100	—	104-107
Telephones.—			
National Telephone, Ordinary	5	—	4¼-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5¼
—— 4 per cent. Deb. Stock, Red.	100	..	101-104
—— 3½ per cent. Deb. Stock, Red.	100	—	96 99
Oriental Telephone and Electric Company	1	—	¾-1¼

Digitized by Google

NOTES.

Institution of Electrical Engineers.—We are informed that the Dublin section of the Institution of Electrical Engineers will hold a conversazione on the 29th inst. at the rooms of the Royal Dublin Society. This conversazione is to take the place of the meeting which was announced for the 22nd instant, and which has been postponed.

Society of Model Engineers.—The eighth monthly meeting of the Liverpool branch of the Society of Model Engineers was held on the 7th inst., when a general discussion on compound engines, etc., took place. The next meeting is to take place at the Balfour Institute, Liverpool, on Dec. 5, when a lecture will be given on model boilers. The hon. secretary of the Liverpool branch is Mr. F. T. Stewart, of 14, Adelaide-road, Kensington, Liverpool, from whom all necessary particulars may be obtained.

The Philippine Cable.—We notice that it is stated by Reuter's correspondent at Washington that President McKinley will recommend to the Congress that justice be done to the British Cable Corporation's claim for indemnification and substantial recompense for damage suffered through the occupation of the Philippines, and to the claims of the Manila and Dagupan Railroad Company. The United States Attorney-General has held that both companies have equitable claims. There has been a good deal of correspondence on the subject, the British authorities earnestly supporting the claims of the British subjects interested.

An Electric Log.—An interesting application of th use of electricity in navigation is the electric indicatin log of a new type, which was recently given a trial ogthe United States torpedo boat "Porter." It is the invention of Captain A. N. McGray, of Boston, Massachusetts, and consists of a small propeller trailed after the ship by a long cable containing two insulated conductors. The propeller operates a train of mechanism which periodically closes an electric circuit. An electromagnet on board the vessel advances the indicating mechanism step by step with the closing of the circuit. The instrument tested registered to twentieths of a mile, and is said to have given results correct to one-half of 1 per cent. on a trial run of 44 miles.

Waterford Lighting.—The Corporation of this old and important town in Ireland have decided to apply for an electric lighting provisional order, and are considering the advisability of the introduction of water power. We gather from a report in one of the local papers that the River Clodagh at Portlaw used formerly to work mills, and that the Waterford Corporation hope to be able to get rights for this water power. Without a knowledge of the district it is, of course, impossible to discuss the feasibility of the scheme, but the Corporation will not find it economical to lay down large works for the use of water power unless there is a regular flow and a considerable head. We wish the undertaking every success.

The Late Mr. G. J. Symons, F.R.S.—At a meeting held in May last to consider the question of a memorial to the late Mr. G. J. Symons, the distinguished meteorologist, and founder of the British rainfall organisation, it was resolved unanimously that the memorial should take the form of a gold medal to be awarded from time to time by the council of the Royal Meteorological Society for distinguished work in connection with meteorological science. An executive committee was appointed to take the necessary steps to raise a fund for that purpose, and their appeal has, we understand, been very heartily responded to. The committee have decided to keep the list open until the end of January, 1901, in order to allow all who wish to contribute to the memorial fund.

Hooligans.—We hear a considerable amount just now as to the doings of what Londoners have been pleased to term "Hooligans." It appears, however, that London is not the only place in which trouble is experienced from persons who use violence in order to attain their ends. Thus, in Paris, on the electric tramway, one recent evening, some six or eight men are stated to have jumped on a car on its arrival, and commenced to attack the conductor in order to take away his money satchel. He, however, used a crowbar to some purpose, and the thieves left him alone. Instead, however, of clearing off, they then entered the tramway office and attacked the man in charge, who was alone. This man would have been killed but for the arrival of the police, who captured three of the band after a severe struggle.

An American Patent.—Another case of the curious awards given by the American Patent Office is brought to our notice in the *Electrical World* in connection with a patent recently granted to Mr. E. W. Rice, jun., for a means of transforming polyphase currents into direct. The object of the so-called invention is to permit the current being used for feeding three-wire or kindred systems. When one looks into the arrangement patented, one finds that it consists in using each single phase of the three-phase system independently. The energy is transformed down by independent transformers, and then converted into direct current by independent rotary converters. For this combination Mr. Rice has been granted a patent. We should much like to see the expert opinion of the United States Patent Office on the novelty of the combination. It seems to us to be new neither in detail nor in combination.

"The Street Railway Review."—Following on the same lines as on a previous occasion, the *Street Railway Review* during the recent meeting of the American Street Railway Association at Kansas City published a daily edition, there being a number for each of the four days. These daily editions contained the programme of the proceedings to be followed during the day, and a practically verbatim report of the proceedings and discussions of the previous day. Chatty descriptions of visits to works and small numerous paragraphs dealing in more or less remote ways with street railways were also given. The idea is in our opinion a very good one, and supplies a want which is always felt to a certain extent in connection with long meetings lasting for a week or so. The daily editions do not take the place of an ordinary number, but form a very useful supplement to the whole volume.

Tramway Shares.—We have received a circular from a syndicate who, by its title, professes to deal chiefly with rail and tram shares. The circular states that the syndicate wishes to purchase certain electrical tram shares in small amounts. Amongst the companies mentioned, there are some old-established ones whose shares are easily obtained on the Stock Exchange, provided that the would be purchasers are prepared to pay the usual market rates. It would be no advantage to the shareholders to sell these shares to the syndicate in question, as it offers for them a lower price than can be obtained in the open market. One is inclined to question whether the shares demanded are actually required or whether the syndicate wishes it to be known that it is prepared to deal in them. In any case it is difficult to see why it pays to circularise the whole profession and others in order to get hold of some £400 or £500 worth of stock. The conclusion would appear to

Digitized by Google

be that it pays in such matters to deal through recognised channels.

The Electric Testing of Meters.—At last an arrangement has been come to as far as the City of London is concerned with respect to the testing of electric meters. A new outfit is to be obtained, and placed under the care of Mr. A. A. Voysey, the City electrical engineer. The expenses of the department will be contributed to by both the electric lighting companies having works in the City, each having agreed to provide £200 per annum for the purpose. It is not proposed at present that all the meters to be used on the City circuits are to be tested by Mr. Voysey before they are installed, but rather that he should act as electrical inspector when any consumer has doubts as to the accuracy of the reading of his meter. We believe that, subject to the approval of the Board of Trade, he may also have a voice in the type of meters to be installed by the companies, insomuch that he will be able to condemn all those which, after a few months' trial, do not give satisfactory results.

Electric Lighting in St. Marylebone.—The new Borough Council of St. Marylebone propose to hold a special meeting on Dec. 20 in order to approve of a proposal that an application should be made for an electric lighting provisional order. We presume that, in order to comply with the provisions of the Electric Lighting Act, the Council will have to advertise now their intention to apply, as it will be too late after the meeting to give the necessary notices to the Metropolitan Electric Supply Company. We fail to see in what respect the new Council is entitled to an order which was not granted to the old St. Marylebone Vestry, unless they are quite prepared to buy out the present company, and only come before Parliament in order to draw attention to the high price asked for the purchase of the works within their area. In any case we hope that the electric lighting policy of the new Council will be decided in December next, and that it will be carried out with a firmer hand than was displayed by the Electric Lighting Committee of the old Vestry.

Japanese Railway Building.—The *Electrical Friend*, in one of its recent issues, contained an illustrated description of various plant which is being used in connection with the construction by the Government of the new central steam railway. In constructing this line a mountain called the Sasso Toge is to be bored through, and special power plant has been ordered for carrying away the rocks which will be excavated in the making of the tunnel. The tunnel is to be some three miles in length. The power plant consists of a 46½-h.p. Leffel horizontal turbine with an 80ft. head, and which is provided with Replogle's mechanical governor. The dynamo is a 45-kw. 500-volt Westinghouse machine, running at 850 revolutions, the locomotive being also of Westinghouse construction. It consists of a double-motor truck provided with two 15-h.p. motors. The draw-bar pull is 1,500lb., and the gauge of the road about 30in. Some 6,549lb. can be carried in one train, and the line is said to be doing excellent service. The lighting also of the tunnel is effected by electricity, and for this purpose there is installed a 16-h.p. turbine, driving a 15-kw. dynamo.

The Alternating-Current Arc.—Mr. C. Wiley recently read before the Chicago Electrical Association an interesting *résumé* on the action which goes on in the alternate-current arc lamp. The main object of the paper was to explain the reason why the enclosed alternate-current arc is not so satisfactory as the direct-current enclosed arc. That this is so everyone knows who has tried to obtain from electrical manufacturers a really reliable enclosed alternate-current arc lamp. The reason for the instability of these lamps is considered by Mr. Wiley to be the great resistance of the carbon vapour between the two extremities of the carbons. The current, of course, is reversed twice in every alternation, and with this great resistance it falls to zero almost as soon as the current begins to fall. Hence during the larger part of the cycle the current is zero, or has a very small value, and the arc tends to extinguish. The author then goes into the question of the influence of a core in the carbons used for the alternating arc, and shows that if the core consists of a mixture of certain chemical salts the resistance of the arc is decreased, and a much more steady result is obtained. Another point of interest is that the author shows that it is much more advantageous to have a small inductive resistance in series with the arc than an ohmic resistance. This is so because the E.M.F. of the former will help the lagging current over the zero or dead centre of the arc.

The Caledonian Electric Power Company.—The above is the name of a new company which is to be incorporated under the Private Legislation Proceedings of Scotland Act of 1899. The object of the company is—as its name discloses—to do with the distribution of electrical energy. The area which the company proposes to work includes the large manufacturing district on the West of Scotland, comprising the whole of the county of Renfrew, a portion of the county of Lanark, and portions of the counties of Dumbarton, Stirling, and Ayr. In fact, the company proposes to act on much the same lines as those companies which obtained powers last year for the production and distribution of power in bulk in Lancashire, Durham, and South Wales. In order to avoid undue complication, the city of Glasgow is excluded from the operation of the scheme. In this, the most important area of Scotland from an industrial point of view, there should be a great opening for cheap electrical energy. It will be interesting to see when the Bill comes before the House of Commons as to whether the promoters have succeeded in obtaining any water-power rights, or if they will be obliged to depend wholly on the energy produced by the burning of coal. We are informed that Messrs. Maclay, Murray, and Spens, of Glasgow, are the solicitors, and Mr. A. A. Campbell Swinton, M.I.C.E., of 66, Victoria-street, Westminster, the engineer to the scheme, which is said to have the support of leading manufacturers of the district.

Rubber.—The imports of raw rubber into Liverpool, we gather from the *Liverpool Journal of Commerce*, reached during the 12 months ended June 30 last a total of some £6,000,000. Raw rubber being, however, a rather dear commodity, the £6,000,000 represents a comparatively small tonnage, the value per ton ranging between £280 and £500. The tonnage actually delivered during the year amounted to 10,437 tons of Para rubber and 6,977 tons of mediums, totalling altogether 17,414 tons. This total, although it appears to be small, is more than half of the total arrivals in Europe during the season, these European arrivals amounting to 30,194 tons, and it was also but little short of the total arrivals in the United States ports, these being 20,883 tons. The world's approximate total production of rubber for the whole season of 1899-1900 was 53,348 tons, so that the deliveries in Liverpool were nearly one-third of the world's estimated production. The landings of rubber in London do not approach to anything like the tonnage of the Liverpool imports. The importation of the year's tonnage into Liverpool, the warehousing, handling, etc., provides work for a large number of persons, there being at present some 14 firms in Liverpool in the rubber trade acting either as importers or consignees. This growth of tonnage shows a healthy state of the trade, and

Digitized by Google

an increasing value of the trade to Liverpool, as most of the Para rubber shipped eastwards comes to this port, and it will be gratifying to those interested in the port to note these facts of the extent and growth of the indiarubber trade.

The London Streets.—With the outcry one sees in the daily papers about the state of the London streets, one usually finds at the end of the editorial comments that in a few months' time the work as far as the City is concerned will be completed. It has, however, begun to dawn on the minds of a few persons that even when the telephone conduits are laid, there still remain to be placed in the public streets the mains of the Charing Cross and Strand Corporation. We notice that the engineer of the Post Office has been interviewed on the question of interference with the streets, and he excuses a certain amount of the inconvenience on the ground that this electric lighting company is partly responsible. For instance, in Fleet-street up to the present practically no telephone ducts have been laid, but there has been a considerable interference with the traffic for the past three months. Now that the street surface is down again, the Post Office are commencing at the upper end to open it up for the telephone conduits. It would surely be much preferable to have the two obstructions at the same time, and to close the street to through traffic. As it is at present, the average speed of the vehicles passing through the street is so small that it is practically useless to all but the heaviest goods traffic. It is not pleasing to contemplate that this interference is likely to go on for another year at the very least, and we shall be surprised if the electric lighting company in question will have completed the work by that time. As we pointed out when the order was granted, we very much doubt if the gain from competition in electric lighting is worth the great waste of time and money entailed in laying a complete new system of electric lighting conduits throughout the length and breadth of the City.

Electrical Towing.—We have mentioned before that on certain of the canals of Germany towing by electricity is being brought into use. We now notice that the New York untechnical Press are commenting on the fact, owing to their consul at Frankfort having sent in a report on the matter. Thus it is stated that a number of experiments have been tried on a short section of the Finow Canal, on the route between Berlin and Stettin. This canal is traversed by 25,000 boats in each direction annually, or 100 boats a day for eight months out of the year. The portion of the Finow Canal selected for the recent tests included several sharp curves, and at least one railway bridge, so that it might present most of the serious difficulties likely to be encountered in this class of work. A small electric locomotive like those used in America for switching purposes was employed, and a track was laid for it on the towpath. The motor weighed about two tons, was 6ft. 10in. long and 1ft. 10in. wide, and derived its current from an overhead wire, like a trolley car. The machine was capable of developing 15 h.p., which was more than was required. The track had a gauge of 3·28ft. One rail was much heavier than the other, one weighing 18lb. to the yard and the other 9lb. The heavier rail was the outermost, or furthest from the canal, and on it rested four-fifths of the weight of the motor. The same rail served also to convey the return current. Most of the track was laid at the level of the towpath, part of it on sleepers and partly on blocks of concrete. But at one point for a few rods the track was carried on a wooden structure, 9½ft. above the towpath. Posts 12in. square and 18½ft. apart were connected by longitudinal cap pieces, on which the heavy rail was laid. The other rail was carried by a stringer supported on brackets. The conductor was an 8mm. copper wire, the poles for which were from 100ft. to 132ft. apart. The boats on the Finow Canal are barges capable of carrying from 150 to 175 tons. A few have a length of 132ft. and a beam of 15½ft. The consul reports that "these experiments showed the system to be capable of meeting all needs, working, as it did, with safety and economy."

The Nernst Lamp.—A great deal has been written from time to time concerning the structural evolution of the Nernst lamp, but reliable data as to the commercial efficiency of the most recent form of the lamp—*i.e.*, that exhibited by the Allgemeine Elektricitäts-Gesellschaft at the Paris Exhibition—are very slow to leak out, whence it may be adduced that its practical success is not yet. We had occasion to refer in a recent issue to a beautiful souvenir issued by the company in question of their extensive exhibits at the Exhibition. This souvenir contains some interesting general information about the lamp, but we were disappointed in finding no mention of its prospects of commercial success, though it affords some consolation to know that our German contemporaries are little better informed in this respect, and, indeed, join in giving expression to the above complaint. For the time being, then, it seems we shall have to content ourselves with general information, and even of this little fresh has transpired. Considerable importance is, however, attached to the invention, especially by the Allgemeine Elektricitäts-Gesellschaft, who have devoted a large floor space at their Berlin works to its evolution and manufacture; and if ultimate success from a commercial point of view is at all within the bounds of possibility, we may rely upon this firm to obtain that success. Lamps suitable for pressures of 110 and 220 volts, and of 25 c.p., 50 c.p., and 100 c.p. are being made, we understand, while experiments with lamps of greater power are in progress. Since the Nernst lamp consumes 1½ to 1¾ watts per candle-power, it follows that the consumption of energy for a given intensity of light will be only about half as great as would be the case with the ordinary type of incandescent lamp. This advantage is, however, partially eliminated by the relatively short life of the Nernst lamp, which has hitherto attained to but some 300 working hours. No authentic data as to the molecular change of the incandesced material and the decreased illuminating power thereby involved is yet available, but in this respect an advantage is undoubtedly obtained, in that the Nernst lamp retains two-thirds of its original value after it has become unserviceable. Further developments of the lamp are awaited with interest.

The Telephone Service in Chicago.—We gather that great interest has recently been aroused in Chicago by the Chicago Bell Telephone Company undertaking to instal public and private telephones on a call system at a uniform rate of 2½d. per call. These installations will be on what are known as party lines, or, in other words, 10 subscribers will have the use of a common line wire, and it will hence not be convenient at certain times of the day owing to the fact that a number of subscribers on these line wires will be wanting to use their instruments at the same time. The guarantee which is to be required before these instruments will be installed will be two calls per day for offices and one call per day for residences. If these numbers of calls are not made, the subscriber will have to pay the difference at the end of the month. While knowing that the value of money is rather more here than in the States, the price does not seem to us to be remarkably cheap. Of course, with it a subscriber might be able to get his telephone in a private

Digitized by Google

house for £3. 16s. per annum, but the service would be by no means the best possible, and we hope in this country to get an individual line for very little more per annum. The instrument being used in Chicago provides for the insertion of the toll in a slot in the subscriber's machine, and in the event of a call not being possible, the money is returned by the closing of a circuit by the operator at the exchange. A very large number of new subscribers is expected in consequence of this new service. We notice in connection with this service, as described in the *Electrical World*, that there is in the same issue a *résumé* of the various improvements which have been tried with varying success for recording the number of messages sent by a given subscriber. In the first class of these instruments the counter is placed on the subscriber's premises, and is controlled by the operator at the exchange. When a call which moves the counter through one division is given, the subscriber hears a signal, and knows that a record of the call has been made against him. In the next class the meter is placed in the exchange and is operated either by hand by the switchboard operator or automatically by means of relays in connection with the circuit. In the third system duplicate registers are made on the subscriber's premises and at the exchange. The fourth system is also described as only on the subscriber's premises, and is worked by the subscriber, who presses a button. This gives the operator at the central exchange the signal, and also registers the call, the connection being made in the usual way.

The Telegraphone.—The wonderful inventor who has under various names found his way of late into the daily Press has reappeared again under the guise of the inventor of the "telegraphone." This instrument, as might be expected from its name, is going to be an automatic recorder of messages spoken into the telephone. To Herr Poulsen belongs the glory of the invention, in which he employs, we gather from the *Daily News*, a microphone transmitter connected to a battery of two or three dry cells and an electromagnet of a peculiar shape, which takes the place of the ordinary telephone. The electromagnet, in fact, is said to be a telephone without the vibrating plate. Instead of an iron plate vibrating over the pole of the electromagnet, a steel wire travels past the pole in such a way that the magnetism excited in the pole of the electromagnet by the varying current induces a corresponding magnetism in the wire. To this end the electromagnet is made very small, no bigger than a nutshell, and it has two poles inclined to each other, so that the wire passes between them, and is magnetised on two sides. The wire is about $\frac{1}{8}$in. thick, and it is remarkable that the magnetism produced in it is localised in a very definite manner. The wire is wound spirally on a drum or cylinder which revolves, and the electromagnet travels along the cylinder from one end to the other as it revolves, thus bringing the whole length of the wire past the pole of the electromagnet, to receive its charge of magnetism. In this way the varying electrical current of speech from the microphone makes its magnetic record on the wire. So much for the record, but in order to get the record to reproduce the original sounds the process must be reversed. The magnetism of the wire as it moves past the pole is then to induce magnetism in the pole, and in doing so excites an electric current in the bobbin of the electromagnet. This induced current varies in strength with the magnetism in the wire, and consequently reproduces the original sounds in the receiving telephone, which, of course, is held to the ear. The inventor says the magnetic record will persist for a year, and give over a thousand repetitions of the message. It can also be "rubbed out," and the same wire used over again for other messages, this being done by sending a constant current through the electromagnet and passing the wire before its pole. Herr Poulsen proposes by a similar instrument to deliver news to a number of clubs or exchanges. It is further stated that Herr Pedersen, a collaborator of Herr Poulsen, has devised a "duplex" method of recording two messages on the same band or wire, but it is kept a secret for the present. It is a pity that Herr Poulsen cannot invent another machine which will do away with the necessity of going to the telephone at all, but which would answer any queries which might come automatically. Such an instrument would appear to us to have more chance of success than the present arrangement.

Cathode Rays.—In the current issue of the *Physical Review* is a long article contributed by Messrs. E. Merritt and O. M. Stewart on "The Development of Cathode Rays by Ultra-Violet Light." The authors made several experiments with an apparatus consisting of a vacuum tube with the cathode at the bottom and three electrodes at the top. The cathode was connected with the negative terminal of a dry battery. Immediately above the cathode was the anode, consisting of a ring of aluminium wire. In order to admit the ultra-violet rays into the interior of the tube, a quartz plate was mounted on a side tube. The ultra-violet light which fell on the polished zinc cathode came through the quartz from a spark between zinc terminals. From experiments with this apparatus the authors state that it is clear that the effect of a magnetic field is to produce a deflection of the photo-electric rays. The path followed by the escaping charge is altered, while its amount remains practically unchanged. Three tables are given, showing the effects with a magnetic field direct, with the magnetic field reversed, and with a very strong field direct. In the first case the maximum effect was obtained, but with the field reversed the charge rate diminished instead of increasing as at first. In the third case with a strong field the charge rate was reduced nearly to zero, instead of being increased. The experiments prove to the authors' satisfaction that photo-electric rays are magnetically deflected. As to the source of the formation of the photo-electric rays, this can still only be regarded as unknown. It is the same, with certain important differences, with ordinary cathode rays. The following way of looking at the matter, however, is thought to be sufficiently plausible to deserve consideration. Thus, assuming first that the primary effect of illumination is to cause the development of cathode rays, and that these rays are produced not only at low pressures, where it has been possible to detect them directly, but also under ordinary atmospheric conditions, remembering that the rays make the air a conductor, it is seen that the photo-electric current will, in general, consist of two parts—viz, the current carried by the photo-electric rays themselves, and the current carried by the ionised air. At high vacua practically the whole current will be carried by the photo-electric rays. But as the pressure of the surrounding air increases, the rays will be more and more completely absorbed, and since this absorption results in ionisation, the conduction current through the air will become more important. At atmospheric pressures the rays are probably absorbed in the immediate neighbourhood of the charged surface. In this case the discharge is almost wholly carried by electrolytic conduction, but since the ions are developed very close to the surface, the case differs essentially from that of the ionisation produced in gases by other causes. In most cases both positive and negative ions are present throughout the gas. But in the photo-electric discharge the positive ions pass at once to the cathode and are destroyed.

Digitized by Google

The American Automobile Club.—The first annual exhibit of the Automobile Club of America was opened on the 3rd inst. at Madison-square Garden, New York. In spite of the counter-attraction of the election parades, there was a very fair attendance at the show. The grounds were very carefully laid out, and had a track constructed round the arena upon which the automobiles could be run. In order to show the climbing powers of the automobiles a track was erected which had a very steep grade. This runway was 200ft. long, and at the highest point 53ft. above the floor. It was 8ft. wide and laid on scantling. It was built in four sections, these being stated to be running from 20 per cent. grade up to 43½ per cent. Amongst the exhibits we notice a novel arrangement shown by the General Electric Company. This was an electrical hydrant, designed to be used by electric vehicles that are in need of replenishing their batteries. The hydrants are to be placed at convenient points, and are operated on the "penny-in-the-slot" principle. When a vehicle needs a charge, all the operator has to do is to run up to the hydrant, put a suitable charging plug in one of the four receptacles designed to receive it, and then drop a quarter-dollar piece in the slot and wait. There are four receptacles, each of which is numbered. No. 1 represents a charging current of 20 amperes, No. 2 a charging current of 30 amperes, No. 3 a charging current of 40 amperes, and No. 4 a charging current of 50 amperes. Provision is made by means of a push button by which the charging plug can be taken out of any one receptacle and placed in any other without cutting off the current supply paid for. The supply is about 2·5 kilowatt-hours, and when this has been furnished the current is automatically cut off, and no more can be obtained until another 25-cent piece has been put in the slot. In connection with this charging hydrant, or "electrant," as it is called, an interesting point is that of the eight makes of vehicles exhibiting but three used charging plugs and receptacles that were similar. The other five used specially-constructed plugs, each of a different design, and none of which could be used in the receptacles provided in the hydrant. It would, therefore, seem as though there were need of standardisation in this matter, and that all electric vehicles should have a standard charging-plug receptacle fastened somewhere in circuit. This would eliminate the necessity of providing several different styles of charging plugs at the different charging stations. In connection with this exhibition the *Electrical World* comments unfavourably on the practice which some manufacturers indulge in of claiming a much greater mileage capacity for their vehicles on one charge than they can accomplish under ordinary everyday conditions. In this way the would-be purchaser is misled, and if he buys he is disappointed with his purchase. The dissatisfaction which he feels with his vehicle will probably become communicated to his friend, who will be very careful as to buying electrical vehicles manufactured either by that particular maker or by any other. Many instances of this kind might have a very bad effect on the development of the automobile industry in any particular district.

Electric Traction in Italy.—We notice in the *Electrical Review* of New York a description of the electrical equipment of the Lecco, Sondio, and Chiavenna line in North Italy. We have referred to this line in previous issues, but a few additional details may be of interest. The length of the line upon which electric traction is used is about 66 miles, with a maximum gradient of 22 per cent. In summer the line has very considerable passenger traffic, but at other times also there is a steady freight traffic. In order to serve both interests the service has been organised along the following general lines: the complete separation of passengers and freight traffic; a complete distinction in make-up and schedule between express trains running over the line from end to end and trains for local service; designing the trains with a capacity sufficient for expected needs by increasing in advance both the number and weight of trains in service. The passenger trains are drawn by an electric locomotive of about 300 h.p., and weighing about 50 tons. This vehicle can carry 60 passengers and two tons of baggage and draw four ordinary cars behind it at about 37 miles per hour on grades up to 10 per cent. Freight trains are drawn by locomotives of 700 h.p., capable of drawing 250 tons up a 10 per cent. grade at a speed of 19 miles per hour. The system difficulties of the long-distance electrical transmission have led to the adoption of the three-phase high-tension current, both for general transmission and for distribution to the motors on the trains. The current for operating the plant will be generated directly at 20,000 volts at the water-power station at Morbegno, 10 miles from Colico, from which it is led by a three-conductor overhead line, using copper wire 7mm. in diameter, to 12 sub-stations situated along the line at distances of just over six miles apart. These sub-stations reduce the tension to 3,000 volts, and the current is distributed at this pressure to the motors by means of two trolley wires 8mm. in diameter, the track being used for the third conductor of the three-phase system. The two trolley wires are suspended 18½ft. above the track, except in the tunnels, where the height is 14ft. In the power station at Morbegno are four units, consisting of a turbine and alternator, direct coupled together, of 2,000 h.p. The water-wheels are of the usual type, and are provided with auxiliary power governors. The alternators have rotating fields and generate at 20,000 volts in each phase, and have a frequency of 15 cycles per second. Current is taken from the line by two aluminium rollers, these having a diameter of 3in. By means of a collecting brush running on a graphite collar, current is taken from each roller, and passes, by means of a highly insulated cable, directly to the primary windings of the principal motors. Short-circuits between the conductors of different phases at switches or junction points are avoided by arranging the contact rollers on a slant. By this arrangement much complexity is avoided, the overhead structure in no case weighing more than 180lb. complete. The 3,000-volt current connection to the motors is protected by metallic tubing surrounding the cables carrying it, these being connected with the ground. The primary winding of two of the four induction motors on the car are directly connected with the contact roller, and their two secondaries or rotor circuits may be connected either to a liquid resistance or to the primary circuits of the other two motors with which the car is furnished. In the secondary circuits of the latter are inserted variable resistances. If the four motors are coupled two by two in series the velocity of rotation of the two rotors will be practically half that of the primary rotating field, and also half that which the two primary motors would attain if fed directly from the line. This arrangement gives two running speeds of 37½ and 18½ miles per hour, but in order to avoid abrupt passage from one to the other, a liquid rheostat is inserted into the secondaries, giving an adjustable resistance. Line switches have been arranged so that shunting may be done with the electric locomotives at stations. The first of these vehicles has recently been tried, and the tests made at a speed of 53 miles per hour were successful. It is hoped that the line will be in working order by the spring of 1901.

Digitized by Google

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

1. *General, and the Management of Men.*

In the following notes it is not proposed to discuss at all the various methods of distribution as to their respective merits or as related to generation, the question of method being generally settled beforehand either by the consulting engineer or the resident engineer, and one in which the mains engineer is not asked for his advice, but has practically to do as he is told. But there are many points on which the chief engineer consults the mains engineer during the running of an installation, or on extensions. It is with a view to assist the mains engineer in such consultations and in his routine work that these notes have been compiled. The text will include cable laying and jointing, cable testing, sub-stations and sub-station gear, house connections and installations, and street-lighting. Attention will in many cases be paid to detail, and mains engineers will find that it is only by such attention on their part that they can hope to lay down a system of mains which will give them the least amount of trouble after completion, and which will insure them against night calls, things not at all to be desired after a worrying day's work.

There is no doubt that electric mains have not had their fair share of attention hitherto. There has always seemed to be a tendency on the part of consulting and chief engineers to relegate the mains to a secondary place, and to give their best efforts to the generating plant. But surely it is necessary for good results that the mains should be as perfect as the generators. A most important point for the mains engineer is that he should as far as possible aim at making a permanent job at the start, so that the work has not to be done over two or three times. He is very often hampered in this way through promises which are often given by committeemen and sometimes by chief engineers to intending and worrying consumers, but a little forethought during previous work and to the general area of proposed supply will save much of the temporary and rushed work which so often obtains. In addition to this view of temporary work there is the question of expense, which is an important one, if only to the chief engineer.

A most important item in this question of temporary work is the reopening of streets for the laying of extra cables or larger cables. To cut down initial capital cables are not estimated for which everyone knows will have to be laid, probably before the expiration of a year, with the result that the poor, unoffending mains engineer has to bear the burden of the outraged shopkeeper's maledictions. The mains engineer should therefore, at any opportunity, suggest as to the size and number of cables. Of course, he will probably be met with a remark to the effect that the money is better in the bank than lying underground in the form of copper. But in municipal districts it is no bad tip to keep the mind of the shopkeeper quite calm, as, from experience, he will cheerfully pay his lighting bill, if only the corporation do not block his shop-front. Also, in an alternating system, the initial size of transformers is another matter worthy of notice, as often the transformers first put down are overloaded before the second winter, entailing much labour to lift out of the ground and to replace with larger, including the alteration of many connections and the scrapping of much cable, introducing also, to however small an extent, a certain amount of unnecessary risk to life on the part of the jointer, and, finally, the selling of the small transformers at a considerable loss.

Turning again to the question of attention to detail, personally, on the part of the mains engineer, it is a good plan on the smaller undertakings for the mains engineer to act somewhat as foreman, thus keeping himself thoroughly in touch with all that is done. This plan, however, cannot be carried so far on a large system; much has then to be left to the foremen, and even to the workmen. Seeing that this is the case, how necessary is it then that the mains engineer should thoroughly understand the management of his men. This is so both in the case of the small and the large undertakings, but much more vital in the latter. The mains engineer must, above all, be firm in his dealings with the men—that is to say, when he gives an order he must see that it is carried out, and in his way. If he makes a rule he should not break it unless under very exceptional circumstances, and then only after pointing out these circumstances to the person in whose favour the rule has been broken. Smoking and drinking should at all times during regular working hours be definitely vetoed. Smoking, however, should be allowed during the working of overtime.

The one great thing in the management of men is to beget confidence; show them that you trust to them, and also let them see that they can confide in you. Although the engineer is firm, he can still, to a large extent, sympathise with his men. He can hear their troubles and often give good advice, which is most thankfully received, as a rule, by them. And in any case of supposed wrong-doing which arises the engineer must not give way to rash judgments, but must try to look at the case from the man's point of view, and remember that the lives of his men are not always the rosiest, and give his judgment accordingly, always trying to smooth over obstacles, and, however little, to elevate the mental position of the men. It is also a great mistake to be stingy with wages, as an extra halfpenny per hour means very little at the end of a year, and on well-managed jobs most of it goes down to capital account, so that at all times a good man should rapidly be advanced to the top rate of pay.

During the working on repairs to breakdowns, the men often have to work many hours at a stretch. In cases of this sort, it is imperative that they should be allowed time to get full meals, as nearly as possible at their regular hours. It is this attention to the men and their personal comfort that will go far to procuring good work, as they then feel themselves to be necessary units to the good working of the thing, and the details before mentioned will so be properly attended to by the men themselves. It will also be found that if the men do make a mistake or have an accident with their work, they will immediately inform their engineer, knowing that they will get justice from him; and they will never attempt to hide anything. The engineer will find that if he follows in these lines his management of his men, on his leaving one berth for another his men will nearly always want to follow him—a certainly good state of affairs for the departing assistant, but not usually liked by the chief.

The judicious selection of men and their training so as to be quickly useful is another point which requires careful attention on the part of the engineer. The taking on and discharging of men cannot be left to a foreman if harmonious working is desired, as in nearly all cases the foreman makes favourites and is down on other men, for various reasons which do not bear looking into. Many an excellent man has had his career nearly spoilt by some unreasonable dislike which the foreman has taken to him, and has only been saved through the fact that the engineer has had his eye on the man, and has enquired into the reason of the foreman's dislike. A new job is usually started, as far as mechanics are concerned, by borrowing from the cable makers, and some of these men prefer to stay in the town to which they have been sent. It then becomes necessary to provide them with mates. It is in providing these mates that a little care is required. As a rule, boys have been found to be almost useless—they certainly are useless as jointer's mates, as they are not strong enough to open ground—thus a third person is required to do this. It is obvious, then, that a jointer's mate should be, at any rate, nearly a man. In selecting a man for a jointer's mate, he should be selected for strength, and if he has been a navvy so much the better. He should also look fairly bright, but he should certainly have no preconceived ideas as to his own fitness because he has been used to tinkering in some other line. Such a man will not care about using pick and shovel, and will be a perpetual worry. It is far best to train a man from perfectly raw material: he will then always do as he is told. It will then be best not to employ youths under 18 years of age if it is expected that they should earn their money, and even so young they would be better sent with, say, a meter fixer. Apprentices are a side issue of the question, and they should be left severely alone on municipal jobs, leaving them to the cable firms, to whom they are useful in many ways. A good mate so selected should make a fairly good jointer for low-tension work in from two to three years, and can afterwards be slowly advanced to the position of high-tension jointer.

One of the hardest tasks a mains engineer has to perform

Digitized by Google

is that of selecting a foreman. In the training of their young men, it might be as well that the employers—corporations or supply companies—should insist on the men going to a night school for technical training at least for two evenings a week, the employers paying the fees. A small well-selected library of elementary text-books might also be advantageously kept for the use of the men. Amongst other subjects which the men should be induced to take up is the subject of building construction. Scarcely one electrical man in a hundred knows anything about it, and yet it is of the utmost importance. As soon, then, as it is possible to notice a man taking a more than usual intelligent interest in his work he should be carefully watched, and assisted and raised in position as much as possible. Such a man, if trained from absolutely raw material, will make a good foreman and be a blessing; for good foremen are rare, and bad ones, legion. Probably the very best way to work the foreman question is to import a stranger as foreman—*i.e.*, a man who does not know the men whom he has to superintend. This method does away with a lot of trouble arising from favouritism.

As to the hours of work, the best hours undoubtedly are from 7 a.m. to 5 p.m., except on Saturdays, when knocking off time should be 1 p.m. If the men start at 7 a.m. they have their breakfasts before they come, and so get five hours' good work in before knocking off for dinner, for which they take one hour. If work is started at 6 a.m., as is sometimes the case, the men take from this time till breakfast time preparing their breakfasts Breakfast time being supposed to finish at 8.30, at least 2½ hours are completely wasted. Another point about the start at 6 a.m. is that foremen do not turn up punctually, unless the engineer makes it a rule to be there too. Overtime should be paid for at the rate of time and a quarter for the first two hours after the normal time, and then time and a half up till the next starting time. Double time should be paid from midnight on Saturday for any time worked between then and midnight on Sunday. As a general rule, however, overtime should be discouraged, as the same amount of work is never done in the same amount of time.

On the whole, it may be taken as certain that the best men, as far as best work goes, are to be found with electrical contractors, as these people will not have any men who are not well up to the mark, while on municipal undertakings many men are pushed into the work through the influence of residents, often to the chagrin of the engineer, who, although he is expected to make things pay, has to put up with these, very often most worthless men.

THE FACTORS WHICH DETERMINE THE DESIGN OF MONOPHASE AND POLYPHASE GENERATORS.*

BY B. A. BEHREND.

(Concluded from page 706.)

III. The Short-Circuit Characteristic.

In the preceding article the manner of determining the dynamic characteristic from the static and short-circuit characteristics has been set forth. If n is the number of conductors per pole and phase, I the current flowing through each conductor, and x the number of ampere-turns in the field for one closed magnetic circuit, then we have for a short-circuited armature the equation:

$$\lambda n I = x \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In this equation λ is a coefficient varying with the dimensions of the armature and the field.

The theoretical determination of λ is extraordinarily difficult; indeed, it might be doubted whether any weight should be attached to such a calculation which must needs contain a great number of other coefficients, about the value of which we are equally as uncertain as we are about λ itself. It has been assumed as though it were a matter of fact that λ could easily be calculated from the ampere-turns of field and armature. If there were no primary and secondary leakage, this could, indeed, easily be done. The calculation yields a value for λ, according to the assumptions made, varying between 2·2 and 2·8 for three-phase currents. As there are a great many people who believe that λ, even if we neglected leakage, which is entirely unallowable, can be calculated by merely figuring out the maximum value (as some do) or the mean value (as others prefer) of the ampere-turns on the armature, it may be desirable to point out that λ depends very much, not only upon the arrangement of the armature winding, but also on the ratio of the width of the pole to the pitch of the poles. If the dimensions of the armature and field are properly taken into consideration, the lowest values of λ—that is, without leakage—can be calculated, and this is of some interest, as it will increase our surprise when, instead of $\lambda = 2\,7$, for instance, λ rises to 5·4—in other words, our generator gives us only one-half the short-circuit current that we expected it to give.

All of us who have been designing alternators for high frequencies or low speeds have had to go through such experiences. A great many speculations and wild guesses have been advanced to account for these apparent discrepancies between theory and observation. About three years ago I began to suspect that the absolute value of the pole-pitch might offer a clue to the explanation of these discrepancies. Almost all of the machines that I measured were of the inductor type, and in them the influence of the air-gap on λ greatly complicates the problem. But with the accumulation of experimental material, the problem grew more and more perspicuous, and the influence of the air-gap on λ could be separated from that of the pole-pitch.

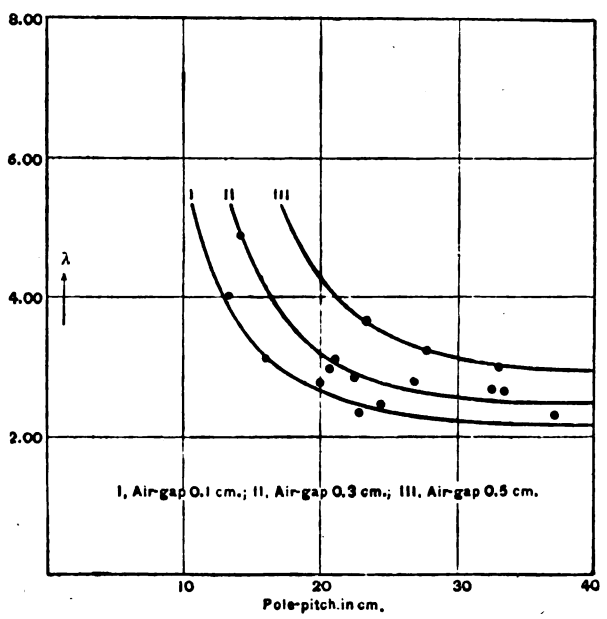


FIG. 7.—Values of λ

After the preceding it is hardly necessary to speak of the importance of λ as determining the design of the alternator. The output of single and polyphase generators working on power circuits, and, to a certain extent also, the output of generators working on light, is determined by the maximum drop permissible. This drop is directly proportional to the value of λ; hence I am justified in saying that λ is the factor on which hangs, in large measure, the success of the design.

The curves in Fig. 7 show the value of λ as a function of the pole-pitch and of the air-gap in three-phase inductor generators. The ordinates of the curves represent the values of λ, the abscissæ the pole-pitch. Curve I. is drawn for an air-gap $\Delta = 0\,1$cm.; Curve II. for $\Delta = 0\,3$cm.; Curve III. for $\Delta = 0\,5$cm. The magnetic and electric arrangement of the machines measured is shown by Fig. 8. The pitch of the armature coils was equal to the pole-pitch; the armature coils were lying in slots, one per pole and phase. The width of the pole-horns was equal to or slightly smaller than the pole-pitch. The most striking feature of these curves is their tendency to rise rapidly if the pole-pitch is smaller than 25cm. For small pole-pitches the air-gap is of intrinsic importance; with increasing pole-pitch the curves tend to converge. Let us

* From *Electrical World and Engineer* (New York).

Digitized by Google

try to account for these observations. If we diminish the pole-pitch, the magnetic flux emitted by each pole is diminished in the same ratio as the pole-pitch. If we assume that the magnetic resistance of the main field remains constant, then the ratio leakage field : main field, has increased in the same proportion as the pole-pitch has been diminished, since the magnetic resistance of the leakage field decreases in proportion to the pole-pitch. This holds good of the

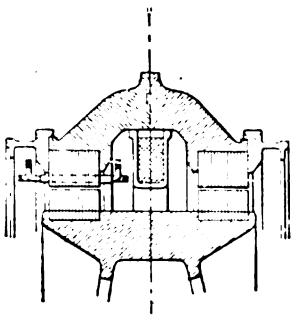


Fig. 8.—Details of Machine from which Values of λ were Derived.

leakage of the field as well as that of the armature, as can easily be seen. A glance at Fig. 9 shows that the leakage lines of the armature run in loops around the slots. The leakage remains, therefore, constant, whether we change the pitch of the coil or not. But the field which produces the E.M.F. in the coils varies in proportion to the pitch of the coil, hence the ratio, armature leakage : main field, varies inversely as the main field—that is, as the width of the pole, or as the pitch of the poles, since the ratio width of pole : pitch of pole may be assumed as constant. By means of the curves of Fig. 7, it is easy to find the value of λ for any pole-pitch and air-gap for three-phase current generators of the inductor type. My experience with generators with alternating poles is not sufficient to enable me to plot their λ curves for pole-pitches smaller than 20cm. For pole-pitches larger than 20cm. the values of λ agree well with Curves I. and II. For these large pole-pitches λ is practically independent of the air-gap; for small pole-pitches λ increases with increasing air-gap.

Frequency.—We are now in the position to study the bearing of the frequency on the dimensions of the generator. The question which the practical designer is called upon to answer is whether a generator wound for, say, 50 ⁓ can be more advantageously used for a higher or lower frequency. This question can immediately be answered with the help of our curves. A glance at them teaches us that the problem cannot be solved in a general way, but that each case has to be treated individually. As for the same voltage and the same magnetic frame the total number of conductors in the armature is the same for all frequencies—increased field leakage for small pole-pitches being neglected—the number of conductors per pole and

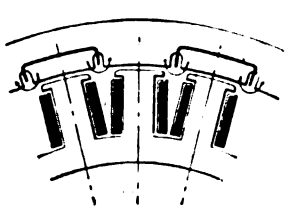


Fig. 9.—Illustrating Leakage.

phase is inversely proportional to the frequency, hence the short-circuit current for the same excitation, x, in the field can be given by the formula :

$$I' = I'' \times \frac{\lambda''}{\lambda} \times \frac{\sim'}{\sim''} \quad . \quad . \quad . \quad . \quad (3)$$

In this equation I' and I' denote the short-circuit current, λ' and λ'', the values of λ pertaining respectively to the frequencies ⁓' and ⁓''.

If a higher frequency is to be advantageous the quotient $\frac{\lambda''}{\lambda'}$ must be larger than the quotient $\frac{\sim'}{\sim''}$. An example will bring this into clearer light. The pole-pitch will be 25cm. for 50 ⁓. For 80 periods it would be 15·6cm. The value of λ for 25cm. pole-pitch is for an air-gap of 0·3cm. equal to 2·75, while it is for a pole-pitch of 15·6cm. equal to 4·15. Hence the short-circuit current for 80 ⁓ is equal to

$$I_{80} = I_{50} \times \frac{2{\cdot}75}{4{\cdot}15} \times \frac{80}{50} = 1{\cdot}06\ I_{50}.$$

In other words, the short-circuit current I_{80} is practically equal to the short-circuit current I_{50}. For the same drop the output of the 80 ⁓ machine is therefore equal to the output of the 50 ⁓ machine, with practically the same amount of iron and copper. Of course, it is obvious that the 80 ⁓ machine is more expensive than the 50 ⁓ machine, on account of the greater number of slots and poles, needing more insulating material and involving more labour. For 40 ⁓ we should have

$$I_{40} = I_{50} \times \frac{2{\cdot}75}{2{\cdot}57} \times \frac{40}{50} = 0{\cdot}86\ I_{50}.$$

Hence for 40 ⁓ the machine would give a smaller output than for 50 ⁓. For 60 periods we have

$$I_{60} = I_{50} \times \frac{2{\cdot}75}{3{\cdot}00} \times \frac{60}{50} = 1{\cdot}1\ I_{50}$$

In other words, the generator gives 10 per cent. more power for 60 ⁓ than for 50 ⁓. Table IV. contains the output of the generator for different frequencies.

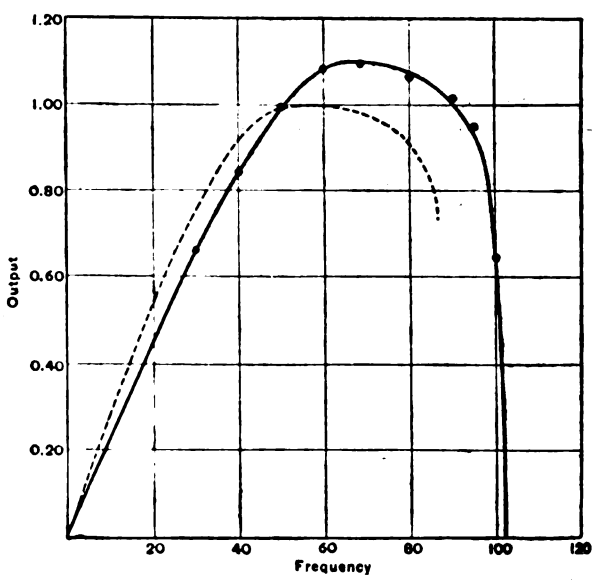


Fig. 10.—Frequency Curves.

Fig. 10 represents these relations graphically. The curve illustrates that between 45 ⁓ and 90 ⁓ the output of the generator is practically constant. If the increased field leakage at higher frequencies were taken into account, the curve would have the form of the broken line curve, and the output would, at no frequency, be greater than at 50 ⁓. If the frequency is increased above 80 ⁓, the machine is worked at a part of the curve where the slope is so steep that we can no more rely on any predetermination, as a very slight inaccuracy of the λ curve reduces the output tremendously. It would, therefore, not be advisable to work with a frequency higher than 80 ⁓. This, of course, holds good only in the case under consideration.

Table IV.

⁓	Pole-pitch.	λ	Output.
30	41·6	2·50	0·66
40	31·2	2·58	0·86
50	25	2·75	1·00
60	20·8	3·04	1·09
70	17·8	3·52	1·095
80	15·6	4·14	1·06
90	13·9	4·80	1·03
95	13·2	5·54	0·95
100	12·5	8·50	0·65

The way of reasoning here followed out supposes that the pole-pitch cannot be increased at higher frequencies. This is the case when the circumferential speed limits the diameter of the field. If circumferential speed does not

Digitized by Google

limit the diameter, as in slow-speed generators, mechanical and economical conditions restrict the diameter. The way chosen for the determination of the best frequency is therefore applicable in general.

In our calculation we have tacitly assumed that the induction in the air-gap is the same for all frequencies. This assumption involves a far greater loss through eddy currents and hysteresis with higher than with lower frequencies. For induction motors a low frequency of 40 or 50 is always desirable, as in them a large pole-pitch is of even greater importance than in alternators. How the curves of Fig. 7 can be used for the calculation of three-phase current generators will now be clear without further comment. The total sectional area of all the wires of the armature coils for which can be found room in the generator can approximately be set proportional to the circumference of the armature. Per 1cm. circumference of the armature we may reckon about ½ square centimetre of copper in the armature coils. Having thus found the amount of copper that we can place on the armature, the diameter of which being already determined, we find the number of convolutions of the armature coils by choosing a value for the current density, a good mean value being 300 amperes per square centimetre. Thus, the number of turns being found, we proceed to calculate by means of equation (1) the flux per pole. As the pole-pitch is known, λ can be taken from the curves of Fig. 7, the short-circuit characteristic can be drawn, and the dynamic characteristic be determined. It is not very long ago that the coupling in parallel of alternators was constantly under discussion I fully agree with Mr. W. M. Mordey that "there is no evidence whatever that lowering the frequency is an advantage in connection with parallel working, except in some inferior types of machines." Those who failed in coupling alternators for high frequencies in parallel, failed not on account of the frequency having been too high, but because the pole-pitch in their alternators was chosen too small, on account of the high frequency. They thus mistook a coincidence for a cause—a symptom for the evil.

Two-Phase Alternators.—Take a three-phase generator, separate the three phases, and connect two phases in series. The E.M.F.'s in the two phases, though unequal, are in quadrature with each other. The E.M.F. of the one phase being called E, the E.M.F. of the two phases connected in series is, then $E\sqrt{3}$. If we short-circuit these two phases, each in itself, the sum of the short-circuit currents is equal to the sum of the short-circuit currents in three phases when in star connection. The only difference between the two-phase machine in our case and an ordinary two-phase machine is that in the former one phase has one slot per pole, the other two; while in the latter the number of slots is equal in both phases. This will cause the short-circuit current to be slightly smaller in the latter case than in the former. From the foregoing we gather that λ for two-phase currents is equal to two-thirds of λ'' for three-phase currents.

$$\lambda'' = \frac{2}{3} \cdot \lambda''' \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Single-Phase Alternators.—The value of λ' for single-phase alternators is about one-half of λ'', sometimes a little more, sometimes a little less. This shows that for equal inductive drop an alternator wound for single-phase currents gives one-half more output if wound as a three-phase current generator. But as the load of single-phase alternators consists, in general, mainly of light, the power factor of the external circuit being as a rule near unity at full load, single-phase alternators may safely be wound for the same output as three-phase current generators.

The value of λ is, of course, influenced by the number of slots per pole. The following experiment will elucidate this point. Of two generators of the same type and size one was wound as a single-phase alternator, the other as a three-phase generator. The alternator had one slot per pole, the three-phase generator one slot per pole and phase, three slots per pole. The results were the following:

(1). Single-phase alternator, one slot per pole, $\lambda = 1{\cdot}56$.
(2). Single-phase alternator, two slots per pole, $\lambda = 1{\cdot}39$.
(3). Three-phase generator, three slots per pole, $\lambda = 2{\cdot}90$.

The output in these cases for equal inductive drop is as follows:

(1). $$\frac{E}{1{\cdot}56} = 0{\cdot}64\ E.$$

(2). $$\frac{\sqrt{3} \cdot E}{1{\cdot}39} = 0{\cdot}622\ E.$$

(3). $$\frac{3 \cdot E}{2{\cdot}90} = 1{\cdot}03\ E.$$

The figures speak for themselves, and need no further explanation.

We have seen that Dr. Behn-Eschenburg's method of determining the "synchronous reactance" in alternators gives results accurate enough for practical purposes; but we have also seen that the theoretical value of this method is a doubtful one. The investigator who attacks the problem of the determination of the inductive drop without foregone conclusions will, I feel convinced, arrive at similar results as those which are set forth in this article. The problem is not yet solved, but I doubt whether it will be possible to find a way of predetermining the "synchronous reactance" which is as simple and as accurate within certain limits as the way here taken.

To give experimental corroborations of Dr. Behn-Eschenburg's method of determining the "synchronous reactance"; to dispel the doubt that naturally hangs about a deductive method as long as experimental data do not underpin it; to point to the paramount influence of the leakage, as caused by a small pole-pitch, upon the inductive drop, and, therefore, upon the output of alternators—these are the main points to the clearing up of which I have endeavoured to contribute in this article.

TELEGRAPHS AND TELEPHONES AT THE PARIS EXHIBITION.

The following is an abstract of a paper read by Mr. J. Gavey, M.I.C.E., M.I.E.E., at the meeting of the Institution of Electrical Engineers last night. In the introductory portion of the paper Mr. Gavey pointed out that the various universal exhibitions that have been held in Paris since the year 1878, may not improperly be regarded as milestones along the road of progress in the telegraphic and telephonic industries. Such exhibitions afford unrivalled opportunities for the collective exhibition of new inventions in these industries, and by inspecting the State's telegraph exhibits one could tell how far the inventions of 1878 were employed in actual practice in the present day. The author then proceeded to treat his subject under three heads: telegraphs, telephones, and phonographs. Under the first heading there were three exhibits deserving of special mention, as they were designed either with the object of increasing the number of messages which can be carried by a telegraph circuit, or in order to avoid the labour of transcription at the receiving ends of circuits working with the Morse alphabet.

The first of these three new systems was that exhibited by the Rowlands Telegraph Company, of Baltimore. This consists of an apparatus for multiplex working, which will admit of eight messages being sent at the same time on one circuit—*i.e.*, four in either direction. Satisfactory results are said to have been obtained in America over 600 miles of actual line. Mr. Gavey explained that this was more than can be done with the present Delaney system at use in this country. This system depends for its accuracy on the synchronism between two commutators at either end of the line. If the retardation of the signals, due to the induction and capacity of the line, is then approximately as great as the commutating interval, confusion arises in the signals. Mr. Gavey explains that a modification of the Delaney system, designed by Mr. Pollak, of the General Post Office, is intended to obviate to some extent this defect. This was done by an improvement in the method of synchronising the commutators, which abolish hunting. The commutators were also divided into two concentric rings, the one for sending and the other for receiving. These can be shifted round relatively to each

Digitized by Google

other by an amount which could be made approximately equal to the retardation in the signalling. In the Rowland's apparatus the bad effects of retardation in the line were avoided by making the apparatus synchronous with the received signals and not with the sending period. In this system alternating currents were used to transmit the signals, and the commutator at the receiving end was made to run synchronously with the current received. This was done by a little alternator, which was driven by means of a

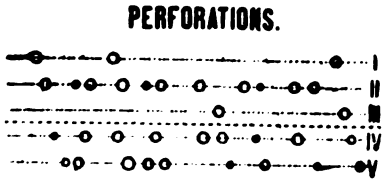


FIG. 1.

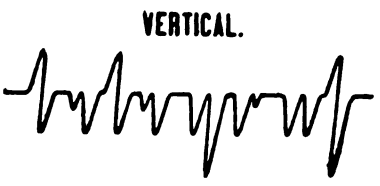


FIG. 2.

FIG. 3.

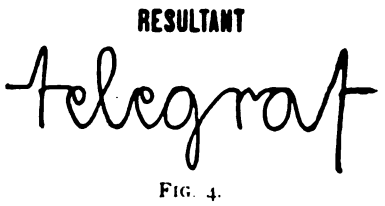


FIG. 4.

continuous-current motor until its speed of alternation was exactly the same as that of the received current. The signals are sent by 11 keys, two of which depressed at the same time correspond to a given typewritten letter. The signals are transmitted by hand, but are printed off automatically at the receiving end in such a form as to be ready for dispatch. Thus the exhibitors stated that each of the four operators at either end can send 30 words per minute, which corresponded to a speed of 240 words per minute over the same circuit. Arrangements were provided by which the sending operator moves the paper at the receiving end.

The next system described by Mr. Gavey was that of Mr. E. Mercardier, of Paris. By this multiple telegraph system it was claimed that 24 messages can be sent simultaneously over one circuit, 12 in each direction. This system was based on the harmonic system. A number of vibrating reeds were used, each differing from the rest by a certain defined period of vibration. These, when used to send signals to the line, caused a complicated system of vibrations to be set up in the currents transmitted. The line current was then analysed at the receiving end of the line by the series of receiving reeds or telephones only responding to the notes to which they had been tuned. With the Mercardier system Morse characters alone could be transmitted up to the present. It was stated that the inventor has been so successful with the tuning of the various parts that satisfactory results had been obtained on a circuit between Paris and Bordeaux. A complete metallic surface was, however, required for satisfactory working.

The third system of telegraphy referred to by the author was that of Messrs. Virag and Pollak. This system of photo-telegraphic and telephonic apparatus has been frequently described before. In the earlier forms Morse signals were transmitted at a high rate of speed, and these had to be transcribed at the receiving end. In the month of August, however, a paper was read before the Electrical Congress, describing an ingenious modification of the system by which telegrams are received in ordinary written characters: "In this modified system a metallic loop is employed, but it is joined up so as to form two circuits (Fig. 5), one being the ordinary metallic circuit, and the second a bridged and superimposed earth circuit of the type well known in telephony. To each of these separate electrical circuits is connected a telephone with a mounted mirror, which is vibrated by the movement of the diaphragm. These mirrors are so placed in relation to one another that a spot of light is reflected, first on one, then on the other, and lastly on the photographic record. The function of one of the mirrors is to receive impulses representing the vertical component of ordinary written Latin characters, whilst the second mirror receives the horizontal components. The transmitting is arranged by means of a punched slip with five series of perforations; the first three transmitting currents to the vertical component mirror, and the second two to the horizontal one. The line of perforations marked 1 (Fig. 1) transmits a negative current of a defined voltage; row 2, a positive current of the same voltage; and row 3, a positive current of double the voltage. Rows 4 and 5 transmit through the horizontal component telephone simple reversals. Two sizes of holes may be perforated along either of the rows, thus admitting of long or short contacts, and by means of a specially designed combination of perforations the vertical and horizontal components are so co-ordinated as to admit of the reproduction of written characters at the receiving end. In the diagram, Fig. 1 illustrates the perforations necessary for the transmission of the word 'Telegraph'; Fig. 2 shows the vertical components; Fig. 3 the horizontal; and Fig. 4 the resultant."

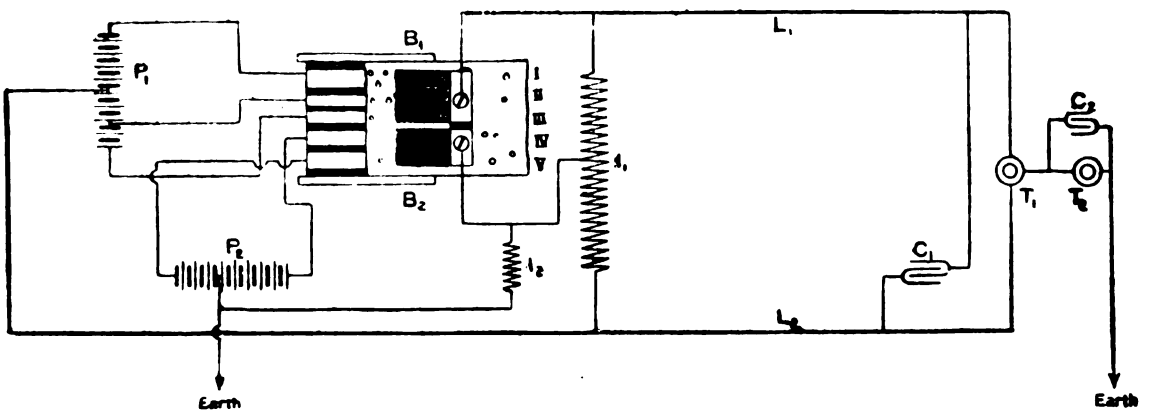


FIG. 5.

Since the last great exhibition in Paris the advance in telephonic practice has been, in Mr. Gavey's opinion, greater than that in the telegraphic departments. The most important advance mentioned in connection with the telephones has been the invention and perfection of the manufacture of dry-core paper-insulated cables. The use of metallic returns for overhead wires involved great expense, but this difficulty can be got over by using one of these cables, by which the wires to 200 subscribers can be drawn

Digitized by Google

into a 3in. pipe. Mr. Gavey predicted that in a few years the earth return for a telephone will be a thing of the past. The advantage of the complete metallic circuit included freedom from disturbance, the ability to use greater power microphones, and automatic signals. This automatic signalling, first insisted on by Sir W. H. Preece, has been greatly extended, as Mr. Gavey showed, in modern installations. Amongst the individual exhibits at the Paris Exhibition in the telephonic department, special mention is made of the central battery telephone switches exhibited by the Western Electric Company. As Mr. Gavey explained, this system of the central battery was being rapidly extended throughout the whole of the United States, and has been adopted by the British Post Office in London, by the National Telephone Company in some of its centres, and by the Belgian Administration in Brussels. He alluded to the advantages of this system in the economy of maintenance, the advantage of automatic signalling, the use of small incandescent lamps as indicators, and, above all, the uniformity in the character and volume of articulate speech. The other details particularly referred to were the Postel-Vinay switches, which consist of an automatic indicator placed immediately over the jack. The Siemens and Halske combined local subscribers' jack indicator. Besides these, several systems of party-line and multiple-way telephones were alluded to as worthy of notice.

As regards the manufacture of carbon granules for microphones, Mr. Gavey referred to the irregular granule which, so far, has been mostly used in this country, and to the regular small spheres of carbon about $\frac{1}{16}$in. in diameter. His conclusion is that there is little to choose between the two for microphone purposes.

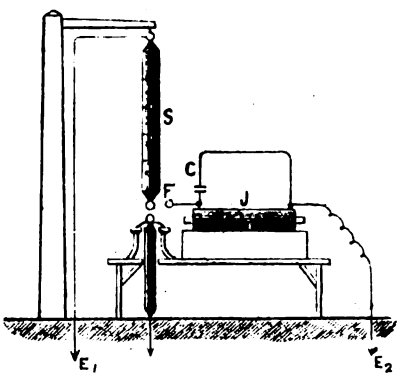


FIG. 6.

The wireless telegraph systems on exhibit were four, the first being that devised by Sir William Preece, which appears in the Post Office exhibit. The next system was the Hertzian system, as developed by Messrs. Ducretet and Popoff. Mr. Gavey stated that this was very similar to the Marconi system. The third system was that designed by Messrs. Slaby and D'Arco, and exhibited by the Allgemeine Elektricitäts-Gesellschaft. In this the inventors have replaced the usual vertical insulated wire, so well known in connection with wireless systems in this country, by a vertical cage, the upper end of which is connected to earth. This is illustrated in Fig. 6. At first sight it would appear as if the effect of the cage would to some extent be neutralised by the waves emanating from the return wire to earth, but probably the self-induction of the earth wire practically confines the oscillations to the cage. This, however, Mr. Gavey considers to be an interesting subject for speculation and investigation. The fourth exhibit was by the American Wireless Telegraph Company, who use a pneumatic arrangement for decohering. The author afterwards referred to the Poulsen microphonograph, which has already been described in our columns. Our readers will remember that the principle consists in recording by means of the transverse permanent magnetism in a continuous steel ribbon the vibrations caused in a diaphragm by the human voice. When the speech requires to be reproduced, this permanent magnetism sets up vibrations in a telephone diaphragm due to the current which it generates in the coils of a small magnet having its poles at either side of the wire. Mr. Gavey suggested that this invention may play an important part in the development of telephone repeaters as a means of increasing the range of telephonic speech, and also in decreasing the cost of long lines. Amongst the miscellaneous exhibits was one by the Telephone Hírmondo, which provides for the transmission of news in the city of Budapest. There were no less than 7,560 subscribers to this system on Jan. 1 last year. In practice, items of news are spoken into the main transmitting telephone every quarter of an hour, and these items are repeated until more interesting news takes their place—in fact, the system is an electrical substitute for an evening paper combined with a theatrephone installation. Mr. Gavey also refers to the novel state of the telephone systems in the city of Mexico. There anyone is allowed to start an exchange, the sole condition being that they must provide intercommunication with all other systems. The result is that eight separate companies are at work with an aggregate of 4,000 subscribers, the average rent for a telephone being half a sovereign per month. In conclusion, the author hopes that the paper may call the attention of the members of the Institution to a few of the most striking developments in the various departments of the Paris Exhibition treated on.

THE GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

A meeting of this section was held in the hall of the Institution of Engineers and Shipbuilders on the 14th inst. Lord Kelvin, G.C.V.O., president of the section, occupied the chair, supported by Prof. Magnus Maclean (vice-president) and Bailie Maclay (convener of the Glasgow Electricity Committee). A paper by Mr. W. A. Chamen, the city electrical engineer, on "Electricity Supply," was read and discussed. After a short speech from Lord Kelvin, in which he expressed his pleasure at presiding over such a crowded audience, he called upon Mr. Chamen to read his paper:

Electricity Supply.

BY W. A. CHAMEN, MEMBER.

This subject has been dealt with so often and by such able hands that the author feels some diffidence in venturing to write a paper upon it. The brief remarks which are now offered, however, will bear only upon two points in connection with the subject, and will naturally take some colour from the particular aspect of the question as applied to the city of Glasgow.

SYSTEM AND PRESSURE OF SUPPLY.

The fact that several undertakings which have commenced with an alternating single-phase high-tension supply have recently been actively engaged in changing their central or nearer areas to low-tension continuous current, supplied direct from dynamos fixed in the generating station without transformation of any kind, must surely be taken as a clear indication that low-tension continuous current is found to be more suitable and more economical for all purposes, where the distance is not so great as to make it too costly in copper. This change has, of course, been brought about by the alteration in the Board of Trade regulations allowing the use of a pressure in consumers' premises not exceeding 250 volts, and consequently of a three-wire system with a pressure not exceeding 500 volts across the outers. Mr. Addenbrooke, in a very able paper read before this Institution in London a few years ago, foretold this result, and showed that with a favourably selected position of generating station an area measuring five miles in diameter could be economically dealt with by means of low-tension continuous current under these altered conditions. Experience has proved this to be so, and in Glasgow the supply is at present carried on over a radius of 2½ miles each way from the new station at Port Dundas. It does not follow, of course, that it will always be economical to work in this way, as the load may grow to such an extent as to warrant putting down other generating stations at the more distant points rather than transmitting many thousands of horse-power through cables from a generating station already fully taxed by a demand of some 20,000 h.p. to 30,000 h.p. within a radius of much less than 2½ miles around it. On the other hand, there may be cases where small amounts of current require to be transmitted to exceptional distances, and in such cases small auxiliary high-tension plants, either continuous or alternating, would seem quite justifiable. The fact, however, that these may be neces-

Digitized by Google

sary is no reason whatever why the whole generating plant should be made high-tension and current transformed down even in central areas close around the generating station.

The obvious common-sense principle on which to proceed is surely to use simple low-tension direct supply at as high a pressure as possible, and when this fails to meet the case, to supplement with high-tension transmission for the remainder. A well-known consulting engineer, in a discussion on this subject some three or four years ago, went so far as to admit that this was the right line to go upon, but said that he found the public wanted an alternating-current supply and not a continuous one, and in consequence recommended that low-tension alternators be used for direct supply to the home areas and that step-up transformers be used in connection with this same supply for reaching the outlying districts, thus avoiding the necessity for any kind of separate generating plant for this purpose. The idea was ingenious, but the author is not aware that any use has been made of it, possibly because it has been found that the public do not, after all, want alternating current. For supplying motors or arc lighting who would prefer single-phase alternating current to continuous? And for incandescent lighting, what is to be gained by using alternating current? It may seem to be wasting your time to ask these questions or to put these arguments before you, but no less a genius than Mr. Ferranti only recently publicly stated his opinion that single-phase alternating current would yet come to be the universally accepted system of supply. There are, of course, those who say that two-phase or three-phase alternating current of low periodicity will shortly supersede everything else, but in their case the public are not found to want alternating current but continuous, and this is managed by means of rotary converters. The object of this system is said to be to allow the generating station (which for some reason, never yet satisfactorily explained, is bound to contain the whole generating plant of any one undertaking or more if possible) to be situated at a considerable distance from the area of supply, where land is cheap and coal readily obtainable. In a place like London, where the cost of land within the lighting area is practically prohibitive, where railway accommodation is impossible, and the conditions and restrictions arising through the interests of surrounding proprietors most onerous, there is no doubt some reason for adopting such a system; but it is somewhat remarkable that in the case of the Glasgow tramway power supply, in which this system is being introduced, there was much anxiety to get a site, not as near the coal-pits as possible, but as near the centre of the city as might be. The site ultimately purchased is about the same distance radially from the centre of the city as the Port Dundas electricity supply works, and figures were given to show both the extra capital which would be involved in going further afield and the annual extra cost through loss in distribution. Again, it is argued that the weak spot in a continuous-current system is the commutator of the dynamo, but experience has proved that this is an absolutely erroneous idea. Nothing could be more satisfactory than the running of the brushes and commutators of most of the dynamos as now constructed, and, in fact, two and three phase alternating systems rely entirely upon commutators in the rotary converters.

The conclusions to which these considerations seem to point are: (1) that there is no more economical or satisfactory method of supply than low-tension continuous current generated upon a site or sites within the area of supply if possible, and supplemented by a small amount of high-tension plant, if necessary, in order to supply remote corners of the area which may be beyond the reach of low-tension supply; (2) that if it be impossible to find sites within the area at any reasonable price, and with railway accommodation, and freedom from onerous restrictions due to surrounding proprietors, then a high-tension generating station or stations without the area will be the next best arrangement, though the cost of supply will be increased to some extent. And it therefore follows that in order to ensure supply at the maximum economy in years to come, sites should be retained in suitable positions within or as close as possible to the area of supply, and with proper railway accommodation and freedom from hampering restrictions, even at some sacrifice in the interval until they are required.

As regards the exact pressure of supply to consumers, it is obvious that the higher the pressure the more economical will be the distribution, and it must also be clear that where lighting and tramways are supplied from the same generating station, it is an advantage to have the pressure for both purposes alike. The pressure allowed by the Board of Trade for tramway supply is 500 volts, and the dynamos are usually constructed to run from 500 to 550 volts for that purpose. These same dynamos will therefore be most suitable, if they are to be used alternatively on lighting mains, for supply on a 500-volt three-wire system, using 250-volt lamps in consumers' premises, with balancers or equalisers to compensate for out-of-balance middle-wire currents. They will allow up to 50 volts drop in feeders at times of heavy load. The Board of Trade regulations for lighting place the limit for low-tension supply at 250 volts, but although the city of Glasgow has some 1,500 consumers, with a maximum load of about 3,000 kw. already supplied at this pressure, and the municipalities of Govan and Greenock have also considerable numbers of consumers supplied at the same pressure with complete satisfaction, the Board of Trade are declining to sanction more than 240 volts declared pressure in the London district and elsewhere. The argument appears to be that the 250-volt limit is one beyond which the pressure must on no account go, and that consequently it cannot be a declared pressure with the margin of variation allowed in another part of their regulations. Whatever may be the actual construction to be put upon the words from a legal point of view, surely it is unreasonable and inconsistent to take this line. The Board of Trade is appointed to look after the interests of the public, but in what way do the public suffer through being supplied at 250 volts? The thing is done, and is an admitted success. It has been in operation in Glasgow for about 18 months, and no trouble of any kind has arisen in connection with it. There can, therefore, be no scientific or practical reason why it should not be allowed. The proposal to establish 240 volts means yet another voltage to worry manufacturers and contractors, and through them the public. If the Board of Trade had taken the line of establishing a standard voltage for the benefit of everybody concerned, there would have been some clear object in it, but the result of this decision will be to make at least five different standard voltages—viz., 200, 220, 230, 240, and 250 volts—in use in various places in the kingdom. On the other hand, to agree upon 250 volts as the maximum declared pressure in consumers' premises would have tended to settle all new work down to this standard, and would have avoided the addition of another voltage to the already too numerous standards in use.

At a time like the present, when standardisation is so much taked about, electrical engineers will do well to give this matter special attention, and if necessary approach the Board of Trade in a body with a view to getting 250 volts sanctioned. It is hard, however, to see what necessity there can really be for taking so much trouble about so small a matter, as all that is required is for the Board of Trade to agree to that reading of Clause 1 in the "Regulations for Securing the Safety of the Public," which shall allow 250 volts to be a declared pressure, subject to the variation of 4 per cent. from that pressure, as laid down in Clause 7 of the "Regulations for Ensuring a Proper and Sufficient Supply of Electrical Energy." Probably the real reason why electrical engineers have not taken any decisive action about this matter is that all the older undertakings are already committed to some other voltage, and will naturally not feel called upon to press for 250 volts when they themselves use 220 or 230, and would not find it worth while to exchange to 250. This, however, is short-sighted policy, and it seems to have resulted in the meantime in the standardisation, not of any of the existing voltages, but of another one—viz., 240 for all new work. In the case of Glasgow, the author of this paper was faced with the problem of converting an existing 200-volt three-wire system into one of a higher pressure, and the question immediately arose as to whether it would be right to be contented with a 400-volt system, using 200-volt lamps in consumers' premises, or to adopt any higher voltage. While making an alteration, it was clear that if any departure were made from the simple multiple of the existing state of things, additional complications would arise in consumers' premises. The next consideration was whether the advantage to be gained was worth the complication and the cost thereof, and it then became necessary, in order to ascertain what the advantage would be, to settle upon some definite pressure as a basis for calculation. Granting that 250 volts could be used, it meant the difference between a 400 and a 500 volt supply—*i.e.*, an increase of 25 per cent. on the voltage. The value of this increase need not be enlarged upon in a paper addressed to electrical engineers. The advantages to be gained in the way of the saving of copper in the mains and ease of regulation of voltage over considerable distances seemed so great as to make it well worth while to take the step. Glasgow always wishes to be in the front line, and it certainly would not have been so had it settled down contentedly to a 400-volt three-wire system at the point when it was starting to lay a distribution system, designed rapidly to extend over an area of some 28 square miles. There is no doubt whatever in the author's mind that this alteration to 250 volts was the right step to take, and if the Board of Trade do not think so now, there cannot be the slightest doubt but that they will come to that opinion shortly. It is, however, much to be regretted that in the meantime other new undertakings should be started in various places at 240 volts instead of 250. There can be no cause for alarm or for the statement that it is a stretching of the regulations which will never end, for it must be quite clear to anyone that 250 volts is the absolute limit of declared pressure at customers' terminals (apart altogether from motive power supplies, which are granted at 500 volts by the special permission of the Board of Trade), and no one could possibly go beyond this figure without deliberately defying the regulations. The author holds, of course, that the regulations as they now stand are perfectly

Digitized by Google

capable of being read so as to allow this 250 volts as a declared pressure, and he doubts very much whether any judge, after hearing arguments, would not decide that the real meaning of the rules is that 250 volts may be used. The words of the two clauses upon which the whole argument depends are as follows:

A.—Pressure of Supply to Consumers.—(1) "The pressure of a supply delivered to any consumer shall not exceed 250 volts at any pair of terminals except with the express approval of the Board of Trade."

B.—Variation of Pressure at Consumers' Terminals.—"The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive, exceed 4 per cent. from the declared constant pressure."

For a time a great deal was made of the argument that 250-volt incandescent lamps could not be made satisfactorily. Before deciding upon the matter, therefore, the leading lamp manufacturers were consulted, and they all stated that there would be no difficulty, and that they would be very pleased to take orders for such lamps. For the most part they had been as good as their word, and although some makers had not been quite successful as yet, they will no doubt shortly be able to fall into line with their competitors. Lamps of even 5 c.p. and 6 c.p. have been in use in Glasgow for over 15 months past at 250 volts without failure. The efficiencies of the good lamps now in use are: 5 c.p. and 6 c.p., 5 watts per candle; 8 c.p., 4 watts; 16 c.p., 4 watts; 32 c.p., 3½ watts, and 50 c.p., 3¼ watts per candle. There seems to be but little in the old idea that thin filaments could not be made to last. The leading manufacturers seem to have so far conquered their original difficulties in this respect that even 250 volts does not seem to be the limit to which they can go. Indeed, it seems doubtful whether in attempting higher pressures the proximity of the terminals in the present design of lamp would not cause greater trouble than the thinness of the filaments. Up to 250 volts, however, no trouble has occurred in this respect. There is another possibility to be borne in mind in connection with this matter, and that is the introduction in the near future of the Nernst incandescent lamp. The construction of the filament in this lamp lends itself most readily to the use of 250 or even 500 volts. The possibilities which lie before us with the Nernst incandescent lamp, giving the necessary light with about half the amount of energy consumed in the present form of lamp, combined with the advantages of the 250-volt supply, are great. A word may not be out of place on the vexed question of interfering with existing arrangements in some consumers' premises, such as two ordinary open-type arc lamps in series on 100 volts, special small motors for dentists' use, low-voltage heaters and cauteries, and such-like complications.

One frequently meets the argument that the increase in pressure is all for the benefit of the Corporation, and not for the benefit of the consumer. This argument is, of course, used by those who think that they will suffer by the change; but they are a very small minority, and do not realise that the object of the change is the cheapening of the supply all round. It is absurd to talk about "the benefit of the Corporation." Who are the Corporation but the representatives of the people, and whose is the undertaking but the people's? The object of the Corporation is to give that form of supply which is most economical, and consequently most convenient, for the majority. Electric light has been in the past too much the exclusive light of the rich man, who can well afford to pay a high price and to indulge in every kind of low-voltage complication which suits his own special fancy or convenience; but to maintain low voltage to suit these consumers means to keep up the price and to prevent the great British public from using electric light at all. The benefit of the majority, while at the same time dealing justly with existing consumers in making the change, is what the Corporation aims at. There are no dividends to make, and all profits are used, after providing for the lasting financial soundness of the undertaking, in reducing the price. The Corporation might have been content to leave things as they were and let the price remain high, but this would have prevented the growth and spread of the undertaking, leaving the supply to those who could afford to pay for it, and whose special and exceptional circumstances it happened to suit. Most people want light, and they want it in 8-c.p., 16-c.p., or 32-c.p. lamps. These therefore demand the first and most careful consideration. The question is how to supply these at the lowest cost. Having settled that, the other consumers must be made to accommodate themselves to the altered condition of things, and it is surprising, after all, how very little difficulty is experienced in modifying existing appliances to suit the new conditions. Voltmeters are met with in several houses supplied at 100 volts. They are not readily altered to suit 250 volts, but why should they be allowed to interfere with progress? They are at best most unnecessary and objectionable things for consumers to have. It is a significant fact that it is only in 100-volt supplies, as a rule, that these voltmeters are found.

In concluding, attention should be drawn to the anomalous position in which the Board of Trade have put the owners of undertakings by allowing them to increase the pressure of supply to all consumers, but only with the consent of such consumers in the case of those supplied previously to the date of the revised regulations. In Glasgow common-sense has always so far prevailed, but in London it does not seem to have done so, and a mere handful of consumers have in some cases held out against the change for no apparent reason whatever, except the unpleasant peculiarities of certain kinds of human nature. A deputation representing some of the London supply companies waited upon the President of the Board of Trade about the matter. While admitting that it seemed unfair for a few consumers to have the power of practically upsetting the whole undertaking, the President is reported to have said that the companies should have done more to conciliate the consumers. One cannot help feeling that the companies in London are hardly dealt with. Every improvement they try to make seems to be obstructed by County Council, Board of Trade, or some other body. They are supposed to be doing everything purely for their own selfish gain, and never with the object of improving the conditions for the consumer. Would not the case be very different if the local authorities of London all held the electrical undertakings in their own hands? Would the President of the Board of Trade have made the same remarks if the local authorities had been making the representation before him? Yet the necessity for the change is the same with the companies as with the undertakings in the hands of local authorities It is to be hoped that the Board of Trade will give compulsory powers in this matter of change of voltage, subject to arrangement or compensation to be settled by an independent arbitrator. The local authorities of London may quite possibly be the right parties to own the electricity undertakings, and it is their own fault that they are not so. Glasgow has realised the importance of the matter and purchased the original undertaking from Messrs. Muir, Mavor, and Coulson, and more recently the Kelvinside Company's undertaking. The whole of this latter company's consumers have now, with one exception, been changed to the 250-volt supply, and great progress has been made with the change of the old central area. Govan, which is not at present part of Glasgow, has started its own supply at 250 volts, so that if ever it is annexed it will join up with Glasgow without further change. In this way the whole of Glasgow and the adjoining communities are in a fair way to get a universal supply at 250 volts, with the exception of Partick, which is said, under the decision of the Board of Trade, to be laying down a supply at 240 volts. This is not good, but Glasgow may nevertheless congratulate itself that it is not like London.

During the discussion which followed, Mr. W. B. SAYERS, after referring to the once keen struggle between alternating and direct current, expressed his almost entire agreement with what Mr. Chamen had said. Direct current would, he thought, always be preferred in cities, particularly where there was a motor load, the chief reason being that speed control was so very easy. Well-designed direct current should and could give a wide and economical speed variation. A variation as wide as 1 to 3 was possible with good motors; certainly the ratio of 2 to 3 should be easily attained. With alternate currents no such variation was possible. Synchronous motors were absolutely constant in their speed, and with induction motors the speed at full load was dependent on the periodicity of the supply circuit, which was generally constant, and could not be varied with convenience. He also thought that there was no reasonable objection to 250 volts as a declared pressure.

Mr. MONTAGUE T. PICKSTONE spoke of some experiments which he had made with a view to obtaining wide and economical speed regulation. The plan was to introduce a counter E.M.F. into the circuit by mean of a motor-generator. It was possible by this means to vary the speed from the maximum to zero, and start up slowly in the opposite direction, all the speeds being obtained with the greatest possible economy.

Mr. JOHN M. M. MUNRO, referring to the battle between alternate and direct currents, pointed out that when the battle was fought in the abstract, and the conditions were the product of the imagination, no difficulty was experienced in proving the superiority of one or other system; the victory lay generally with the most eloquent advocate. Now, when there were numerous examples of both systems of supply scattered over the country, some comparison could be made, and it was obvious that in many cases the

Digitized by Google

advantages of one or other system were most pronounced. Hence it was easy to see that each had its own sphere of usefulness. He agreed that the recognition of 250 volts as a declared pressure was desirable in the interests of all.

Lord KELVIN said that many years ago he had a correspondence with Mr. Addenbrooke, who said that at that time lampmakers were ready to meet any demand for high-voltage lamps, and that no time should be lost in making the change to higher pressure in central-station work. He also remembered Swan's first lamps at 45 volts and Edison's at 100 volts, since which time the progress towards higher voltages had been gradual, but nevertheless sure. Some 18 years ago he suggested 300 volts as the safe limit at which current should be supplied to houses, and it was extremely satisfactory to see the gradual approach to that limit.

Mr. IONIDES spoke of the merits of polyphase motors, and of the possibility of varying their speed.

Mr. SAMUEL MAVOR, referring to the pioneer high-tension alternating-current system of Messrs. Muir, Mavor, and Coulson in Glasgow, said that prior to starting they had obtained the opinion of Lord Kelvin as to the most suitable system. His Lordship advised them to use a high-tension alternate-current system, in order to supply the scattered consumers. After a sufficient number of customers had been brought together, a low-tension direct-current system would prove the most economical. The purchase of the undertaking by the municipality prevented the firm following out the advice of their adviser, but the municipality had done so to its great advantage. On looking over the returns of some 100 supply stations, about 50 being alternate and 50 direct current, he noticed that there was only a small difference in the costs per unit—about ·3d —which showed that each system met the requirements of the town in which it was located.

Prof. MAGNUS MACLEAN made some observations on the number of stations which now supplied current at 200 volts or over.

Mr. W. A. CHAMEN, in reply, said that direct current had proved the most suitable system of supply to meet the requirements of a large variety of customers. Speaking of the suitability of wiring which had been done long ago to suit 100 volts, he said that on changing over no great trouble was experienced; generally all the work which had been connected to the mains within the last few years was suitable for the higher pressure. Switches on 100 volt circuits gave no trouble on 200 volts if the number of lamps were not increased—*i.e.*, switches which could safely carry five amperes at 100 volts could be used on 200-volt circuits if they were not required to carry more than 2½ amperes.

On the motion of Lord KELVIN, a hearty vote of thanks was awarded to Mr. Chamen for his paper.

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Continued from page 657.)

We have so far assumed that there is no internal resistance in either x or y, and that the only external resistances are those grouped at R′ and R″, but the student can readily demonstrate for himself that the results will be exactly the same if the resistances R′ and R″, in place of being collected together, are spread as internal and external resistances over the whole path. This is the case which obtains when we consider the process of commutation, while in addition, except when carbon brushes are employed, the path B C, which represents that which the brush makes by joining together two commutator sections, may be considered as to have only a perfectly negligible resistance. The process and reactions of commutation are exactly the same in both drum and Gramme wound armatures, but as it is simpler to show the various connections diagrammatically with a Gramme-wound armature, it is advisable to select this type for illustration. In all armatures wound with the ordinary two-circuit winding, the brushes are usually arranged to cover one and a-half sections of the commutator—*i e*, they first short-circuit one coil of the armature, and then two, and so on continuously. Fig. 20 diagrammatically represents a Gramme armature with the positive brush at the top, the current flows in a right-handed whorl up the right hand or a series of coils, and in a left-handed whorl up the left hand or b series of coils. Let us assume that the dynamos has to deliver 200 amperes to the outer circuit, then each series of coils must carry half, so that a coil of the a series prior to reaching the positive brush will carry a current of 100 amperes in a right-handed whorl. During the small period of time which it is under the brush this current must be delivered to the outer circuit, must cease in the individual coil, and as was previously stated, to comply with the conditions necessary for sparkless running a current of 100 amperes, neither more or less, must be generated in it in the opposite direction before it leaves the brush finally to pass into the b series of coils; and during this time the whole of the operations are further complicated by the self-induction of the coil, which tends, as we have seen, to prevent the stopping of a current already in existence, and also tends to prevent the formation of a new current. The average speed for a 200-ampere machine may be taken as 750 revolutions per minute, and there will probably be at least 50 sections, so that the actual time that the section is under the brush for all these operations to take place is $60 \div 750 \times 50 = 0{\cdot}0016$ second.

Fig. 20 shows the brush making contact with three sections, 1, 2, 3, and the two coils, d and f, are short-circuited, as the brush joins their otherwise open ends. A current is flowing in both the coils c and g towards the brush; that from g has three paths open to it—viz, $g\,y\,3$, $g\,f\,x\,2$, $g\,f\,d\,w\,1$—and that from c has also the same three paths, except that it would flow through the coils d and f in the opposite direction to that which the

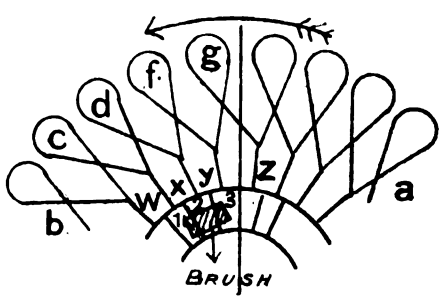


FIG. 20.

current due to the a series would; in addition, the coil d is just about to pass from under the brush and into the b series, and so, in order to fulfil the condition of sparkless commutation, it must be carrying a current in a left-handed whorl of 100 amperes. The vertical line in Fig. 20 represents the neutral plane, and it will be noted that the brush is shown with a forward lead, the short-circuited coils being all in advance of this neutral plane; if, however, we assume for a time that all the coils are not only in a neutral field, but that the armature is held stationary, and that a current of 200 amperes is made to flow through it from the bottom to the top brush, and, further, that the resistance of each coil without its lug is 0·001 ohm, and the resistance of each lug and commutator section is 0·001 ohm, then considering g and c to be the source of the E.M.F. forcing the current to flow to the brush, the resistances of the various paths would be $g\,y\,3 = 0{\cdot}001$ ohm, $g\,f\,x\,2 = 0{\cdot}002$ ohm, $g\,f\,d\,w\,1 = 0{\cdot}003$ ohm, so that were the b series of coils neglected 50 amperes would flow through lug y, 33·35 amperes through lug x, and 16·65 amperes through lug w, but as the resistance of the three paths for the current from the b series are also 0·001 ohm, 0·002 ohm, and 0·003 ohm, 50 amperes will flow through w due to this current, 33·35 through x, and 16·65 through y. Hence at the junction of the coils d and f there will be 16·65 amperes due to a series opposing, 16·65 due to b series, and the two currents will be assimilated and check each other's flow. This will result in only two paths being open for the flow of the a current—viz, $g\,y\,3$ and $g\,f\,x\,2$—and for the b series, $d\,w\,1$ and $d\,f\,x\,2$; so that the a current will divide between these two paths, 66·6 amperes flowing through lug y and 33·3 amperes through lug x, and the final adjustment of the currents through the lugs would be 66·6 amperes due to

Digitized by Google

b through w, 33·3 amperes due to b, and 33·3 amperes due to a—total, 66·6 amperes through x and 66·6 amperes due to a through y. Now, such an adjustment of the current has the benefit of being symmetrical, but would not be satisfactory in practice, for the condition for non-sparking is that at the moment when coil d passes from under the brush there shall be a current flowing in it equal to that flowing in the series to which is added—viz, 100 amperes—whereas we have seen that only 66·6 amperes are actually flowing; hence when it leaves the brush it will immediately have to be increased by an extra 33·3 amperes, and the self-induction will prevent this instantaneously being taken up by the coil, and hence when the armature has revolved into the position shown in Fig. 21 there will be a spark from section 1, which has just left the brush, to the brush due to this additional 33·3 amperes, and as the commutator will be positive to the brush, there will be a wearing away of the commutator. This result is similar to that which obtains when the brush has not a sufficient forward lead. By moving the brushes forward, as shown in Fig. 20, the coils d and f are brought out of a neutral field into the fringe due to the leading horn, and will be cutting lines of force in a direction which will tend to produce a current flowing in a left-handed whorl in these coils. Coil d being further advanced than coil f, a higher E.M.F. will be generated in this coil than in f, and as the resistances of the two coils are the same, it will follow that if each coil were short-circuited on itself, a heavier current would flow round d than round f.

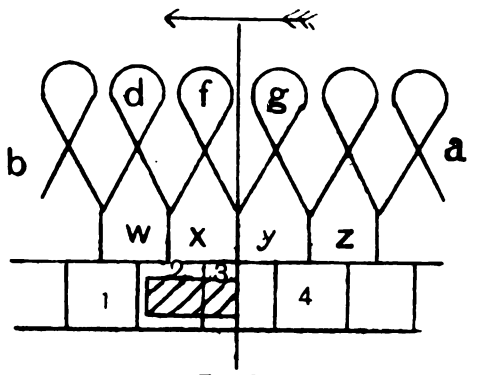


FIG. 21.

If the brushes be given too great a lead, very large short-circuited currents will be generated. We will suppose that, owing to excessive lead, a current of 200 amperes is generated in d and of 150 amperes in f. The condition of things is now greatly altered. There are the main a and b currents tending to flow as before described, while, in addition, there is the d short-circuited current of 200 amperes flowing in the same direction as the b current and having two paths—viz, $d\,x\,w$ and $d\,f\,y\,w$—and the f short-circuited current of 150 amperes tending to flow along $f\,y\,x$ and $f\,y\,w\,d$, the main current from g will be forced to all travel down the lug g, as the portion which before took the alternative path to the brush through coil f, lug x, and section 2 will now be met by the f short-circuited current and blocked. The currents in the three lugs will then be as follows: through lug y to the commutator will flow 250 amperes—viz, 100 amperes due to the main current from the a series plus 150 amperes due to the f short-circuited coil; through lug x will flow to the commutator 200 amperes due to the d short circuited coil, but this will be opposed by 150 amperes flowing from the commutator to the negative end of coil f, hence 150 amperes will be assimilated, leaving 50 amperes to flow to the commutator through this lug; through lug w will flow the 100 amperes due to the main current from the b series, but this will be opposed by the 200 amperes tending to flow to the negative end of coil d, and the main current will be assimilated, and 100 amperes only will flow from the commutator to the coil through this lug, so that we have a net result of lug y + 250, lug x + 50, lug w − 100, brush to external circuit − 200 = 0, which fully accounts for all the currents generated. In this case there will also be sparking, for when the segment 1 leaves the brush, as in Fig. 21, the current of 100 amperes flowing from the brush to the section will be broken, and as the brush is positive to the commutator, the brush will be worn away more than the commutator. If now the lead of the brushes be so adjusted that the E.M.F. induced in d is just 100, we shall get sparkless commutation whatever may be the short-circuited current in f, for this must be less with a well-designed armature than 100, say 75, then we should get 175 amperes through lug y to the commutator 100 − 75 = 25 through lug x, while through lug w there would be 100 amperes main b current to the commutator, which would be opposed by the 100 amperes tending to flow from the commutator to the negative end of coil d, and the currents would assimilate, and being equal in value there would be no flow at all through this lug; hence, when the position shown in Fig. 21 was being attained there would be no current in either direction to be broken, and consequently no sparking, whilst, moreover, the current in the coil newly added to the b series would undergo no violent change in volume upon passing from under the brush, and there could be no induction effects. It will be noted that the object to be attained in rightly fixing the proper angle of lead is not to feed the brush equally, but to divert the current from the nose to the heel; and if this be done, sparkless commutation will be obtained, but if the lead be too great or too little, sparking will ensue from the breaking of either the short-circuited or main currents.

If, as is very often the case, the theory of commutation were left here, the student might justly say, "You are continually talking generally about the self-induction of the coils tending to prevent the stopping of an existing current or the starting of a new one, yet in all diagrams you show currents flowing in the various short-circuited coils, and only mention the induction effect specifically in the one case of the current, in the d coil, being suddenly increased from 66·6 amperes to 100 amperes; how and when is the current reversed in the d and f coils?" The answer to this question is that the current must be stopped and reversed during the time it passes from g to d, and it is this time which has been previously given in a typical case as 0·0016 second. Considering for a moment our last illustration, where a short-circuited current of 100 amperes has been induced in d, we stated that in this case we should get sparkless commutation whatever may be the short-circuited current in f, and for an example 75 was taken, but if a value of 0 had been taken, the result would be the same. We should have had a flow through y of 100 amperes due to the main a coils; a current of 100 amperes through x due to the d short-circuited coil; and no current through w, with sparkless commutation. Hence at the instant when the coil d is thrown into the b series, there can be no current in f, and during the time it has already been under the brush the self-induction may have been gradually reducing the current flowing through it in a right-handed whorl, and during the period it has still to remain under the brush there is time for a short-circuited current of 100 amperes to be generated in it; for it must be thoroughly understood that it must not carry a short-circuited current of 100 amperes when in the position shown in Fig. 20, but this must be the value of the current just previous to the position shown in Fig. 21. If it were carrying 100 amperes at the instant depicted in Fig. 20, the current would be greater than 100 when the coil passed from under the influence of the brush, so that during the time the coil passes from g to f (Fig. 20) the self-induction may be opposing the stopping of the current flowing in a right-handed whorl, while during the period the coil passes from f to the time when it leaves the brush the self-induction will be retarding the growth of a current in a left-handed whorl. It will be readily seen that since $C = \frac{E}{R}$, and $E_{s\,s}$ will always be the same for any coil in postion d, f, or g, providing the dynamo output is constant, that the short-circuited currents will only be the same for all coils if the resistances of the various coils are equal. Hence it is most important in designing and building a dynamo to have perfect symmetry in the coils, not only in their positions on the core, but also in their length and resistance; dirty joints must be rigorously tabooed, for the resistance of any one coil is so very low that the increase or decrease in the resistance of

Digitized by Google

any one coil of the $\frac{1}{1000}$th part of an ohm will so far alter the induced current that we may get one coil when it leaves the brush carrying a current of 100 amperes, while the next coil may when it attains this position be carrying 200 amperes or 50 amperes. In either case intermittent sparking will ensue when the machine is run.

With smooth-core armatures some means have to be adopted in order to drive the inductors, a common device being to insert three or four driving horns. These may be made in two ways. A channel is milled across the core and an iron or wooden horn is driven in. This method has two objections: if iron is employed, the magnetic reluctance of the path from pole to pole is periodically decreased owing to the iron being brought nearer to the polar face; if a wooden or fibre driving horn be used, the magnetic reluctance is increased owing to the iron of the core being cut away at these points. In both cases there results unwarrantable fluctuations in the magnetic field. These driving horns, although a necessary evil, also destroy the symmetry of the armature coils, for whereas the majority of the coils lie evenly spaced round the armature (as in Fig. 20), at stated intervals a driving horn is inserted, and occupies the place of a coil, which is similar to leaving out coil *f*, or rather bending it back to occupy the position of coil *g*, so that when a horn comes between two coils which are under the action of the brush, they cannot both be in the proper position for sparkless commutation, and it is possible that intermittent sparking may ensue, especially as, owing to the horn itself, there is a

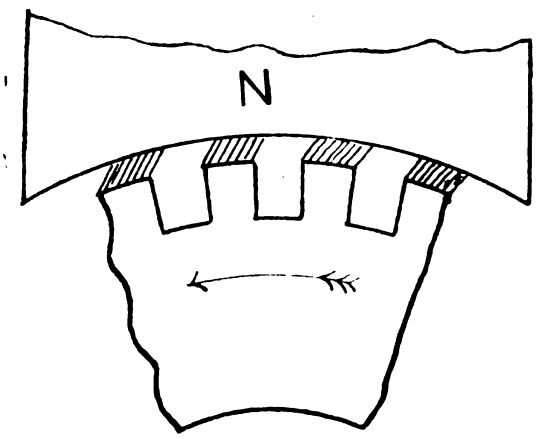


FIG. 22.

disturbance in the magnetic field. It will be readily appreciated that if, in place of inserting a driving horn, the full length of the core pegs are inserted in holes drilled in the core, the magnetic disturbance may be lessened, but is not obliterated. The cutting away of core for these horns is also to be deprecated on account of the burring together of the plates, which, as has been already seen, are carefully insulated from each other in order to prevent the formation of Foucault currents.

With slotted drum armatures the disturbing element of the driving horns is obviated, a more positive drive of each inductor is obtained, and solid copper inductors may be employed without fear of any heating from Foucault currents. Fig. 22 shows the arrangement of a slotted core; the lines of force, which are here represented as flowing from the pole to the core, are seen to be dragged in the direction of rotation of the armature. This dragging movement will be continued until finally the lines snap across the slot in which the inductors are laid. When speaking of the Foucault currents which would be generated in wide solid inductors on a smooth-core armature, it was shown that these currents were due to the difference of potential which obtained between the two sides of the inductor, owing to the number of lines of force cut per unit of time not being the same for the two sides. With inductors laid in a slotted core, and the lines snapping suddenly across the slot, it will be readily seen that the lines cut per element of time will be the same for the two sides, and that hence there will be nothing gained by the use of anti-Foucault stranded inductors, the cutting of the lines being performed as it were by a series of jerks. Other effects which will be produced by the employment of a slotted core are that, owing to the lines being dragged to their utmost extent and then snapping away, there will be a series of small closed magnetic rings formed on the polar face, and the magnetic field will be constantly and periodically disturbed; also the air space between the iron of the core (or rather teeth) and that of the pole-shoe will be greatly reduced, and consequently, not only will the reluctance of the path of the forward induction be considerably reduced, but also that in the paths of both the cross induction and back induction will also be reduced. While the reduced reluctance in the path of the forward induction may be said to compensate for the diminution of that in the path of the back induction, the diminution of the reluctance in the path of the cross induction is a very serious matter, as the effects of the cross induction will thereby be intensified. Various methods have been adopted to prevent any large amount of cross induction, some of which will be dealt with later.

(To be continued.)

THE CONVERSION OF THE METROPOLITAN DISTRICT RAILWAY.

According to one of the halfpenny daily papers, Sir William Preece has stated that there is to be an international battle of brains over five million sterling connected with the conversion of the Metropolitan District line to electric traction. We think a more correct statement of Sir W. Preece's views, after reading the article in question, will be that there is an international battle of brains for the most sensational news concerning this conversion. Another halfpenny daily, which is also noted for its advanced knowledge, claims to have discovered that the interview with Sir W. Preece emanated from an American yellow journal, in which it was printed on Nov. 9. The internal truth of the interview, in which it is claimed that Sir W. Preece has freely expressed his views, does not impress us. For instance, we can hardly conceive that Sir W. Preece would class the prominent English firm of Siemens Bros. amongst the German tenderers. It is well known that this firm constructed the experimental section of line between Earl's Court and High-street, Kensington, and that all the materials required and the technical skill also, were provided from English sources. The order in which the firms are mentioned would also lead us to suppose that an American reporter took a prominent part in the compilation of the article. It will have been remarked by our readers that the American firms are first mentioned in connection with the work, in spite of the fact that there are said to be more English firms sending in tenders. As a last evidence of the unreliability of the supposed interview, we would refer to the five million sterling which the conversion is said to cost. We should not be surprised to learn that the magnitude of this figure was intimately connected with the conversion of dollars into pounds. It will be seen from the advertisements inserted in the papers this week by the Metropolitan District Railway Company that they propose to introduce the Bill before the next session of Parliament to enable the company to convert their system to electric working. Powers are sought to this end, and to enforce on all of the companies having running powers over the system the use of electric locomotives. It will only be necessary in this case that the trains should be adapted for hauling by electric locomotives, as we presume that the locomotives themselves will be supplied by the Metropolitan authorities, as in any case these locomotives would draw their energy from the same generating station as the Metropolitan District trains. Under the proposed Act the capital of the company will be reorganised, and powers are sought to raise £500,000 in debentures, which would either rank in priority with the present debenture stock or on an equality with it. If this were granted, under the terms of their Act they would be able to borrow a further £166,000 in consequence. The company also seek powers to use for the conversion to electricity the whole or part of the £1,200,000 authorised

Digitized by Google

to be raised by the Metropolitan District Railway Act of 1897 and the additional £400,000 which could be borrowed in connection with the same under the same Act. It will be seen from these figures that the directors, if the Bill is passed, will have approximately 2¼ millions at their disposal. We do not think that all of this will be required. We believe that the last-mentioned sums were to be expended in improving the condition of the atmosphere in the tunnels by providing additional openings and forced circulation of air. If we are correct in our surmise, there is no reason whatever why the money should not be used for installing electric traction, which will give the same improvement in the condition of the air in the tunnels. The last rumour of the newsmongers is that the British Westinghouse Company are the real promoters of the above Bill, and that the same company will find the new capital as well.

SIMPLIFIED CALCULATION.

In a short contribution to the *Elektrotechnische Zeitschrift* Mr. Arthur Löwit points out that many trial calculations are necessary in the majority of cases in order to determine that diameter of wire which will give the requisite number of ampere-turns in a coil of given dimensions and with a given terminal potential. He then evolves a formula whereby the correct diameter may be at once found. From the calculated current density in the wire of the determined sectional area, it may then be decided whether the winding room at disposal is sufficient.

Let E = potential per coil;
i = current strength
R = resistance per coil;
n = number of turns;
L = total length of wire in the coil;
d = diameter of wire, in millimetres;
s = resistance of 1m. of wire of one square millimetre sectional area;
Z = number of ampere-turns per coil;
u = mean length of one turn.

Then
$$Z = n \cdot i \quad \ldots \quad (1)$$
$$n = \frac{L}{u}.$$
$$L = \frac{R \pi d^2}{4 s}.$$

By inserting the latter values in (1) we obtain:

$$Z = \frac{R \pi d^2}{4 \cdot s \cdot u} \cdot i = \frac{E \pi d^2}{4 s u}.$$

Whence
$$d = \sqrt{\frac{4 Z s u}{\pi E}} = 1{\cdot}13 \sqrt{\frac{Z \cdot s \cdot u}{E}} \quad \ldots \quad (2)$$

By introducing for the round coil $u = \pi D$ into formula (2), which serves equally well for any form of coil, we get:

$$d = 2 \sqrt{\frac{Z \cdot s \cdot D}{E}} \quad \ldots \quad (3)$$

For copper wire in a cold condition, $s = 0{\cdot}0166$, and for a round coil

$$d = 0{\cdot}258 \sqrt{\frac{Z \cdot D}{E}} \quad \ldots \quad (4)$$

It yet remains to decide whether the current density which would obtain for a wire of the determined diameter under the given conditions falls within the permissible limits. This may be calculated by means of a formula suggested by Uppenborn:

$$(d + \delta) = \sqrt{\frac{a \cdot \pi \cdot D \cdot l \cdot h \cdot s}{E}}$$

wherein δ = double thickness of cotton insulation;
a = density per one square millimetre;
l = length of the winding space in millimetres;
h = depth of the winding space in millimetres.

According to the formula, for copper wire and round coils

$$a = 19{\cdot}2 \frac{(d + \delta)^2 E}{D \cdot l \cdot h} \quad \ldots \quad (5)$$

Should the current density be found too great, the winding space must be increased accordingly.

As is apparent from formula (4), the number of ampere-turns remains unchanged so long as the mean circumference of a winding is the same.

THE GRAND.

A brand-new variety theatre to be called "The Grand," and meant to replace a popular music hall of the same name, is to be opened on the 26th inst. at Wandsworth, near Clapham Junction Station, under the managership of Mr. Arthur Yates, well known in a similar capacity at the Oxford, and at the Alhambra, Blackpool. The new building, which has an enormous seating capacity of the most comfortable description, is remarkable for having a very compact and well-arranged electric lighting plant of its own. The architect, Mr. Ernest H. I. Woodross, A.R.I.B.A., has provided three rooms on the ground floor, directly opening into the yard, for the reception of the machinery, which is just being placed *in situ* by Messrs. Geipel and Lange, of Victoria-street, Westminster. The centre room holds the dynamo, engine, and condenser; the others contain the boiler and the accumulators respectively. When one has got used to crawling about in dark and musty basements or other not easily accessible odd corners of theatres in search of the electric lighting plant, it comes as a pleasant surprise to see the engineers provided with plenty of fresh air and daylight. In the winter also the arrangement of having to work in a moderate-sized room will be found an advantage. The dynamo is a 120-ampere 160-volt continuous-current machine, made by Messrs. Laurence and Scott. It is directly coupled to a 20-h.p. high speed enclosed Reavell engine. Messrs. G. H. Hudson and Co., of Sheffield, furnished the economiser, and the boiler is of the Economic type, supplied by Messrs. Davey, Paxman, and Co., of Colchester. There will be 57 Tudor accumulators. The plant will provide for about 500 16 c.p. incandescent and 10 arc lamps, eight of which are at present erected. The wiring and lighting contract is in the hands of Messrs. Marryat and Place, of Hatton-garden, who also supplied the switchboard. Liquid resistances are used for dimming the incandescent lamps, which are on a 100-volt circuit. There are some very artistic brass chandeliers in the vestibule. We also noticed a plentiful supply of gas lamps all over the house. The whole work does much credit both to the architect and to Mr. C. Gray Hill, the contractor; and there appears to be every reason that the nightly rush for seats now taking place at the old hall will be transferred to the new building.

FORTHCOMING EVENTS.

MONDAY, NOV. 26.

Society of Arts.—At 8 p.m., Cantor lecture on "Electric Oscillations and Electric Waves" (lecture I.), by Prof. J. A. Fleming, F.R.S.

Institution of Electrical Engineers (Newcastle Section).—Ordinary meeting.

TUESDAY, NOV. 27.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., at Owens College, ordinary meeting. Paper on "Relative Advantages of Direct Current and Three-Phase Distribution for Small Installations," by Mr. H. A. Earle.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Further discussion on paper on "The Metropolitan Terminus of the Great Central Railway," by Messrs. G. A. Hobson and E. Wragge; and, time permitting, paper on "Machinery for the Manufacture of Smokeless Powder," by Mr. Oscar Guttmann.

WEDNESDAY, NOV. 28.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting. Papers on "Single-Phase Generators at the Paris Exhibition," by Mr. J. T. Irwin," and "Polyphase Generators at the Paris Exhibition," by Mr. C. N. Nettley.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the L. and S. W. Railway Locomotive Works, Nine Elms.

THURSDAY, NOV. 29.

Institution of Electrical Engineers.—At 8 p.m., extra meeting at Institution of Mechanical Engineers. Paper on "The Supersession of the Steam by the Electric Locomotive," by Mr. W. E. Langdon.

FRIDAY, NOV. 30.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, inaugural meeting of twentieth session. Presidential address by Sir Lowthian Bell, Bart., F.R.S.

SATURDAY, DEC. 1.

Institution of Electrical Engineers.—At 2 p.m. and 3 p.m., students' visits to the generating station of the Waterloo and City Railway.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "The Overstraining of Iron," by Mr. Jas. Muir.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	721	Common-Sense Principles	738
Practical Notes on Electric Mains	726	Reviews	739
The Factors which Determine the Design of Monophase and Polyphase Generators	727	Correspondence	739
Telegraphs and Telephones at the Paris Exhibition	729	The Resistance Offered by Iron Conductors to Alternating Currents	741
The Glasgow Local Section of the Institution of Electrical Engineers	731	Questions and Answers	743
The Philosophy of Dynamo Design	734	Physical Society	746
The Conversion of the Metropolitan District Railway	736	Legal Intelligence	747
Simplified Calculation	737	Contracts for Electrical Supplies	747
The Grand	737	Traction Notes	749
Forthcoming Events	737	Lighting Notes	751
		Companies' Meetings and Reports	754
		New Committees	754
		Provisional Patents	755
		Traffic Returns	756
		Companies' Stock and Share List	756

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

COMMON-SENSE PRINCIPLES.

As might have been expected, Mr. Chamen, in his exceedingly practical paper before the Glasgow section of the Institution, puts aside all fads and fancies and plumps for common-sense principles in electric central stations. Naturally, during the early years of any rapidly-growing industry there is a continued shifting of ballast; and the opinions of the "man in the street" vary with the shifting of the ballast. It is hardly to be expected that the majority of engineers will give allegiance to the view that "the obvious common-sense principle on which to proceed is surely to use simple low-tension direct supply at as high a pressure as possible, and when this fails to meet the case to supplement with high-tension transmission for the remainder." The battle of the pressures as regards electrical work is following the course of the battle of the gauges in railway work. By-and-by pressure will be more or less standardised, and so conduce towards the standardisation of machinery, which some manufacturers so much desire. Mr. Chamen brings us back to the consideration of direct as against all other methods of distribution. Within certain limits he concludes it is the very best, but that is just what many who had really thought out the question conceded from the commencement, and yet each fashionable craze has run its day. Recently the value of polyphase working has been urged. The fun is that no one doubts its value, but what a good many of us have often said is that no system is universally applicable; each must be considered on its merits, and the conditions surrounding each central station must be carefully examined before any system is adopted for the particular position. The most important question, however, raised by Mr. Chamen is not about direct or alternate current working, but is that of pressure and interference with previously declared pressure and the customers' installations. Here, as in other mundane matters, common-sense might with advantage be used. The world is a world of change, and if the change can be proved to be advantageous to both buyer and seller, the supineness or ignorance of the former ought not to be allowed to stop an improvement. It is needless for us to dilate upon the advantages to the generating station of a five hundred-volt pressure between the outers of a three-wire system as against a two hundred-volt pressure; they are well known. The more important question is how to reap those advantages. At the present time half a dozen, or even a single consumer stands master of the situation. The voltage has been declared at one hundred volts at the customers' terminals. The sellers desire to change over to five hundred volts between the outers, or two hundred and fifty at the customers' terminals, and practically all but these few of their customers agree. As the law stands, the change over cannot be made in face of this opposition. The seller may be perfectly willing to change the lamps, to make such alterations in the installations as are necessary at their own cost, to subsequently supply current at a lower cost per unit to the customer. Yet if the customer won't agree,

Digitized by Google

there is no help for it. Of course, we are assuming that the lower price of current will effectually compensate for decreased efficiency of lamps, if any, and that there is no doubt but that the consumer does get his share of the benefit through the change over. Mr. Chamen charges the Board of Trade with having caused some of the troubles to manufacturers, in that it has a varying policy as regards pressure. In Glasgow two hundred and fifty volts is the maximum, in London two hundred and forty volts—why? As Mr. Chamen says: "There can, therefore, be no scientific or practical reason why it (two hundred and fifty volts) should not be allowed" anywhere and everywhere. It may be doubted if the Board of Trade is the culprit in this instance, the varying pressures allowed being determined by the requests of the various engineers responsible for the supply at the different places. In Glasgow the engineer asked for and got permission to supply at two hundred and fifty volts at the terminals. In London the request was for two hundred and forty volts at the terminals, and other pressures at other places. The Board of Trade, however, is responsible for its own regulations, and the last part of paragraph 6 of Section B reads: "Provided that no change shall be made in the pressure of the supply to any premises which at the date of these regulations are supplied with energy by the undertakers, *except with the consent of the consumer.*" The italics are ours. All responsible authorities, whether connected with municipalities or companies, are in accord as to the necessity to alter this clause. Change for the better can be stopped by any consumer refusing consent, provided that customer was supplied at the date of these regulations. In this particular, then, the profession stands united, and we trust concerted action may be taken to bring the matter formally before the Board of Trade and to obtain a satisfactory remedy.

REVIEWS.

The Lead Storage Battery. By DESMOND G. FITZ GERALD. Biggs and Co., 139-140, Salisbury court, E.C. Price 7s. 6d.

This is a book which it is a pleasure to read, full of instruction and of experiment, steadily directed to a purpose, and as steadily reasoned out; but unlike many other books of which the same might be said, it is bright and readable, instead of requiring an effort to control one's attention. A good example of this is in Chapter VIII., illustrating the difference between exothermic and endothermic chemical reactions. One is rather puzzled when invited to consider the chemistry of 2½ cubic feet of carbonic anhydride, 36 grammes of water, 42 of nitrogen, 16 of oxygen, and 1 of hydrogen; nor does it greatly enlighten us to learn that it requires 397·3 foot-tons of work to reduce this somewhat heterogeneous mixture to the elementary condition. But this bears another aspect when we find that the substances represent some 5oz. of nitro-glycerine, capable of doing an enormous quantity of work while decomposing. This, of course, opens out the general principles of the storage of energy in chemical combinations.

The work commences with some seemingly elementary experiments upon coated lead plates; but simple as these may seem, they convey effectively that fundamental instruction which many are apt to think beneath them, but the clear comprehension of which is the only foundation of real knowledge, as distinguished from that which "everyone knows," but probably few really understand.

The early and seemingly obvious theory of storage or "polarisation" batteries was that their operation depended upon the decomposition of water, H_2O, into its nascent elements, and the so-called secondary actions of these upon surrounding substances, and especially upon "the combination of its oxygen with lead, to form PbO_2." Mr. Fitz-Gerald then shows that this is but a crude summing up of a final result of several intermediate processes, and that these several stages, reproduced in the course of discharge, correspond to the varying E.M.F. which is available.

It is shown by clear experiments that, contrary to a common opinion, PbO, lead protoxide, does not readily combine with acids; so, also, lead sulphate is with great difficulty formed into peroxide. These facts give an explanation of a loss in secondary batteries proportioned to the difference between 2·5 and 2 volts. Further study of the processes of "forming" in the Planté type, and of charging in the Faure or "pasted" type of cells, and of the various oxides of lead, shows that red lead, Pb_3O_4, is not, as often stated, a mere mixture of the proto and peroxide, but a definite stable chemical compound; it appears that the production of this, probably as a hydrate, corresponds to the high voltage stages, while the reduction of $Pb_2O_3 = PbO,PbO_2$, first to PbO, PbO, and then to 2Pb, or practically $2PbSO_4$ corresponds to the several lower stages. A corresponding compound, $PbO,PbSO_4$, is shown to be probably the harmless stage of sulphate of lead, readily oxidised in the charging. In justification of these theoretical studies in a work for practical men, it is most truly remarked, "I hold that the man who is practical, in the higher sense of the word, cannot work contentedly and satisfactorily to himself without having some clear conception of the causes involved in his results."

An interesting account is given of the various forms and processes of production of Mr. Fitz-Gerald's own peroxide, "lithanode." This substance, which has promise of a future, is the outcome of endeavours to combine porosity and solidity. This requires a cellular but continuous molecular structure, which can undergo chemical substitution of constituent radicals without destruction of the molecular cohesion and physical continuity.

A somewhat severe (but not unjustly so) criticism of Marchenay's chloride of lead patent specification introduces a full description of the many different forms of secondary cells which have been introduced. A discussion of the nature and properties of celluloid and pyroxylin will prove interesting and valuable to those who look forward to improvements, while those who have the present management of batteries will find abundant information in the many pages of formulæ and principles related to the due proportionment of active materials, acids, and vessels. The true economy, that is, the use of all necessary means towards the desired end, together with avoidance of everything unnecessary, depends on the understanding of such principles. There will also be found much information on the vexed problem of batteries for use with motors, which promises to be of so much importance in the near future.

The book is very free from errors of the press, but one on p 141, line 8, may confuse those not very familiar with chemical formulæ: $3Pb_2,PbO$ should be $3PbO_2,PbO$. A copious index, that essential element of a work of reference, completes a book which is likely to become a standard authority on the subject of storage batteries.

JOHN T. SPRAGUE.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RATING OF INCANDESCENT LAMPS.

SIR,—Prof. Rowland's paper on this subject is, as Mr. Hobson remarks in your journal of Nov. 9, most interesting. Electrical engineers and lampmakers will no doubt give it the attention it deserves, and when they have fully digested it afford the general public the opportunity of profiting by

Digitized by Google

Prof. Rowland's observations. The paper, however, is of especial interest to me, owing to my close association with inventions having for their specific object to provide a remedy for the very defects which Prof. Rowland enlarges on. I trust, therefore, that for this reason, and in view of the fact that Mr. Hobson in his letter, while admitting the advantages of the spiral globe, refers to some alleged disadvantages attending its use, you will permit me space for the following remarks.

I gather from Mr. Hobson's letter he is of opinion that the ideal incandescent electric lamp would be one furnished

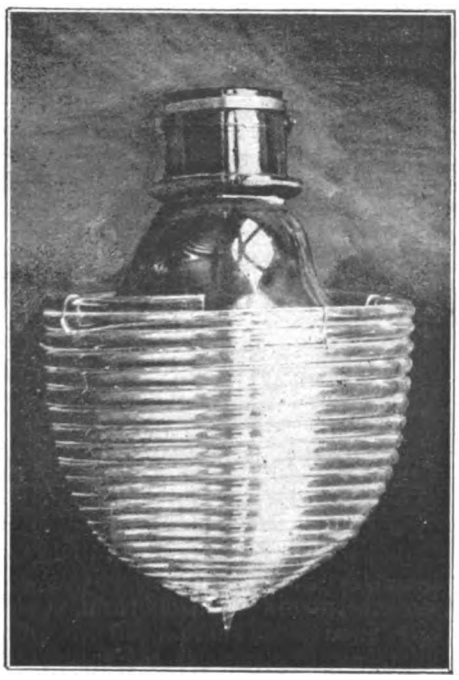


FIG. 1.—View of the Spiralette Globe.

with a device capable of refracting and diverting the side rays into the required direction without diminution. In this I cordially and emphatically agree, but I cannot admit that such a lamp is not at present in existence, for the spiral globe, which he refers to as being the "nearest approach to what is needed," more than fulfils Mr. Hobson's requirements. You will see that he himself bears witness to this fact, and anybody who takes the trouble to test the effect of the spiral globe with a photometer, as Mr. Hobson has done, must arrive at the same

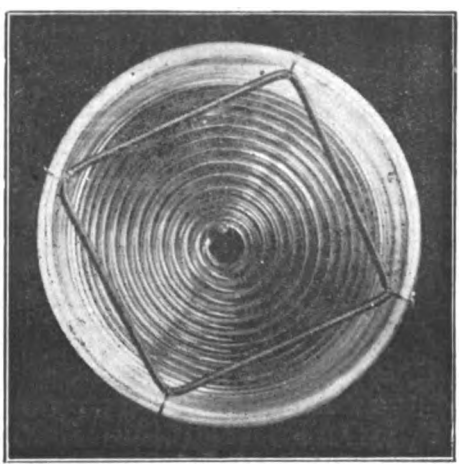


FIG. 2.—End View of the Spiralette, showing Springs for Gripping the Incandescent Lamp.

conclusion. This was, however, established two years ago, as will be seen by the test made by the Electrical Standardising, Testing, and Training Institution. I enclose copy of this test, by which you will see the increase given in effective illumination is from 70 to 100 per cent. in the most useful and desirable direction.

The objections to the spiral globe alluded to by Mr. Hobson are really of very minor importance when the advantages it possesses are taken into consideration. Moreover, one of them has to a considerable extent been very recently remedied. Hence I assume that Mr. Hobson, being a scientist, and not an electrical engineer, is not acquainted with these lamps as now placed on the market.

The objections are three in number—viz., weight, expense, and unsuitability for all kinds of installations. I am bound to admit the latter objection, for in the case of lamps surrounded by certain kinds of shades or other adjuncts the spiral globe is inadmissible. There are, however, such a vast number of lamps unprovided with shades, etc. (as in large premises, etc.), that this objection may be disregarded, for the spiral globe was primarly invented to secure comfort and not for ornamental purposes. Expense—*i.e.*, first cost of lamps—was not taken into account, for it was thought that the use of the invention would (and as a matter of fact does) result in such an increased illuminating effect, coupled with increased comfort, that the additional expense of the lamps would be warranted. Now, however, the lamp has been so modified that the possibility of putting the lamps on the market at a price very little in excess of the cost of ordinary lamps has been afforded. Hence one of Mr. Hobson's objections, at all events, falls to the ground.

However, this is only by the way, as my chief object in addressing you was to call Mr. Hobson's and your readers' attention to the fact that such a device as this gentleman asks for has been produced and is now being placed on the market. This device is a direct outcome of the spiral globe itself, and hence it is termed 'the electric incandescent mantle," the "spiralette." It is applicable to lamps of all makers, while being especially suitable for the "improved glow lamp" and Edison and Swan's "Queen lamp," in which a reflector projects the rays downwardly and renders the glare of the filament so intense so as to be hurtful to the eyes. This device consists of a hemispherical or cup-shaped screen constituted by a spirally-coiled glass rod (as in the spiral globe), provided with adjuncts which serve to secure the screen firmly in place on the lamp, these adjuncts being of such character that any person may apply and remove the screen instantly. In view of this, I am compelled to challenge Mr. Hobson's statement that there is not a cheap efficient device, applicable to every kind of lamp, serving to direct the rays into the required direction, and one which all lampmakers may use, for the "spiralette" possesses all these qualifications.

I might enlarge on the merits of the device, but I fear to encroach on your space. Consequently I will content myself with inviting all lampmakers and others interested in this very important subject to call here and see the device, of which I send you a specimen herewith for your inspection.—Yours, etc., S. B. APOSTOLOFF.

28, Bush-lane, E.C., Nov. 16.

[The two illustrations herewith we have prepared from the samples referred to. The cup-shaped spiral of glass rod is a wonderful example of what can be done in the fashioning of glass.—ED. *E. E.*]

THE DIRECTOR QUESTION.

We have received a copy of the following letter, which has been sent to the various shareholders of the British Electric Traction Company:

"Ladies and Gentlemen,—In view of the gratuitous distribution among the shareholders of the British Electric Traction Company of a paper containing an article, followed by several anonymous letters, commenting on the number of companies of which I am a director, I think it due to you to make this communication.

'The statements referred to are entirely misleading. All the companies of which I am a director are—with only one exception—associated companies of the British Electric Traction Company, in which that company has very large interests. I am a director of these companies in virtue of my position as managing director of your company, and by the instruction of your Board. Whatever fees or remuneration I receive from any of these companies are paid over to the British Electric Traction Company.

"The fact that it is necessary for the business of the British Electric Traction Company to be carried on mainly

Digitized by Google

by means of separate companies has already been fully stated to the shareholders in the annual reports. Those companies are in the nature of departments of your business, and it is the wish of your Board that I should for a time, at any rate, share both the responsibility and the satisfaction of establishing these companies on a successful basis.

"Prior to the formation of the British Electric Traction Company, I was a director of several electric lighting companies—*e.g.*, the County of London Electric Lighting Company and the Chelsea Electricity Company—but when, last year, my work as your managing director became heavy, I voluntarily resigned my directorships on all companies not directly associated with the British Electric Traction Company with only one exception.

"The exception is the Electric and General Investment Company, of which I have been a director since its formation 10 years ago, and I have retained my seat on that Board at the request of your chairman.—I have the honour to be, ladies and gentlemen, your obedient servant, "E. GARCKE."

THE RESISTANCE OFFERED BY IRON CONDUCTORS TO ALTERNATING CURRENTS.

The following is an abstract of an article contributed by Messrs. C. Feldmann and J. Herzog to the *Elektrotechnische Zeitschrift*:

If a conductor of somewhat considerable dimensions be traversed by alternating currents, the assumption of a uniform distribution of the current over the whole area of the conductor cannot be admitted. In fact, the individual lines of force generate local fields which are densest at the centre of the conductor, permitting only weak currents to pass there. Lord Rayleigh and, subsequently, Lord Kelvin were the first to draw attention to this fact. But it is well known that, so far as practical measurements are concerned, the increased resistance of copper wires arising from this un-uniform distribution of the current is a negligible quantity for the periodicities in vogue. If desired, the slight increase of resistance may, however, be approximately determined by means of the following formula:

$$R' = (1 + 7{\cdot}5 \cdot \sim^2 \cdot d^4 \cdot 10^{-7})\, R \quad . \quad (1)$$

or,

$$\frac{R'}{R} = 1 + \frac{1}{12}\left(\frac{2\pi \sim l\mu}{10^9 R}\right)^2 - \frac{1}{180}\left(\frac{2\pi \sim l\mu}{10^9 R}\right)^4 + \quad . \quad (2)$$

These formulæ are identical if we take the magnetic permeability, μ, in equation (2) as equal to unity. By substituting R in (2) by $\frac{\sigma l}{10^9 f}$, we obtain

$$\frac{R'}{R} = 1 + \frac{1}{12}\left(\frac{2\pi \sim \mu f}{\sigma}\right)^2 - \frac{1}{180}\left(\frac{2\pi \sim \mu f}{\sigma}\right)^4 + \quad . \quad (2A)$$

In equations (1) and (2) the diameter, d, and the length, l, are expressed in centimetres; the section, f, in square centimetres; and the specific electrical resistance, σ, in ohm-centimetres. Should the conductor, on the other hand, consist of magnetic material, μ in equation (2A) then becomes so great as to considerably complicate the calculation. Resource is therefore had to another formula, by which means, according to Messrs. J. J. Thomson and J. A. Ewing, approximate deductions may be made. Thomson has shown that in a plate of the thickness $2a$, which is magnetised by a current parallel to its length, a magnetic force, H_x, is set up vertical to this direction, having its maximum value, H_0, at the surface of the plate, while the amplitude of the force for any point within the area of the plate at the distance, x, from the plane through the centre of the plate (Fig. 1) possesses the following value:

$$H_x = H_0 \sqrt{\frac{\cos 2mx + \cos 2ma}{\cos 2ma + \cos 2ma}} \quad . \quad (3)$$

wherein $\cos 2mx = \cos$ hyp $2mx$

and

$$m = 2\pi \sqrt{\frac{\mu \sim}{\sigma}} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Further, μ represents the magnetic permeability, and σ the specific electrical resistance of the plate. If, in order to picture the distribution of the lines of force in such a plate, we set down

$$\mu = 2{,}000,\ \sigma = 50,\ \sim = 10{,}000,$$

it follows that $m = 19{\cdot}85$, and we obtain for plates of different thickness the following table, Fig. 2 showing the distribution of the lines of force:

	$\frac{x}{a}=0$	0·2	0·4	0·6	0·8	0·9
$2a = 0\,05$, or $\delta = 0\,5$mm.	0·98	0·98	0·98	0·98	0·985	0·992
0 1 1· ,,	0·775	0·775	0·782	0·805	0·875	0·93
0·2 2· ,,	0·276	0·278	0·312	0 427	0·657	0 81
0·5 5· ,,	0·0	0·0	0·0	0·14	0 37	0·607

$= \frac{H_x}{H_0}$.

This magnetic shielding effect, which in the case of the thickest plate practically excludes all lines of force from the centre, may also be regarded as an imaginary jacket, which by uniform magnetisation with the full magnetic force, H_0, receives the same total magnetising current as the un-uniformly magnetised plate at the moment of the maximum. This equivalent thickness of plate on each side of the plate is

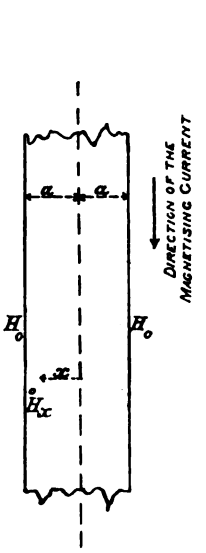


FIG. 1.

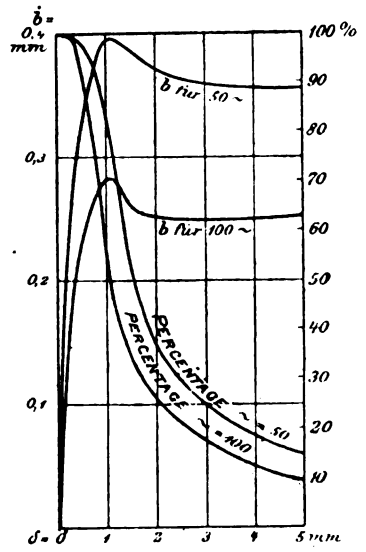


FIG. 3.

$$b = \frac{1}{m\sqrt{2}} \sqrt{\frac{\cos 2ma - \cos 2ma}{\cos 2ma + \cos 2ma}} \quad . \quad (5)$$

and amounts to the following values for the ratios given—that is to say, for

$$\frac{\delta}{m\sqrt{2}} = 0\,0355\text{cm}.$$

(Fig. 3), with

Millimetres.		Centimetres.	Percentage of the thickness of plate.
$\delta = 0\,5$	$b = 0{\cdot}0355 \times 0\,7 = 0{\cdot}0248$	.....	$= 99$
1	$= 0{\cdot}0355 \times 1{\cdot}12 = 0{\cdot}0398$	.....	$= 80$
2	$= 0{\cdot}0355 \times 1{\cdot}03 = 0{\cdot}0366$	.....	$= 36\,6$
5	$= 0{\cdot}0355 \times 1{\cdot}00 = 0{\cdot}0355$	.....	$= 14{\cdot}3$

For $m = 28\,1$ (corresponding to a periodicity of 100); the values of b, according to Ewing (Fig. 3), are:

Millimetres.		Millimetres.	Percentage of the thickness of plate.
$\delta = 0\,25$	$b = 0\,1245$	.....	$= 99{\cdot}5$
0·5	$= 0\,233$	.....	$= 93\,2$
0 75	$= 0{\cdot}285$	.....	$= 76$
1 0	$= 0{\cdot}282$	.....	$= 56\,4$
1·5	$= 0{\cdot}256$	.....	$= 34{\cdot}2$
2 0	$= 0\,250$	.....	$= 25$
∞	$= 0{\cdot}252$	.....	$= 0$

From the foregoing we may therefore conclude that the approximate penetration of the magnetisation into plates of moderate thickness amounts to only ½mm. with a periodicity of 50, while it is ¼mm. with a periodicity of 100. The same remarks apply with regard to the penetration of alternating currents into conductors of magnetic material. In the latter case the phenomena are identically the same, except that it is no longer the magnetisation, but the electrical current which decreases

Digitized by Google

so rapidly from the circumference towards the centre, that we may picture the electric current conveyed by the conductor at the moment of maximum flow as being substituted by an equivalent jacket round the conductor, which with a uniform density of current has the thickness

$$b = \frac{1}{m\sqrt{2}} = \frac{1}{2\pi}\sqrt{\frac{\sigma}{2\mu\sim}} \quad . \quad . \quad . \quad (6)$$

The assumption of an equivalent jacket seems to be, in general, only permissible for certain purposes; it corresponds in no way to the actual conditions, but enables a ready insight, and in the foregoing example also a quick computation to be made. In the same way as the magnetisation in a plate is represented in Fig. 2 we must likewise here assume the current density to decrease rapidly from the circumference of the iron conductor towards the centre at such a rate, for example, that the maximum current density at a depth of 1mm. below the surface represents only about 0·14, and at a depth of 5mm. less than $\frac{1}{10000}$th, of the density at the surface. Let the measured resistance offered by a certain conductor to the flow of an

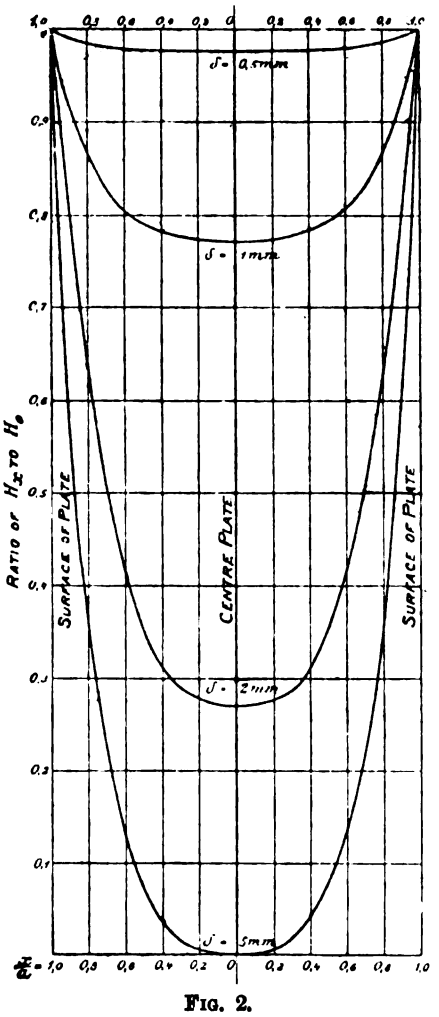


FIG. 2.

alternating current be R, to a direct current, R, the length of the conductor being l in centimetres and its section f in square centimetres. We may then, on the basis of the assumed equivalent jacket, calculated from the conditions

$$\sigma = \frac{10^9 . f . R}{l} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$\frac{f}{f'} = \frac{R}{R'} \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and from the known circumference of the conductor determine approximately the thickness, b, in centimetres, and from this the permeability, μ, for the magnetisation generated by the alternating current flowing through the conductor. For example,

$$\mu = \frac{\sigma}{(2\pi b)^2 . 2a} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

or for $\sim$ = 50 periods

$$\mu = \frac{\sigma}{3{,}948 . b^2} \quad . \quad . \quad . \quad . \quad . \quad (9A)$$

Equation (7) indicates that on the basis of the assumed equivalent jacket we must consider only a part, f', of the total section, f, as conductive, the ratio of which part to the total cross-section is determined by the relation $\frac{R'}{R}$.

The values given in Table I. were ascertained in regard to some conductors of wrought iron, cast iron, and steel for a periodicity of 50. When the band No. 5 was spaced by means of wood blocks at a distance of about 3cm. parallel to the I-girder No. 4, a resistance R′ = 0 00833, which is somewhat greater than before, was obtained. An increased resistance due to the near proximity of a magnetic conductor is apparent here. In making such measurements especial care must be taken to obtain good contacts. These once secured, reliable measurements may then be made with the aid of a Weston milli-voltmeter and corresponding hot-wire ampere-meter, which should be calibrated before and after use, and may be used both for direct and alternating currents.

Certainly the degree of accuracy obtained in the tests given above will suffice to show that with conductors of wrought or drawn iron, and with a periodicity of 50 per second, the thickness of the equivalent jacket surrounding the conductor amounts to about ½mm., and that for the permeability in equation (5) we must set down 1,000 to 1,200. Table II. gives the complete figures relative to a test, from which we learn that with increasing magnetisation the resistance R′ (due to eddy currents) decreases somewhat.

TABLE II.—Outer diameter = 20·3mm.; inner diameter = 14·4mm.; $\sim$ = 50; tubes of 4,270mm. length.

Amperes.	135·5	124	143 5
Volts	0 515	0·47	0·55
RΩ	0·00382	0 00378	0 00383
Amperes.	101	118	149	179	214
Volts	1 611	·78	2·10	2 34	2·6
R′Ω	0 0159	0·0159	0 0141	0 01310	·0122

This increase of the resistance is of practical importance in regard to railways worked by means of multiphase currents where the rails are used as a return. Under such conditions it is not advisable to take the figures which represent the resistance of the rail return for continuous-current working, since under the modified conditions a shallow depth only of the metal around the circumference of the rail profile must be regarded as conductive. Measurements made on the trial section of track belonging to the Helios Company, of Cologne-Ehrenfeld, gave the values set out in Table III. for a periodicity of 50.

The rails weigh about 44lb. per metre, the periphery of the profile being 472mm., and the sectional area 2,640 square millimetres. Properly speaking, the measurements Nos. 7, 8, and 13 only should be taken into consideration. These show that the rails without joints offered about nine times more resistance to the passage of alternating currents than to direct currents, while in the finished track the influence of the additional joints allowed the resistance offered to the alternating currents to attain only the four times the value as with direct currents. If it be desired to ascertain the influence of the joints in the 10m. length of metals, we must take into account the measurements Nos. 9 to 12; $\frac{R'}{R}$ for the joint and about 10cm. of the iron amounts to only about 2·2, but for 29m. of rails with three joints increases to 4 9, or for the same rail length and one joint less to 6·0. If we consider the rail joints in the same manner as the iron conductor, which seems justifiable only for the purpose of comparison, the influence of the joints on the fictitious values of b, σ, and μ is rendered still more apparent. For the purpose of the tests one only of the line of rails constituting the track was provided with joints, so that f = 26 4 square centimetres had to be set down also for the measurements Nos. 9 to 12. The measurements on the short lengths had to be conducted with currents of from 400 to 800 amperes, so that the pressure at the end terminals might be transformed up in order to render it readable on the milli-voltmeter.

The following further measurements relating to tests made with unlaid rails in the laboratory of Messrs. Ganz and Co., Budapest, have been placed at our disposal. In

Digitized by Google

TABLE I.

Shape of the conductor.	Length, in metres.	R Ω.	R′ Ω.	f.	f'.	b. Mm.	σ. Microhm-cm.	μ.
1. Tube d_a = 20 3mm. d_i = 14 4mm ..	4 27	0 0038	0·015	1·61	0·407	0·65	14·35	865
2. ,, = 26mm. = 20mm. ...	2 9	0 00185	0 009	2 17	0 447	0·55	13 8	1,170
3. ,, = 26mm. = 20mm. ...	3·19	0 00209	0·010	2 17	0·447	0·55	14 2	1,190
4. I-girder, periphery 780mm.	9 0	0 0003	0 00308	41·0	4·0	0·51	13 65	1,330
5. Flat steel band, 10mm. × 85mm.....	4 8	0·00083	0·00813	8·5	0·87	0·46	14·70	1,740
6. ,, band, 12mm. × 29.nm.	6 0	0·0024	0 0162	3·48	0·515	0·63	13·60	875

TABLE III.— $\sim$ = 50.

Description of conductor.	R Ω.	R′ Ω.	f'. Sq. cm.	b. Mm.	σ. Microhm-cm.	μ.	$\frac{R'}{R}$
7. 10m. rail without joint	0 000707	0 00615	3 03	0·64	18·7	1,155	8·7
8. 10m. ,, ,, ...	0 000681	0·0064	2·80	0·60	19·4	1,370	9·4
9. 26m track, 2 joints	0 0025	0 01515	4·35	0·92	25·4	750	6·0
10. 29m. ,, 3 ,, ...	0 0043	0·0209	5 42	1·15	39·2	760	4 9
11. 0·1m. ,, 1 ,, ...	0·000352	0·00078	12·0	2·55	93 2	352	2 2
12. 0·1m. ,, 1 ,, ...	0·000363	0 00078	12 2	2·60	96·0	358	2·15
13. 180m. ,, 18 ,, ...	0 016	0·0647	6 6	1·40	23·5	302	4 0

these tests rails weighing 23·35 kg. per metre were placed side to side at distances of 30cm. apart, and over each other with 15cm. separation between each, this separation being regulated by means of alternate layers of wood in such manner that the equivalent of 68m. rail length could be subjected to the test. In order to lessen the mutual induction, the connections between the rails were made in zigzag fashion with stout copper wire.

The results obtained were as follows :

TABLE IV.

With Direct Current.

Volts.	Amperes.	Watts (observed).
1·1	134	156·5
1·23	157	205

With Alternating Current $\sim$ = 42.
Taper Curve of the E.M.F.

Volts.	Amperes.	Watts.	Cos ϕ.
8·1	188	1,233	0·81
7·25	165	945	0·79
6·1	146·5	738	0 83

With Alternating Current $\sim$ = 15.
Sine Curve of the E.M.F.

Volts.	Amperes.	Watts.	Cos ϕ.
6·25	214	1,160	0·87
5·75	196	973	0·87
5·2	174·6	807	0·89

The resistance with direct currents was, therefore,

$$R = 0{\cdot}0082\ \Omega;$$

for peaked wave form of alternating currents,

$$R' = 0\ 043\ \Omega = 5{\cdot}25\ R \sim = 42;$$

for sine form alternating currents,

$$R'' = 0{\cdot}0295\ \Omega = 3\ 6\ R \sim = 15.$$

The effective loss was, on account of the hysteresis and eddy currents, in the first case four times and in the last instance three times as great as with the use of direct currents. The relatively high resistance observed in regard to the direct current may be attributed to the considerable magnitude of the contact resistance. For the same reason the increased resistance due to alternating currents appears relatively smaller here than for the conditions given in Table III. Taking into account the increased resistance due to the alternating currents, we obtain with a periodicity of 50 for

$$\text{1 km. length of rail about } R_s' = \frac{10}{W}$$

$$\text{1 km. track } R_{gl} = \frac{5}{W}.$$

Hence about eight times as much as for direct currents if W represents the weight of the rail per metre in kilogrammes.

For other periodicities, $\sim_1$, the numerators of the fractions vary in inverse proportion to the square roots of the periodicities. With direct currents carefully executed, rail joints double the resistance of the track. With alternating currents their influence is considerably less. If we assume 200 joints per kilometre of rail, each joint having a resistance of 0·0002 Ω, they will consequently present a combined resistance of 0 04 Ω. For a rail section giving a weight of 25 kg. per metre they will therefore represent about 10 per cent. of alternating-current resistance, whence for the finished track the alternating-current resistance,

$$R_g = \frac{5\ 5}{W},$$

or four to five times the amount which would be opposed to continuous current.

Hence, in using alternating currents, we may assume that the resistance no longer amounts, as for continuous currents, to from one-quarter to one-third that of the outgoing conductor, but to about one to one-and-a-half times that of this conductor, and that the effective loss in the rails may be determined from the fall of potential, the current, and the cos ϕ = 0·8.

Although these points should not be neglected, at the same time their importance must not be overestimated. The solution of the trunk-line problem will probably be reserved to multiphase currents in the one or other form, when the compensation pressure and effective loss may be rendered negligible by using slightly more copper in the lead, or by the partial use of copper in the return. Besides this, the existing tendency to adopt low periodicities—say from 15 to 20—for such railways will probably be pursued. A circumstance in favour of the latter practice is that multiphase motors for low periodicities and equal speeds require relatively fewer poles, and are therefore much more satisfactory. In virtue of this advantage, the increased initial cost of the primary plant and for transformers entailed by the low periodicities might be regarded in the majority of cases as balanced. However, in special cases it may appear advisable after careful consideration to adopt the most favourable periodicity.

The simple task of determining the resistance offered by the rails to the passage of alternating currents is, therefore, invested not only with theoretical interest, but also with considerable practical importance.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

Digitized by Google

Questions.

327. The commutators for large direct-current generators are frequently required by the engineer's specification to be assembled in such a manner that a portion of the bars may be removed without disturbing the remainder. How is this best accomplished, particularly with reference to the end insulating rings, which presumably would be in sections and would require skilful jointing?—Z.

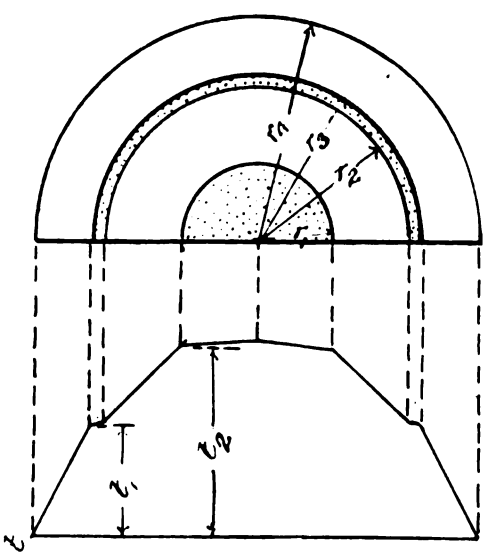
328. What should be a fair coal consumption for a 10-hour day with the following output—600 amperes 105 volts steady over the 10 hours. Engine is high-speed three-crank tandem compound single-acting, with variable expansion governor (rated as 127 b.h.p. with 100lb. steam pressure), coupled direct to 80-kw. dynamo. Steam is kept at 10lb. square inch higher than is registered by gauge (75lb. square inch) on engine side of governor valve, with 600 amperes. This is Lancashire boiler hot feed water.—Beta.

Answers.

Question No. 321.—Why does the temperature of the outer conductor of a concentric cable rise to nearly double the temperature of the inner when working at its full carrying capacity?

Best Answer to No. 321 (*awarded* 10*s.*).—A simple investigation proves that when any cable, concentric or otherwise, has acquired a steady temperature at all points of its section, the interior must of necessity be hotter than the outside, for heat always flows along the lines of temperature drop from regions at higher to those at lower temperatures, just as current flows from places at higher to those at lower E.M.F. Thus, if heat flows in any direction, the temperature drops in that direction.

Now, if the outer part of the cable were at any time hotter than the inside there would be a flow of heat radially inwards until the central region was as hot as the outside. For mathematical equality of temperature, it is true, an infinite time would be required, but it would be sensibly at the same temperature very soon.



The whole temperature condition at all points of a cable's section may be exactly determined by an application of the integral calculus, or found with sufficient accuracy by the following method, provided the following particulars are known: (*a*) The dimensions of the section. (*b*) The heat produced per centimetre length of each conductor = $C^2 R$ watts, where R is the resistance of each conductor in ohms per centimetre. (*c*) The conductivity of the insulation for heat = k. (The unit of heat is the calorie—*i.e.*, a quantity of heat sufficient to raise the temperature of 1 grm. of water 1deg. C. The heat conductivity of a substance is the number of calories which pass per second through each square centimetre of a plate of the substance 1cm. thick, and having 1deg. C. difference of temperature between its faces.) (*d*) The temperature, t, of the outside of the cable.

Now, assuming equal resistances for inner and outer conductors, $2\,C^2 R$ watts are liberated per centimetre length of cable per second. Since 4·2 watts = 1 calorie, this is $\frac{C^2 R}{2\,1}$ calories.

The flow of heat through any surface is given by calories per second = conductivity × area × temperature difference at faces ÷ thickness in direction of flow.

Hence t_1, the temperature inside the outer insulation, is found.

$$\frac{C^2 R}{2\,1} = \frac{k\pi(r_4 + r_3)}{r_4 - r_3}(t_1 - t)$$

$$t_1 = \frac{C^2 R (r_4 - r_3)}{k\pi(r_4 + r_3)} + t.$$

Copper being an excellent conductor of heat, no great error is introduced by considering the temperature of each conductor uniform across its section. The outer is thus at temperature t_1. Across the inner insulation, $\frac{C^2 R}{4\cdot2}$ calories pass per second. Hence, calling the temperature of the inner conductor t_2,

$$\frac{C^2 R}{4\,2} = \frac{k\pi(r_2 + r_1)}{r_2 - r_1}(t_2 - t_1)$$

$$t_2 = \frac{C^2 R (r_2 - r_1)}{k\pi(r_2 + r_1)} + t.$$

The temperature distribution is plotted in the sketch with temperature as ordinates on the diameter as base. Zero.

Answer to No. 321 (*awarded* 5*s.*).—It does not. The inner is always the hotter. For suppose the outer to be at the same or at a higher temperature than the inner, then it is obvious that no heat can pass from the inner to the outer; and if we take a considerable length of cable, there is no other way for the inner to lose heat. But heat is being continually generated in the inner and, therefore, its temperature must continue to rise until it fuses, however small the current. This is, of course, absurd. Therefore, it is clear that the inner must be hotter than the outer.—J. W.

Answer to No. 321 (*awarded* 5*s.*).—This question is one which turns upon the law of cooling of bodies. This law is stated in a simple manner by the following equation:

$$Q = E S \theta t \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

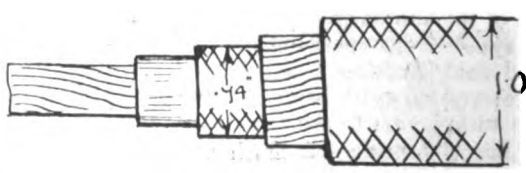
Q = quantity of heat to be dissipated;
S = area of the external surface of the body;
θ = the difference in temperature of the surface of the body and that of the surrounding medium;
t = time;
E = the coefficient of thermal emissivity for the particular radiating surface.

(Note.—Thermal emissivity is the quantity of heat per unit of time per unit of surface per degree of excess of temperature that the body loses to the surrounding medium.)

Transforming equation (1), we may write

$$\frac{Q}{t} \cdot \frac{1}{S} = E\theta,$$

from which it will be noted that $\frac{Q}{t}$ = rate of dissipation of heat. This, in our electrical question, will correspond to the watts lost in the cable. We may also note that $\frac{Q}{t} \cdot \frac{1}{S}$ = watts to be radiated for each unit of area of cooling surface.



We may now apply this law to our concentric cable. The accompanying shows a sketch of a sample of concentric cable which, when measured up, gave the diameter over the inner to be ·74in. and the diameter over the outer to be 1·06in. The cross-section of copper in the outer was equal to the cross-section of that of the inner. Consider a length of cable equal to L inches, then the resistance of the

Digitized by Google

inner for length L will be approximately equal to the resistance of the outer for the same length. Call the resistance R; let C = current flowing in the inner and also in the outer. Then

Watts lost in the inner = $C^2 R$.
Watts lost in the outer = $C^2 R$.

Therefore Watts to be radiated by inner = $C^2 R$,

and Watts to be radiated by outer = $2 C^2 R$.

Area of radiating surface of inner = $\pi \times 74$in. $\times$ L.
Area of radiating surface of outer = $\pi \times 1{\cdot}06$in. $\times$ L.

Also let E, the coefficient of emissivity, be the same for both inner and outer surfaces. Then equation for outer giving rise in temperature is:

$$\theta = \frac{2 C^2 R}{\pi . 1{\cdot}06 \times L \times E} \quad . \quad . \quad . \quad . \quad (2)$$

Equation for inner:

$$\theta_1 = \frac{C^2 R}{\pi \times {\cdot}71 \times L \times E} \quad . \quad . \quad . \quad . \quad (3)$$

Dividing (2) by (3) we get

$$\frac{\theta}{\theta_1} = \frac{2 C^2 R}{\pi \times 1{\cdot}06 \times L \times E} \times \frac{\pi \times {\cdot}74 \times L \times E}{C^2 R};$$

$$\therefore \frac{\theta}{\theta_1} = \frac{1{\cdot}48}{1\ 06} = \frac{1{\cdot}4}{1}.$$

Therefore, the ratio of

$$\frac{\text{rise in temperature of outer}}{\text{rise in temperature of inner}} = \frac{2 \times \text{diameter of inner}}{\text{diameter of outer}}.$$

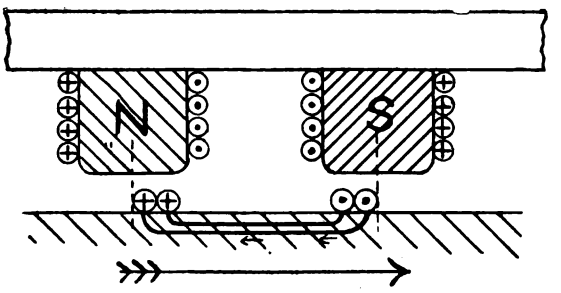
The above shows that the temperature of the outer of a concentric cable may be considerably higher than that of the inner, according to the relation between their linear dimensions.—P.

[N.B.—We give this reply as a sample of many we have received from men who, knowing their theory, will have been led astray by this question.—Ed. *E. E.*]

Question No. 322.—Being in charge of an alternating station having a motor-alternator, I have noticed that, when this is being driven off the big plant to charge cells, the excitation on the big plant is considerably less (about 15 per cent.) than when it is on lighting load alone, although the motor-alternator adds about seven primary amperes to the lighting load. If field resistances be altered to bring excitation on the big plant to a normal, machines merely drive badly. Required cause.

Best Answer to No. 322 *(awarded* 10*s.).*—I assume that the question is not meant to imply that the exciting current on the big plant is automatically reduced by putting the motor-alternator on load, but rather that a rise in the main voltage is occasioned thereby, in which event the man in charge of the voltmeter would naturally insert extra resistance in the exciter shunt circuit, thus lowering the exciter voltage, and, in consequence, the exciting current, and lowering the station voltage to the normal. If this is the case, it is almost certain, I think, that the alternate-current motor is over-excited—*i.e.*, the field is such that if run on a separate circuit at synchronous speed as a generator, the voltage at its terminals would be in excess of the main voltage of supply. If we were dealing with a continuous-current motor, and the field were thus increased, the motor would slow up, reducing its back E.M.F. sufficiently to allow the required current to flow, but in the case of the alternating-current motor the speed is fixed by the synchronous speed of the main plant, and the increased field produces a complicated reaction upon the armature current, which has the effect of causing it to lead in phase with respect to the E.M.F. of supply.

Now let us consider the effect of this upon the main machines. The figure depicts two adjacent poles of an alternator, and also an armature coil (consisting of two turns only for the sake of simplicity) in its middle position—*i.e.*, the position at which the rate of cutting magnetic lines, and consequently the E.M.F., is greatest. Now, if the current is absolutely in phase with the E.M.F., the current in this position of the coil will also be a maximum, and it is evident from the figure that the effect of this current will be to produce a magnetic pole midway between N and S, and of such a nature as to cause a resultant field in which the near side of N is strengthened and the near side of S correspondingly weakened. But the current in the coil is of an ever varying value, and it is plain, I think, that as the coil, when a little to the left of its present position, would be carrying a lesser current for an increasing value, its tendency would be to increase N; similarly, when past the middle position, the current will be decreasing, and its magnetic effect will correspondingly decrease S. So that when the current is in phase with the E.M.F., the armature field distorts that due to the magnets, but does not alter its total value, only inasmuch as it lowers the permeability of the poles by causing a crowding of magnetic lines at the near side of N.



Now suppose the armature current, instead of being in phase, has a *lead*, the current will now rise to a maximum before the E.M.F.—*i.e.*, before the coil reaches its middle position shown in figure; and in this case it is clear that N will be materially strengthened by the magnetic effect of the coil whereas when the coil passes into the position in which it would normally have weakened S, the current will have fallen to zero, or, at any rate, greatly below what it was when the coil held a corresponding position with reference to N. The net result of this lead, therefore, is to increase the strength of the field magnets. Similarly, if the current has a lag, the current in the coil will be strongest when nearest to S, and the net result will be a demagnetising effect. The maximum effect, of course, occurs when the lag or lead = 90deg., for then the armature pole, when the coil is carrying the greatest current, is directly under the field pole.

Now, the alternator armature possesses a certain amount of self-induction, and in all probability there is also a small self-induction in the main lighting circuit (particularly if asynchronous motors or series arc lamps are installed), so that the current will normally have at least a small lag, and will in consequence tend to produce the demagnetising effect upon the fields referred to above which effect must be compensated for by an increase in the exciting current. When the motor-alternator is running over-excited, the lead due to this will at any rate, partially neutralise the lag of the main current, and may, if the main current is not great, actually cause it to lead with respect to the E.M.F., and this would fully account for the difference in the excitation necessary for the main fields.

Now, the question also states that if the excitation on the big plant is brought to a normal, the machines merely drive badly. To raise the excitation to its original value would produce a corresponding rise in the voltage, unless the speed of the plant were reduced, and this, I presume, was done because such a rise would not be permissible on a lighting circuit. If this were the case, I expect it was this lowering of the speed that produced the unsteady running, for I have often noticed that with certain makes of alternators any deviation from the specified speed is productive of this effect.

Has the questioner tried the effect of lowering the exciting current of the motor fields? Because if the above explanation is correct, it should be possible to find a value for it which would cause no alteration in the excitation of the big plant. If the field reaction of the motor was causing the main current actually to lead, a reduction in its field would also produce a reduction in the current it was taking for a given load, whereas if the current as supplied to the motor has originally a lag, the reduction of the motor field may produce an increase in the motor current, because such reduction would decrease the leading effect which originally helped to neutralise

Digitized by Google

the lag, and thus a lagging current would be passing through the armature.—W. G. MURRIN.

Answer to No. 322 *(awarded* 5*s.).*—The cause of the change produced in the condition of the alternating generators when the motor is switched on is due to the lag in current of the generator owing to its load becoming more inductive, and also in part due to the increase of current. If, as is probably the case, the normal load be mainly incandescent lamps, and so non-inductive, the E.M.F. of the generator and its current are very nearly in phase together, the slight lag being due to the self-inductance of the armature. In this case the work done by the machine is the product of effective volts by effective

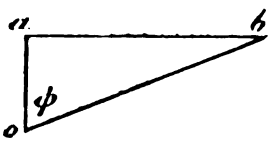


FIG. 1.

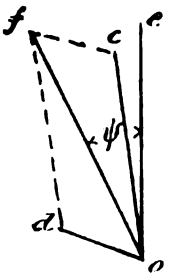


FIG 2.

amperes. When the motor is put on to the load the current, owing to its inductance, lags behind E.M.F. If $o\,a$ represent the product of effective amperes in the motor by its armature resistance, and $a\,b$ represent the counter E.M.F. of motor, then $o\,a$ and $a\,b$ being at right angles, $o\,b$ denotes in magnitude and position the supply pressure, and ϕ is the angle of lag—*i.e.*, the current reaches its maximum $\frac{\phi}{360}$ of a phase later than the E.M.F. in the motor (Fig. 1). The effect on the generator is found by setting off (Fig. 2) $o\,e$ to represent E.M.F., $o\,c$ to represent current in lamp load, and $o\,d$ representing motor current, the angle between $o\,e$ and $o\,d$ being ϕ. The generator current is now $o\,f$, the diagonal of $o\,e$ and $o\,d$, lagging by the angle ψ.

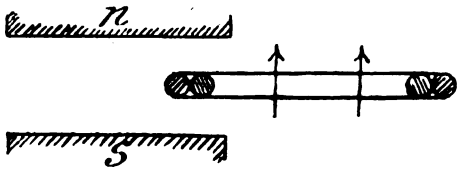


FIG. 3.

Now, where there is little or no lag, the reaction of the generator armature is a minimum, since the greatest current flows in the armature coils when they are in such a position as to have considerable magnetic resistance to their back lines (Fig. 3); when there is lag, however, the current maximum flows at a time when the coils have moved into a position having much less magnetic resistance, hence the field strength of the generator is weakened (Fig. 4). This weakening amounts in the machines mentioned in the question to as much as 15 per cent., giving a corresponding drop in the voltage of supply.

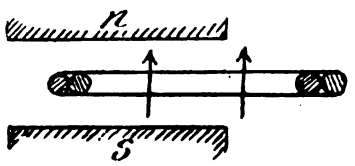


FIG. 4.

The back ampere-turns in the armature at a lag ϕ is in most alternators about equal to $\frac{N\,C\,2\sqrt{2}\,\phi}{\pi}$, where C is current and N the turns in one coil. If the excitation be increased by removing resistance from the magnet coils, the maximum E.M.F. is increased considerably, as is obvious from the fact that now the work done is the product of effective volts by effective amperes by cos ψ, and that this should be greater than before the motor was added. The conditions of working are thus considerably changed from those at which the engines and alternators usually run.—ZERO.

Answer to No. 322 (*awarded* 5*s.*).—To answer this question we must make two assumptions; each, however, is likely to be correct. The first is that the alternator is working on an inductive load, say supplying transformers, some of which are on light load. The result of this is that the current lags behind the E.M.F. When an alternator is supplying a current which is in phase with the E.M.F.—*i.e.*, when it is working on a non-inductive load—there is no lag and no armature reaction. When it is working on an inductive load of low resistance, the current lags almost 90deg. behind the E.M.F., and the whole of the ampere-turns on the armature oppose the field. At any intermediate point the armature reaction = ampere-turns on armature × sine angle of lag.

We will now consider the motor. It must be remembered that an alternating-current machine will run as a motor even when generating a greater E.M.F. than the source of supply, but in this case the motor takes a current which is in advance of the supplied E.M.F.—*i.e.*, it acts something like a condenser. Our second assumption, then, is that the motor is over-excited. It is possible that it is purposely over-excited, as it would be less likely to fall out of step; but it is not necessary to go so far as this. Suppose, as is probable, that the motor is brought up to synchronism, and up to the same voltage as the supply, and then switched in and loaded. There will be a fall of volts in the armature equal to CR_a, therefore the voltage driving current through the motor will be less than that generated by it, and we get a leading current.

The result of adding a leading and a lagging current depends on the comparative amperages of the two currents and the angles of lag and lead. To take an extreme case, consider the motor running light but over-excited, and the other circuit to consist of nothing but unloaded transformers, taking the same current as the motor. Then the two currents will almost neutralise one another and reduce the current in the generator to a very small amount, which will be in phase with the E.M.F. In the present case, however, the total current is increased by seven amperes, but the addition of the leading current of the motor to the lagging current of the other circuit has brought the current so much more nearly into phase with the E.M.F. as to reduce the armature reaction and the exciting current.—J. W.

PHYSICAL SOCIETY.

At an ordinary meeting of the Physical Society held on Friday last,

Dr. R. A. Lehfeldt read a paper on "**Electromotive Force and Osmotic Pressure.**" This paper is an attempt to explain a difficulty in the interpretation of the ordinary logarithmic formula for the E.M.F. between a metal and solution, pointed out by the author at the Dover meeting of the British Association. An expression for the E.M.F. of a concentration cell is obtained thermo dynamically upon the assumption that the electrolyte is only partially dissociated. A partition is used which is permeable to water but not to the salt or its ions, and the conclusion follows that the E.M.F. depends, not on the osmotic pressure of the metallic ions, but on that of the solution as a whole. A graphical representation is given, plotting osmotic pressure against dilution, assuming Boyle's law to hold, and it is shown that the E.M.F. is not proportional to the integral $\int P\,dV$, but is the converse integral $\int V\,dP$. Assuming, further, that the osmotic pressure changes according to Van der Waals's equation, the E.M.F. is greater than that calculated from Boyle's law. If the electrolytic solution pressure is calculated from the integral $\int P\,dV$, it comes out 10^{19} atmospheres, but if from the converse integral the value obtained is about 20,000 atmospheres. A comparison between actual E.M.F.'s and those derived from the equation given by the author should afford, if the formula is correctly deduced from the assumptions made, a measure of how far the osmotic pressure deviates from that indicated by Boyle's law. Experiments upon concentration cells have been made by Helmholtz, Wright and Thomson, Moser, Lussana and Goodwin, but as their work was performed upon cells with migration of ions, the calculation of the osmotic pressure is rendered uncertain by the introduction of the transference ratio. Accordingly, the author has measured the E.M.F.'s of cells without migration, using zinc as electrodes, and chloride and sulphate of zinc as salts. The E.M.F. was measured by the compensation method, using a Post Office box through which a current was sent by an accumu-

Digitized by Google

lator. The accumulator kept up a constant potential difference, and was standardised daily by means of a Clark cell. The experimental results agree with that calculated over the range centi- to dia-normal, showing that the deviation from the value given by the logarithmic formula is accounted for by the incomplete dissociation of the salts. The osmotic pressures are then calculated from the E.M.F.'s and the values of P V plotted. They show irregularities due to the combined effect of the decreasing dissociation of the salt and the increasing departure from Boyle's law. Dividing the product P V by Van't Hoff's factor, determined from conductivity, values are obtained showing variations similar to those observed in the behaviour of gases when subjected to high pressure.

Mr. Whetham said there was one form of membrane which is quite permeable to water, and yet does not allow either salts or the ions to get through. He referred to the free surface of the solution itself. The water being volatile can get out, but the salt cannot.

Dr. Donnan said the author seemed to have discovered things well known; for instance, the integral $\int V\,d\,P$ is generally taken as proportional to E.M.F. He expressed his interest in the explanation of the difficulty in the logarithmic formula.

Dr. Lehfeldt, in reply, said Goodwin had used the integral $\int V\,d\,P$, but had not made any nominal calculations by means of it.

Mr. A. Campbell then read the following papers: (*a*) "**On a Phase-Turning Apparatus for Use with Electrostatic Voltmeters.**" Electrostatic voltmeters are particularly insensitive at the lower parts of their ranges, the divisions closing in very much towards the zero point. When measurements of small direct-current potential differences have to be made, it is an easy matter to add to the voltage to be measured a constant voltage large enough to bring the deflection to an open part of the scale. If the small voltage to be measured is an alternating one, it is necessary that the auxiliary voltage should alternate with the same frequency and be in phase with it. The apparatus described enables the phase of the auxiliary voltage to be turned until it agrees with the one to be measured. The phase difference referred to is not the time lag, but the angle whose cosine is the power factor, and may be called the power lag. The method is to get two independent equal voltages, U_1 and U_2, differing in power phase by $\frac{\pi}{2}$, and to add together suitable fractions of these, such as $U_1 \sin \phi$, $U_2 \cos \phi$. The resultant is equal to U_1, but with the power phase joined through ϕ. The unknown small voltage is connected in series with an auxiliary voltage and a voltmeter, and the phase of the latter voltage is turned until the maximum deflection is obtained.

(*b*) "**On a Method of Measuring Power in Alternating-Current Circuits.**" The circuit in which the power is to be measured is connected in series across the supply circuit with a small non-inductive resistance. By means of a transformer the small voltage on this resistance may be transformed into one whose power phase is 180deg. behind the voltage on a non-inductive resistance. This is added to the voltage on the circuit to be measured, and then reversed and added again. The difference of the squares of these effective resultants is shown to be equal to a constant into the power to be measured. If there is any direct current, it must be measured separately by a Weston voltmeter or other suitable instrument.

(*c*) "**Note on Obtaining Alternating Currents and Voltages in the Same Phase for Fictitious Loads.**" When testing instruments for the measurement of large amounts of electrical power or energy, it is usually desirable to do so by means of fictitious loads—*i.e.*, by applying to the instrument under test current and potential difference representing the required load. In order to obtain a fictitious non-inductive load with alternating currents, the potential difference and current should be in the same phase. The current for the instrument under test is got by means of a transformer worked on a 100-volt circuit. The potential difference in the same phase is got by allowing the current to flow through a non-inductive resistance and increasing the voltage at the ends of the resistance to the required amount by means of another transformer.

The society then adjourned until Nov. 23.

LEGAL INTELLIGENCE.

WOLVERHAMPTON CORPORATION v. BRITISH ELECTRIC TRACTION COMPANY, LIMITED.

This important case was heard last week in the Chancery Division before Mr. Justice Joyce. The question at issue was connected with the sale by the British Electric Traction Company to the Wolverhampton Corporation of the tramways owned by them within the Corporation boundary. A draft contract for the sale was prepared, but the defendants refused to complete unless they were granted running powers over certain of the lines to be transferred to the Corporation. The value of the undertaking had to be ascertained by arbitration, and this had been done. From the evidence we gather that the dispute arose over a clause in the 1888 order known as the Dudley, Sedgley, and Wolverhampton Tramways Order, in which there occurs a clause which reads as follows: "If at any time hereafter any tramways are constructed or purchased within the borough of Wolverhampton by the Corporation of that borough, the promoters shall, if required by the said Corporation, and are duly authorised by provisional order or by Act of Parliament, make and maintain, at the joint expense of the promoters and of the Corporation, all necessary and convenient junctions between the tramways of the promoters and the tramways of the Corporation, and each shall grant running powers over their respective tramways."

It was argued by the counsel for the defence that without these running powers the inhabitants of the outlying districts supplied under the 1888 order would be seriously inconvenienced, and that the above clause gave them the right to running powers over the line to Wolverhampton, in spite of the transfer. It is worthy of note that certain of the urban district councils of the outlying districts supported the British Electric Traction Company in their defence.

After hearing the arguments on both sides, which centered around the interpretation of the above clause, **Mr. Justice Joyce** reserved judgment.

J. CAMERON v. P. C. MIDDLETON AND CO.

Sheriff Burnet at Aberdeen has issued an interlocutor in the action in which the trustees of the late Mr. John Cameron, contractor, sought to prevent Messrs. P. C. Middleton and Co., Limited, electric engineers, from so working their engines in the electric station at Cults, Aberdeen, as to cause annoyance to the neighbours. The defence was that the engines worked silently and smoothly, as well, indeed, as such engines possibly could, and that the noise made was too inconsiderable to cause any discomfort of which the law could take notice.

His Lordship found that the noise of the engines was such as to cause the plaintiffs material discomfort, and to diminish the use and enjoyment by them of their properties adjoining the electric station, and that the noise had diminished the value of the properties. His Lordship delayed granting an injunction, in order to give the defendants an opportunity of obviating all cause of complaint. He also granted leave to appeal.

MADRAS ELECTRIC TRAMWAYS COMPANY, LIMITED, v. COOPER AND OTHERS.

On Thursday, Nov. 15, Mr. Justice Cozens-Hardy, in the Chancery Division, delivered judgment in the case of the Madras Electric Tramways Company, Limited (Electric Construction Company, Limited), v. Cooper and others, the short point involved being whether the first mortgagees—debenture holders—who were in possession by their trustees, were entitled to the whole amount which had been advanced and expended by them on the Madras Electric Tramways Company's undertaking in priority to the second mortgagees.

After considering the claims, **Mr. Justice Cozens-Hardy** said he thought that he must find that the terms of the bargain were set out in the deed, and that he could not and ought not to consider what might have been the rights of the parties if the money had been advanced by the plaintiffs to the trustees independent of such a deed. In the result he must hold that any advances made by the plaintiff company subsequent to Nov. 25, 1898, when notice was given of the second mortgage, were postponed to the second mortgagees' claims.

MERCIER'S PATENT COMPANY v. NEW FLINT COLLIERY COMPANY.

In the Nisi Prius Court, Manchester, Mr. Justice Bucknill and a jury recently heard an action brought by Mercier's Patent Company, Limited, against the New Flint Colliery Company, Limited, for the recovery of money for goods supplied and work done.

According to counsel's opening statement the case arose out of a telephonic installation in a coal-pit belonging to the defendant company, which was carried out by the plaintiffs. Their charge for this and for the supply of certain accessories was £295, of which the defendants had paid £175 on account, the balance being refused on the ground that the installation was defective, and that the prices were excessive.

Mr. Mercier, managing director of the plaintiff company, described the arrangements between the parties and the manner in which the work was done, and said the telephone frequently failed to act, but this was due to the presence of an unusual amount of water in the pit, and to mishandling by the employés of the colliery company.

After hearing witnesses for both sides the jury returned a verdict for plaintiffs for £90, this being in excess of the £75 paid in court by defendant, who would also have to bear the costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ilford.—The Urban District Council invite tenders for the supply of lamp columns in quantities of about 50 at a time. Tenders by Nov. 26.

Kendal.—The Corporation invite tenders for the supply and erection of various plant. Tenders by Dec. 1. Details in our advertisement columns.

Digitized by Google

Aberdeen.—The Lighting, etc., Committee have resolved to invite offers for boilers, batteries, etc., for the electricity station.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons and oils for one year. Tenders by Dec. 17. Details in our advertisement columns.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads. Tenders by Dec. 13. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for supply of 12 workmen's tramcar bodies. Tenders by Dec. 1. Details in our advertisement columns.

Partick.—The Commissioners invite tenders for electricity meters, demand indicators, and fuses. Tenders by Dec. 4. Details in our advertisement columns.

Birkenhead.—The Corporation invite tenders for switchboard and instruments for Craven-street generating station. Tenders by Dec. 4. Details in our advertising columns.

Halifax.—The Tramways Committee invite tenders for tramcars, trucks, motors, and electrical equipment for same. Tenders by Nov. 27. Details in our advertisement columns.

Cuevas (Spain).—Applications are invited by the Municipality for electric lighting of the town for 20 years. Tenders by Nov. 30. Specification, etc., may be seen at the office of this paper.

Bermondsey.—The Vestry invite tenders for arc lamp columns, arc and incandescent lamps, automatic switches, and fittings. Tenders by Dec. 3. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by Dec. 31. Details in our advertisement columns.

Nottingham.—Tenders are invited for the installation of an electric lighting plant at the new workhouse. Specifications may be obtained from Mr. G. Muncaster Howard, clerk, Poor-Law Offices, Nottingham.

Portsmouth.—The Corporation invite tenders for the overhead electrical equipment of tramways in the borough of Portsmouth, and extending to Cosham, Hants. Tenders by Dec. 7. Details in our advertisement columns.

Wolverhampton.—The Tramways Committee invite tenders for electric motor tramcars. General conditions, etc., may be obtained from Mr. J. W. Bradley, borough engineer, Town Hall, Wolverhampton. Tenders by 26th inst.

Oldham.—The Electricity Committee invite tenders for the supply, delivery, and erection of an extension switchboard for supplying current for the tramways. Tenders by Nov. 27. Details in our advertisement columns.

Bexhill.—The Council invite tenders for the supply, delivery, and erection of a water-tube boiler and pipework and one 150-kw. steam dynamo at their electricity supply station. Tenders by Dec. 10. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for the following: (Section 4) 75-kw. motor-generator and Tudor storage battery; (5) lead-covered cables; (6) 20-ton travelling crane. Tenders by Nov. 28. Details in our advertisement columns.

West Ham.—The Council invite tenders for two 25-b.h.p. oil-engines, two 15 kw. dynamos, one battery of accumulators, switchboard, etc., at Dagenham Hospital, Essex. Tenders by Nov. 30. Details in our advertisement columns.

Southwark.—The Electric Light Committee invite tenders for the supply and erection of certain back E.M.F. cells at the Corporation electric light station, Penrose street, Walworth-road. Tenders by Dec. 3. Details in our advertisement columns.

Oldham.—The Tramways Committee invite tenders for the erection of a tramway car depot at Wallshaw, within the borough. Specifications, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by Dec. 5.

Budapest (Hungary).—A telephone exchange to accommodate 10,000 subscribers is to be constructed at the Government expense. It is designed so that at some future date it can be made to include a further 10,000. Firms of any nationality may submit tenders for the work.

Dublin.—Tenders for the hire of plant, etc., required for the electric lighting of the State apartments, Dublin Castle, during the next Castle season, will be received at the Office of Public Works, Dublin, up to 10 a.m. on 27th inst. Specification can be seen at the Office of Public Works.

Brighton.—The Council invite tenders for the supply and delivery of the following: points, crossings, etc., soleplates, manhole covers with frames, gully grates with frames, tie-bars, fishbolts, and other bolts for fastenings, etc. Tenders by Dec. 6. Details in our advertisement columns.

Newcastle-upon-Tyne.—The Tyne Improvement Commissioners, Northumberland and Albert Edward Docks, invite tenders for the supplying and laying of cables, and the fixing of wires, poles, arc and incandescent lamps, and all accessories. Tenders by Nov. 30. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the permanent-way construction and underground feeders in connection with the equipment for electric traction of the tramways in the borough of Portsmouth, and extending to Cosham, Hants. Tenders by Dec. 7. Details in our advertisement columns.

Hornsey.—The Urban District Council invite tenders for 50 cast-iron lamp columns, 25 cast-iron side entrance covers, and 25 telephone pit covers and frames for carriageways. Particulars may be obtained on application to Mr. E. J. Lovegrove, engineer and surveyor to the Council. Tenders by 26th inst.

Leeds.—The Corporation invite tenders for the various works required in erection and completion of buildings in extension of the present electric lighting works in Whitehall-road. Plans, etc., may be obtained from Mr. H. Dickinson manager, Electric Lighting Works 1, Whitehall-road, Leeds. Tenders by Nov. 27.

Wolverhampton.—The Tramways Committee invite tenders for steel stanchions, wrought-iron roof trusses, rolled-steel joists, etc., and other works required at the tramway car depôt. Plans, etc., may be seen on application to Mr. J. W. Bradley, borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Dec. 3.

Oldham.—The Tramways Committee invite tenders for the supply and erection of the iron and steel work required in the completion of a car depot at Wallshaw, within the borough. Specification, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by Dec. 5.

Salford.—The Tramways Committee invite tenders for erection of a car depôt and workshops, covering approximately 11,300 square yards, likewise for about 500 tons of constructional iron and steel work in the roofs, etc. Specifications, etc., may be obtained from Mr. Ernest Hatton, tramways engineer, Town Hall, Salford. Tenders by Nov. 30.

Stockport.—The Tramways Committee invite tenders for the supply and delivery of about 1,050 tons of grooved steel girder tramway rails, fishplates, tiebars, bolts and nuts, points, and crossings. Plans, etc., may be obtained (£3. 3s.) from Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Stockport.—The Tramways Committee invite tenders for the overhead equipment and supply of rail bonds for six sections of their electric tramways, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Specifications, etc., may be obtained from Mr. A. J. H. Carter, electrical engineer, or Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Stockport.—The Tramways Committee invite tenders for the laying of the permanent way of their electric tramways, including concrete foundation, but excluding bonding and paving, in six sections, having a total length of about 2 miles 3 furlongs 5 chains double line, and 2 miles 2 furlongs single line. Plans, etc., may be obtained on application to Mr. John Atkinson, A.M.I.C.E., borough surveyor, Central-buildings, Stockport. Tenders by Nov. 24.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

RESULTS OF TENDERS.

Aberdeen.—The Town Council have accepted the tender of Messrs. Johnston, Lundell, and Co., at £3,990, for a 420-kw. set for the Dee Village electric lighting station.

Grimsby.—The Corporation have accepted the tender of Messrs. Chamberlain and Hookham, of Birmingham, for meters, at £4. 7s. 6d. each for 5, 10, 25, and 50 amperes.

Barnsley.—The Park and Lighting Committee have recommended that the tender of Messrs. Venner and Co., for the supply of electricity meters at £4. 10s. each, be accepted.

Lewes.—The tender of Messrs. Field and Co., of Brighton, at £3,777, has been accepted by the Electrical Power Distribution Company, Limited, for building an electricity generating station.

Bedford.—The tender of Mr. W. Laughton, at £33. 10s. each, has been accepted for building two underground sub-stations on the sites indicated on the plan submitted by the electrical engineer.

Bradford.—Messrs. T. Broadbent and Sons, Limited, Central Ironworks, Huddersfield, were the successful contractors in the recent tender for 30-ton electric travelling crane for the new generating station of this Corporation. The acceptance of this tender is subject to the sanction of the Local Government Board being obtained for the requisite borrowing powers.

Dublin.—A clerical error of £10,000 having been discovered in the totalling of Messrs. Siemens Bros. and Co.'s tender for lighting mains, the tenders now stand as follows:

St. Helens Cable Company	£108,039 15 0
British Insulated Wire Company (accepted)	109,447 10 8
Western Electric Company	113,004 13 9
Siemens Bros. and Co.	113,687 12 1
W. T. Henley's Company	120,965 3 8
Callender's Cable Company	125,542 12 0

Grimsby.—A tender from the British Insulated Wire Company has been adopted. The estimate for mains in Bethlehem and Osborne streets, etc., is £670. 8s. 4d.; at the scheduled prices it is £658. 17s. 1d. The committee will also obtain 100 yards distributing cable, etc., at £31. 5s., including delivery, and three Gilbert arc lamps, as spare arc lamps, at £41, as well as two arc lamps, at £67, for lighting up the central station, with from £8 to £10 extra for wall cases. The tender of Mr. Stephenson, at £69. 11s., for fitting up the offices of the electrical engineer and of the cashier, has been accepted.

Digitized by Google

Grimsby.—The Corporation have received the following tenders for wiring the free library:

A. C. Dickins, Northampton (accepted)	£72	12	0
Jackson and Co., West Hartlepool	78	18	0
National Electric Wiring Company	87	0	0
National Electric Wiring Company (alternative)	98	10	0
D. Brown, Newcastle	94	11	0
G. F. Cook, Lightcliffe	106	0	0
G. F. Cook, Lightcliffe (alternative)	89	0	0
G. F. Cook, Lightcliffe (alternative)	125	0	0
G. F. Cook, Lightcliffe (alternative)	166	0	0
D. Firth and Son, Manchester	112	0	0
D. Firth and Son, Manchester (alternative)	102	0	0
J. Findlay, Glasgow	115	11	3
Reames, Wokes, and Co., Hull	118	0	0
G. R. Cole, Grimsby	119	10	6
Lumby and Postlethwaite	125	10	0
G. A. Howard, Lincoln	129	0	0
J. E. Lester, Leicester	138	10	0
Crowther and Co., Manchester	171	0	0
Queen's Dock Electric Works, Liverpool	198	10	0
Sharple, Taffs, and Co., Manchester	204	0	0
Hayes, Wood, and Co., Manchester	220	0	0

Tunbridge Wells.—The following tenders have been received for the supply of electricity cables at per 1,000 yards:

Low-tension electricity cables.

·034 cable.

British Insulated Wire Company	£135	0	0
Callender and Co. (accepted)	109	0	0
W. T. Glover	114	11	8
Henley and Co.	106	5	0
Johnson and Phillips	107	0	0
J. Littauer	102	11	0
Polland and Co.	126	8	0
Siemens and Co.	109	0	0
St. Helens Cable Company	115	10	0
Western Electric Company	115	0	0

·06 cable.

British Insulated Wire Company	193	0	0
Callender and Co. (accepted)	168	0	0
W. T. Glover	175	0	0
Henley and Co.	165	17	6
Johnson and Phillips	166	0	0
J. Littauer	164	10	0
Polland and Co.	187	6	0
Siemens and Co.	161	0	0
St. Helens Cable Company	173	0	0
Western Electric Company	168	0	0

·1 cable.

British Insulated Wire Company	246	0	0
Callender and Co. (accepted)	228	0	0
W. T. Glover	237	10	0
Henley and Co.	229	5	0
Johnson and Phillips	233	0	0
J. Littauer	226	6	0
Polland and Co.	256	8	0
Siemens and Co.	222	0	0
St. Helens Cable Company	238	0	0
Western Electric Company	230	0	0

·15 cable.

British Insulated Wire Company	322	0	0
Callender and Co. (accepted)	295	0	0
W. T. Glover	312	10	0
Henley and Co.	305	0	0
Johnson and Phillips	312	0	0
J. Littauer	306	10	0
Polland and Co.	336	17	0
Siemens and Co.	295	0	0
St. Helens Cable Company	311	0	0
Western Electric Company	296	0	0

·2 cable.

British Insulated Wire Company	384	0	0
Callender and Co. (accepted)	354	0	0
W. T. Glover	389	11	8
Henley and Co.	375	15	0
Johnson and Phillips	378	0	0
J. Littauer	376	1	0
Polland and Co.	409	15	0
Siemens and Co.	354	0	0
St. Helens Cable Company	373	0	0
Western Electric Company	362	0	0

Twin cable.

British Insulated Wire Company	65	0	0
Callender and Co.	70	0	0
W. T. Glover	68	15	0
Henley and Co. (accepted)	46	10	0
Johnson and Phillips	50	0	0
J. Littauer	25	10	0
Polland and Co.	78	4	0
Siemens and Co.	60	0	0
St. Helens Cable Company	66	8	0
Western Electric Company	62	0	0

High-tension electricity cables.

·025 cable.

British Insulated Wire Company	144	0	0
Callender and Co. (accepted)	113	0	0
W. T. Glover	118	15	0
Henley and Co.	113	10	0
Johnson and Phillips	116	0	0
J. Littauer	115	10	0
Polland and Co.	163	4	0
Siemens and Co.	116	0	0
St. Helens Cable Company	122	10	0
Western Electric Company	124	0	0

·034 cable.

British Insulated Wire Company	164	0	0
Callender and Co. (accepted)	131	0	0
W. T. Glover	137	10	0
Henley and Co.	129	12	6
Johnson and Phillips	138	0	0
J. Littauer	130	0	0
Polland and Co.	232	6	0
Siemens and Co.	130	0	0
St. Helens Cable Company	140	0	0
Western Electric Company	140	0	0

·05 cable.

British Insulated Wire Company	210	0	0
Callender and Co. (accepted)	175	0	0
W. T. Glover	191	13	4
Henley and Co.	178	2	6
Johnson and Phillips	188	0	0
J. Littauer	171	0	0
Polland and Co.	250	19	0
Siemens and Co.	175	0	0
St. Helens Cable Company	190	0	0
Western Electric Company	186	0	0

·1 cable.

British Insulated Wire Company	290	0	0
Callender and Co. (accepted)	257	0	0
W. T. Glover	272	18	4
Henley and Co.	266	0	0
Johnson and Phillips	272	0	0
J. Littauer	250	0	0
Polland and Co.	321	17	0
Siemens and Co.	257	0	0
St. Helens Cable Company	276	0	0
Western Electric Company	263	0	0

BUSINESS NOTES.

TRACTION.

Sheffield.—The service to Harcourt-road is to be started in a few days.

Nottingham.—Trials are being made with the electric cars on the new lines.

Bath.—The City Council have agreed to accept the amended tramway agreement.

Liverpool.—The electric car service has now been opened on the Breckfield-road route.

Crewe.—The Town Council have decided to apply for a tramways order and to proceed with the scheme.

Southall-Norwood.—The District Council are asking the London United Tramways, Limited, to retain the double line in their scheme.

City and South London Railway.—The Company are offering 10,000 new ordinary £10 shares at £5 10s. in connection with the Angel extension of this railway.

Bradford.—The cars on the electrical tramway laid by the Corporation between Thornbury and Stanningley commenced to run for passenger traffic on the 16th inst.

Clydebank.—The Commissioners are about to apply, under the Private Legislation Procedure (Scotland) Act, for a provisional order for the construction of tramways within the burgh.

Columbia Motorcar Co., Limited.—This Company has been registered with a capital of £1,000 in £1 shares, the object being to manufacture, sell, let on hire, and deal in electric motors, cycles, etc.

West Cumberland Electric Tramway.—Application is intended to be made in Parliament in the ensuing session for an Act under the above name, authorising the laying down of tramways or tramroads in West Cumberland.

Colchester.—The Corporation of Colchester have decided to run electric tramways through various important streets, so that the three railway stations in the town may be within easy reach of passengers. The rate will be 1d. for three miles.

Kingston.—A statutory meeting of owners and ratepayers for the purpose of adopting a resolution consenting to the promotion by the Corporation in the ensuing session of Parliament of a Bill for obtaining tramway powers was held on Wednesday.

Sunderland.—Lieut.-Colonel von Donop and Major Trotter made their inspections of the tramways on the 20th and 21st inst. respectively. The second section of the overhead electric tramways of the Sunderland Corporation was opened on the 22nd inst.

Cape Electric Tramways Co.—A bonus of 3 per cent. free of income tax payable to all shareholders registered on Nov. 12, and to the holders of coupon No. 7 attached to share warrants to bearer, will be paid after the receipt of transfer returns from South Africa.

Paddington.—The *Daily Telegraph* says that objection is taken to the proposed construction of a new underground electric railway from Paddington to Victoria, for the reason that the railway might prove a serious danger to the houses in Connaught-square, Hyde Park.

Digitized by Google

Central London Railway.—A Bill is to be presented to Parliament in the coming session to enable this Company to construct a double line from the Bank to a new station to be made under the Liverpool-street terminus of the Great Eastern line. An extension is also proposed at Shepherd's Bush.

North Shields.—Notices have been posted relative to a proposed new line of tramways. The promoters intend to apply to Parliament next session for a Bill to authorise the laying of tramlines from North Shields by way of Willington, Wallsend, Walker, Longbenton, to The Grove, Gosforth.

Electric Vehicle Co. of Great Britain, Limited.—This Company has been registered with a capital of £1,000 in £1 shares, the object being to manufacture, sell, let on hire, or otherwise deal with electric motors, cycles, and vehicles of all kinds, and to carry on the business of engineers, electricians, etc.

Coatbridge.—Notices have been posted along the proposed route of the intention of the Airdrie and Coatbridge Tramway Company to apply to the Board of Trade for a provisional order, to be confirmed in the ensuing session of Parliament, authorising them to lay down and maintain tramways in Old Monkland and Coatbridge.

Lowestoft.—At a meeting of the Town Council on the 28th inst., a resolution will be proposed in favour of the promotion of a Bill to empower the Corporation to construct tramways in a number of streets, and to confirm any agreement made with the National Electric Traction Company, Limited, with reference to the leasing of the proposed tramways, etc.

Chester.—The Town Council have resolved to apply to Parliament for an Act empowering them to take over the Chester tramway undertaking, to adapt it for mechanical traction, and to extend the system beyond the borough boundaries. The price paid by the Council to the tramway company is £18,300, and the rolling-stock is taken at a valuation.

Victoria to Putney.—A Bill is to be introduced for the construction of an underground electric railway between Victoria and Putney. The suggested line of route is under King's-road, on the Middlesex side, beneath the bed of the river to Putney, and under Brewhouse lane and High-street, Putney, as far as Montserrat-road, where the terminus will be situated.

Smethwick.—The Town Council have now concluded an arrangement with the British Electric Traction Company upon the question of the supply of electricity to the borough for lighting and power purposes. Mr. J. G. Aldridge has expressed a favourable opinion upon the agreement, which will probably be brought before the Council for their approval at an early date.

Thames Ditton.—The London United Tramways, Limited, propose to apply to Parliament in the ensuing session for power to construct additional tramways, some of which will be within the Council's district. They propose to follow the usual plan of affixing the notices to the lamp-posts in the streets affected, and the Council have refused to allow the notices to be posted on the lamp posts.

Tettenhall.—At the last meeting of the District Council a letter was read from the borough surveyor of Wolverhampton, who sent plans for the construction of the new electric tramway, showing a single line of rails except at the bottom of the rock and a loop line at the top of it. It was resolved that no double line be allowed in the Board's district, nor loop lines between Henwood-lane and Stockwell End.

Hampstead.—Notice has been given by the promoters of their intention to apply to the next session of Parliament for power to lay a system of electric tramways from Hampstead and North Finchley, running along Finchley-road, Regent's Park road, and Ballard's-lane. There will be no overhead or underground current, the idea being to provide a motive power by means of electric engines attached to the cars.

Chester-le-Street.—The Rural District Council are considering an application from the United Kingdom Tramway and Light Railway and Electrical Syndicate, Limited, for the consent and support of the Chester-le-Street authority for the promotion of a provisional order under the Tramways Act, 1870, for the construction of tramways on the overhead electric trolley system from Penshaw Bridge through Washington and New Washington.

Perth.—At the last meeting of the Council attention was called to a letter from Mr. Dempster, solicitor, intimating that the Commissioners' offer of £20,000 for the purchase of the tramways could not be entertained. The minute was disapproved of, and the matter remitted back to the Tramway Committee. It was thought that if that minute was allowed to stand, and the matter was remitted to arbitration, the minute was bound to affect the arbiter's mind.

Castleford and Normanton.—The Pontefract Town Council are in favour of the proposals of the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, to establish a system of electrical trams in and between Normanton, Whitwood, Castleford, Glass Houghton, Pontefract, Purstone, and Featherstone, and also to supply electric light and energy within those areas. The agreement is to be submitted to a select committee of the Council.

Across London.—Amongst the applications for parliamentary powers, there are two schemes for underground electric railways—viz., the King's-road Railway and the North and South Junction Railway. The King's-road Railway will be three miles long, and will be run from Victoria to Parson's Green, and the North and South Junction Railway will run from Paddington *vid* the Marble Arch, Hyde Park-corner, Victoria, Vauxhall, Kennington-oval, to Kennington Park, a distance of nearly five miles. It is intended to have first and third class carriages on both these lines.

Clontarf.—The resolution passed by the Council authorising the United Tramway Company to construct tramlines from Fairview corner to Ballybough Bridge, and to bond their cables along the Strand-road at certain points with the rails, on payment of an annual sum of £100, and the paving of the vicinity of the stopping place at Fairview corner, has been rescinded, and the Council will sanction the proposed works by the tramway company on their paying the sum of £50 and paving the vicinity of Fairview corner, the payment to commence on the running of the trams.

Leeds.—The Post Office authorities are paying £500 a year to the Tramways Committee of the Corporation for the right of the postmen to travel by the cars. The question of the renewal of the contract was considered at the last meeting of the committee. It had been pointed out by the management that, owing to the largely increased service and greater facilities, an additional sum should be paid by the Post Office. The postal authorities, however, objected to any advance at present, and after discussion it was decided to renew the contract on the old terms for another year.

Grimsby.—At a meeting of the Lighting Committee last week the Chairman said he believed the electric light would be in use in the streets of Grimsby at the opening of the new century, and the electric tramcars by Whitsuntide. The district manager of the National Telephone Company had informed him that he believed the effect of the trams would be to render the overhead telephone wires in Grimsby practically useless, and the company would like to lay the principal mains underground. A discussion ensued as to the advisability of municipalising the telephone system and it was decided to hold a meeting in a fortnight to fully deal with the matter.

Cleethorpes.—The tramways company have had many difficulties to contend with in their attempts to provide the district with an improved and more up to-date service. The latest trouble that has come upon them is in relation to water. It appears that immediately underneath a portion of the new rails in Grimsby-road is a water-main. The waterworks company wish the tramways company to divert the main. The tramways company suggest that the matter be obviated by the waterworks company arranging for junctions to the main wherever there is a possibility of there being any side streets from Grimsby-road. The question is at present under consideration.

Surbiton.—The Urban District Council have adopted a report of the Parliamentary Committee containing the following clauses: "(1) We advise the Council to adhere to their resolution to oppose the London United Tramways, Limited, so as to obtain a *locus standi* on clauses; (2) that the clerk be and is hereby instructed to take the necessary measures to oppose the Bill for tramways now being promoted by the Kingston Corporation, as far as that Bill concerns the areas under this Urban Council; (3) that the terms offered by the London United Tramways Company be accepted, and that the chairman be instructed to give effect to the proposed provisional agreement with the company."

Wigan.—The Council have decided to promote in the next session of Parliament a Bill to enable the Corporation to construct tramways along the following routes: (1) Wigan-lane, Wigan; Wigan-road and High-street, Standish-with-Langtree. (2) Woodhouse-lane, Wigan, and Standish Lower Ground, Standish-with-Langtree. (3) Millgate, Scholes, and Whalley, Wigan. (4) New Market-street, Frog-lane, and Woodhouse-lane, Wigan. (5) Caroline-street, Chapel-lane, Bradford-street, and Bradford-place, Wigan. Powers are also to be sought to enable the Corporation to construct street improvements in connection with the proposed tramways, and, in particular, to widen Whalley, Wigan, and Wigan-road, Standish-with-Langtree. Application is to be made for sanction to borrow £18,250 for tramways.

Middlesbrough.—Major van Donnop, R.E., held an enquiry into several matters between the Imperial Tramways Company and the Middlesbrough Corporation on the 21st inst. The principal question dealt with was whether the company should be called upon to construct the lines and portions of lines which were authorised by the provisional order, but which had not yet been constructed. Life-guards were also discussed. The Inspector said that he would send such suggestions as occurred to him with regard to life-guards and steps to the Corporation and the tramways company. Mr. Clifton Robinson stated that he would be pleased to discuss in a friendly spirit with the Corporation or its representative any suggestion which the inspector might make, or which might occur to the Corporation for increasing the comfort for passengers and safeguarding the general public.

Croydon.—At the meeting of the Rural District Council on Thursday last week Mr. Butterworth, clerk to the Wimbledon District Council, attended and explained the plans to the Mitcham and Merton members. He said that the London County Council proposed to bring their trams as far as Tooting, their system being the conduit system. It would be impossible to bring the conduits over Tooting Bridge, but Prof. Kennedy, the technical adviser to the London County Council, stated that there would be no difficulty in changing from the conduit system to the overhead trolley system at Tooting. The total length of single line would be about 3¾ miles, and a rough estimate of the cost was £7,000 a mile, but that estimate was a very rough one, and did not bind his Council. It was agreed that the portion of line referred to be added to the portion in respect of which the Council had applied for a provisional order.

Digitized by Google

Darlington.—The settlement of the dispute between the Imperial Tramways Company and the Darlington Corporation does not seem to come very much nearer. The Corporation, says the *Leeds Mercury*, strongly object to the terms of the provisional order, and seek to obtain, in accordance with a resolution passed at last Council meeting, a hearing by the Light Railway Commissioners. This, it is understood, they have a difficulty in doing, as there is a strong aversion to the tramways company being allowed to take their own course and deviate so largely from their original proposals. The idea which has been repeatedly mentioned of the Corporation buying the existing tramways and carrying out a new system of electric tramways on their own account begins to find more favour, and the General Purposes Committee are, it is understood, making enquiries with a possible view to such a step being taken.

Tyneside.—Now that the electrical supply companies have got the necessary parliamentary powers to operate on both banks of the Tyne, it is likely, says the *Newcastle Daily Chronicle*, that there will be electric tram services from Newcastle and Gateshead, respectively, to the coast. On the south side Jarrow will be connected with South Shields, and from the mid-Tyne borough it is intended eventually to extend the ways to Gateshead. Now there is the probability of a local company running a service on the Northumberland bank of the river. This is an enterprise contemplated by Tyneside capitalists who, in the next session of Parliament, will seek powers to enable them to construct lines between Newcastle and North Shields. If the necessary sanction is obtained they will purchase the electric energy from the company which is at present constructing electrical works, and therefore the tram scheme will be a separate undertaking. A communication to this effect was laid before the Willington Quay Urban District Council the other evening, and they, together with the other authorities, will most likely discuss the proposal with the company at an early date. It may be said that there is a good train service on the north side, and that the trams are scarcely required; but if cheap fares are adopted, there is no knowing what development may take place. Wallsend will soon be large enough to have a tram service of its own, and the surrounding places are growing rapidly.

LIGHTING AND GENERAL.

Hampstead.—The electric lighting of Fleet-road is being considered.

Cheltenham.—The electrical engineer has prepared an exhaustive report on free wiring.

Finchley.—We understand that electricity for lighting purposes will be available shortly.

Colchester.—The Council on Wednesday decided to apply for a provisional tramway order.

Bedford.—The Urban Sanitary Authority have agreed upon several extensions of cables.

Huntingdon.—The question of public lighting by electricity has been shelved for the present.

Birstall.—The District Council have decided upon their electric lighting route for the compulsory area.

Clydebank.—Application is to be made by the Commissioners to the Board of Trade for a provisional order for electric lighting.

Maidstone.—The Council are urging the Local Government Board about the answer to the enquiry with regard to the electric light.

Barnsley.—The Town Council propose to apply for sanction to the borrowing of £20,000 for the purpose of extension of the electric light plant.

Avon Electricity Meter Co.—The transfer books of the ordinary and preference shares will be closed from the 26th inst. to the 15th prox., inclusive.

Ambroath—Offers by Messrs. Edmundson and by Messrs. Crompton and Co. have been remitted to the Electric Lighting Committee for reconsideration.

York.—The Council has decided to purchase the tramways, the formal resolution for which step is to be moved at a special meeting to be held on Dec. 17.

Worksop.—The Urban District Council have obtained a loan of £5,000 (part of £30,000 proposed to be raised for the purposes of electric lighting) at 3½ per cent.

Paignton.—The Electric Light Committee have discussed with Mr. Singer the preliminary arrangements for the installation of the light. The town is to be canvassed.

Trowbridge.—The Urban District Council will apply for a provisional order authorising them to supply electricity for all public and private purposes in their district.

London Gazette.—The estate of F. Metcalfe, 6, Tenter-lane, Swinegate, Leeds, has been released from trusteeship, also that of W. H. F. Bowman, 8, Foster-street, Gainsborough.

Colne.—Mr. H. P. Boulnois has held an enquiry into the application of the Corporation to borrow £39,000 for the purpose of proceeding with the projected electric lighting undertaking.

Edmonton.—The Urban District Council have rescinded a resolution passed by the Council in favour of applying to the Board of Trade for a provisional order to supply electricity in the borough.

Farnley.—The District Council are making enquiries from other urban councils as to what steps they intend to take with respect to any proposal to supply electric power, etc., to their respective districts.

Standish-with-Langtree (Lancashire).—A report on the electric lighting question is being furnished to the Council by Messrs. Lacey, Clirehugh, and Sillar, Westminster and Manchester.

Sale of Plant.—The Markets Committee of the Leeds Corporation invite tenders for the purchase of belt-driven electric lighting plant now at the Kirkgate Market. Particulars in our advertisement columns.

Heddesden.—The Urban District Council have decided to apply for a provisional order to empower the Council to exercise within their district all or any of the powers afforded by the Electric Lighting Acts.

Ilford.—The sum required by the Urban District Council in connection with the electric lighting works is as follows: to the end of the year, £20,000; to the end of February next year, an additional £25,000.

Cleethorpes.—Mr. C. S. Vesey Brown has submitted three estimates for proposed machinery, cables, and general electrical equipment. No. 1 estimate represented £19,129, No. 2 £20,072, and No. 3 £17,388.

Goole.—The electricity works are now in an advanced state, but the committee are waiting for some lengths of piping which has to be specially made. The date when the works will be opened has not yet been fixed.

Stratford-on-Avon.—The generating station is to be erected on a piece of land belonging to the Corporation situate in Rother-street, and the mains are first to be laid in Greenhill-street, Wood-street, and High-street.

Newbury.—Arrangements are in progress for making an application to the Board of Trade for powers to establish electric light works in this town. The matter is being promoted by a London electric light company.

West Ham.—The Guardians have received sanction to a further expenditure of £1,875 on electric lighting of the West Ham Union and Schools, bringing the total expenditure up to £6,500. The work is to be proceeded with at once.

Crieff.—The Town Council have now resolved to apply to the Board of Trade for a provisional order to have the town lighted by electricity, and it is proposed, on obtaining the order, to lease the lighting to a company to carry out.

London County Council.—The Council intend to ask the North Metropolitan Tramways Company whether they are willing to surrender their lease before its expiry (1910), so as to enable the Council to adopt electric traction on these lines.

Rowley.—It appears that the terms of the provisional order of the Midland Electric Corporation are not regarded as satisfactory by the Council, who propose, if they cannot obtain satisfactory terms, to apply for a provisional order for themselves.

Perfect Light Co., Limited.—This Company has been registered with a capital of £25,000 in £1 shares, the object being to adopt an agreement with the Scott, Snell, Phillips Syndicate, Limited, and M. Lachman, and to carry on the business of electricians, etc.

West Ham.—The Local Government Board are prepared to sanction a further expenditure of £1,875 on electric lighting of the West Ham Union and Schools, bringing the total expenditure up to £6,500. The Guardians have resolved to proceed with the work at once.

Cheadle and Gatley.—The Urban District Council are circularising the ratepayers upon the question of supplying electric light and power. Particulars are to be settled by the chairman and the clerk, subject to the price named being 6d. per unit.

East Africa.—It is reported that an eminent Swiss engineer, who is acting for a French syndicate, has started for Abyssinia in order to superintend the construction of a railway between Jibutil and Harrar, and to establish telegraph lines throughout Abyssinia.

Roundhay.—Application is being made to the Board of Trade for a provisional order empowering the Roundhay and District Electric Lighting Company, Limited, to produce and supply electricity for all public and private purposes within the township of Roundhay.

Wallsend.—At a special meeting of the Urban District Council on the 20th inst. it was agreed that a special conference be held between the Council and the promoters of the proposed electric tram scheme from Newcastle to Tynemouth, *vid* Wallsend and Willington Quay.

General Electric Company of Ireland, Limited.—This Company has been registered, with a capital of £2 000 in £1 shares, to construct, purchase, lease, or otherwise acquire tramways in the counties of Dublin and Wicklow, and to equip and work the same by electricity.

Dover.—The Dover Electricity Supply Company are fitting-up a smoke-prevention apparatus at their works. In addition to the other large schemes for which application is being made to Parliament, a Bill is to be introduced for power to buy up both gas and electricity undertakings.

Woolwich.—We are informed that, owing to the rapid extensions since the Woolwich Lighting Company has been taken over by Messrs. Edmundsons, a second 250 kw. turbo dynamo, complete with surface condenser, air and circulating pumps, has been ordered from Messrs. C. A. Parsons and Co.

Roadway Autocar Co., Limited.—This Company has been registered with a capital of £40,000 in £10 shares, the object being

Digitized by Google

to carry on the business of motor, motorcar, and vehicle manufacturers, owners and workers of patents relating to motorcars and vehicles propelled by mechanical appliances, etc.

British and Foreign Electrical Vehicle Co., Limited.—This Company has been registered with a capital of £150,000 in £1 shares, the object being to adopt agreements with Messrs. S. A. Cobbett, E. W. Hart, and C. E. Lee for the acquisition of the business of the Lecoll Electric Battery Company, Limited, etc.

Birstall.—The compulsory area for the electric lighting has been fixed as from the gates of the gasworks, up Smithies-lane, along Low-lane, around by the National Schools, and back by Bradford-road. The latter portion has been included in view of the possibility of electricity being wanted for traction purposes.

Bromsgrove.—The company which recently obtained an order for the construction of the light railway in Bromsgrove and district are this month applying for an electric lighting provisional order this session, Mr. W. H. Scott, of Bromsgrove, being the solicitor, and Messrs. Pritchard, Green, and Co. the engineers.

City of London.—At the meeting of the Common Council last night it was proposed that the Corporation should create and endow a commercial college, and also that it should defray the cost of lighting the church of St. Lawrence Jewry with electricity. These preliminary discussions are always taken with closed doors.

Berwick.—At the last meeting of the Sanitary Authority the Clerk stated that, in answer to a letter to Edmundsons, Limited, regarding the lighting of Berwick by electricity, for which they had obtained the necessary legal powers, he had obtained a reply, stating that the company intended to undertake the work early next year.

Penybont.—The Council have consented to an application of the Post Office authorities to erect telephone poles from Bridgend to Aberkenfig and Aberkenfig to Brynmenyn, and also to the National Telephone Company to erect posts in another part of the district, subject to an agreement, the charge being 1s. per post per annum.

Cardiff.—A meeting of all classes of local electrical workmen was held on Thursday last week for the purpose of forming a local branch in connection with the Electrical Trades Union. It was afterwards resolved that a branch of the Electrical Trades Union be formed in Cardiff, and rules for the guidance of the branch were adopted.

Stock Exchange.—The Stock Exchange Committee have ordered to be quoted in the official list the Hove Electric Lighting Company, Limited, 11,000 shares of £5 each, fully paid, Nos. 1 to 11 000. The committee have been asked to allow the City of London Electric Lighting Company, Limited, provisional certificates for £200,000 4½ per cent. second debenture stock to be quoted in the official list.

Stirling.—Mr. Hanson has prepared a report on the electric lighting of the Craigs district. He estimates the cost of the lighting of this district as follows: arc lamp pillars, £116; brackets and wall boxes, £17; cable, £80; arc lamps, switches, fuses etc., £120; service boxes, £14; trench work, £40; laying and jointing, £23—total, £410. Mr. Hanson is also preparing a report on the extension of the electric light in other parts of the town.

Bridgwater.—At the last Council meeting a lively discussion ensued with regard to the terms of reference for the appointment of the Lighting Committee, which included the doing of all acts and things that were necessary under the Bridgwater electric lighting provisional order. Several divisions were taken at which the voting was each time level, and the Mayor being a shareholder in the gas company was not able to give a casting vote. Finally, the Lighting Committee was re-elected.

Grimsby.—At a meeting of the Public Lighting Committee last week the question of the municipalisation of the telephone was considered, the chairman referring to an interview he had had with the district manager. It was stated that the electrical service for the tramways would affect the telephone, and a desire was expressed to lay the wires underground. A discussion ensued, from which it appeared that the municipalisation of the telephones, if proposed, would meet with a good deal of support. The matter will be fully discussed at a future meeting.

Plucky Rescue.—A steam-pipe in connection with one of the boilers at the works of the Metropolitan Electric Supply Company burst on Saturday afternoon. An employé who was standing near the pipe was terribly scalded by the escaping steam, which quickly filled the place. Notwithstanding the danger, three of the other workmen dashed into the boiler-house, and, groping around, found their comrade lying prostrate and unconscious on the ground. They took him out, and he was conveyed to the hospital, where he now lies in a critical condition.—*Morning Post.*

Appointments Vacant.—The Guardians of the Bethnal Green Infirmary require the services of an assistant engineer.—The Electricity Committee of the Worcester City Council invite applications for a superintendent of mains. Details of these vacancies appear in our advertisement columns.—A practical electrician is required to take charge of electrical plant of large building, steam power and dynamo. Particulars may be obtained from Mr. F. W. Purcell Alexandra Theatre N.—An assistant engineer, a mechanic, a switchboardman, a stoker, and a boy are required for the electricity works in Grimsby.

Inquest.—On the 21st inst. an inquest was held on the body of R. Edwards, an electrical jointer in the employment of the Cheltenham Corporation. The death of the deceased occurred in a sub station, and evidence was brought to show that he accidentally made contact with the 2,000-volt circuit of a transformer. The medical evidence was that death was due to paralysis of the heart, the result of a shock such as might be occasioned by electric current. The jury returned a verdict in accordance with the medical evidence. They added a recommendation to the effect that the electrical engineer and the Corporation would consider whether some better and more efficient steps might be taken to protect machinery of this kind, so as to prevent a similar accident in the future.

The Electro-Harmonic Concert.—Those members and their friends who attended the Ladies' Night Concert of the Electro-Harmonic Society, held in St. James's Hall Restaurant on Friday evening last, when Major R. E. Crompton presided, were well rewarded for their trouble. An excellent and varied programme was provided, Mr. Alfred E. Izard's renderings on the piano being especially appreciated by musical enthusiasts. The efforts of the Westminster Glee Singers were as usual also accorded hearty applause, and Mr. George Nelson's glassophone solos, not to mention the amusing sketches rendered by that popular humorist Mr. R. A. Roberts, afforded a pleasing variety to the more serious items, instilling a freshness into the programme, which was well sustained to the end.

Newport.—The verdict of the coroner's inquest held on the body of Mr. T. W. Griffiths, who was killed by an electric shock in the Newport electricity works on Saturday last, was accidental death. The evidence was to the effect that the deceased was working behind the switchboard, and that he had neglected to use the indiarubber gloves which he was required to wear by the regulations of the station when working on high-voltage cables. At the time he received the fatal shock he was crouched behind the switchboard, and the marks on the body showed that contact was made with live metal on the switchboard by one knee of the deceased. A post-mortem showed that the deceased's heart and liver were badly diseased, so that a slight shock would have been sufficient to cause death. The verdict of the jury exonerated the management of the station from all blame.

Leeds.—The Leeds Highways Committee on the 21st inst. granted the application of the Corporation Electric Lighting Committee to open out 14 streets at Beeston, Hunslet, and New Leeds for extensions, and also acceded to the request of the same committee for permission to construct transformer chambers in Roundhay-road and Vicar-lane. As preliminary steps towards equipping the Burley and Cardigan-road tramway route with electric traction, arrangements were made for breaking up the ground and laying down feeder wires from the Calls to Headingley by way of Swinegate, City-square, Quebec-street, St. Paul's-street, Park-lane, Burley-road, and Cardigan-road. Victoria-road will be similarly treated. The work of erecting poles for carrying the overhead electric wires between North-street and Meanwood-road and Woodhouse-street has been commenced.

The Electrical Co., Limited.—Some few months ago we gave a description of the new showrooms which have recently been opened by the Electrical Company in Shaftesbury avenue. We have now received three of the new price-lists issued by the Company. The first of these deals with single, double, and treble pole knife switches, of which the Company has a large variety. The dimensions and prices of the switches are given, and also diagrams and illustrations of the same. The other price lists deal with lightning arresters and other safety devices, and with direct-current electricity meters. Of these latter, special diagrams of connections are shown and information given as to the testing, etc. The lists are evidently printed for thumb indexing, as the number of the list and the name of the subject with which it deals is placed so that such an index can be made when the complete number of lists is obtained.

Winchester.—The Sanitary Committee, with the Mayor (Mr. J. Marks), the surveyor (Mr. Anderson), the town clerk (Mr. W. Bailey), and a representative of the firm of engineers, Messrs. Lankaster and Sons, of Southampton, to whom the work was entrusted, recently met at the Corporation pumping station to see the turning on of the electric lighting which has been installed in the building, in the yards, and on the feeding platform of the furnaces. The control of the switches is so arranged that one lamp can be lit in any part, so that there will be no waste. The power is obtained from the waste heat of the destructors, and by this means the new illuminant will cost not more than £10 per annum in excess of the cost of the former lighting apparatus (oil). The members of the party expressed themselves as perfectly satisfied with the work. We are informed that the whole scheme has been carried out at the cost of £275.

Proposed New Bills.—Notices have also appeared, besides those noticed elsewhere, in regard to applications by Brompton and Piccadilly circus (Brompton and Piccadilly-circus Railway Company), Metropolitan District Railway (electrical equipment), Piccadilly and City (company), Bexley (U.D.C.), King's-road (company), City and South London (company), Victoria and City and Southern District (company), West and South London (company), City and North Suburban (company), Charing Cross and Hammersmith and District (company), South Yorkshire Electric Supply (South Yorkshire Electric Power Company). Notice has also been published of the intention of the British Westinghouse Electric and Manufacturing Company, Limited, to bring in a Bill next session to enable them to undertake the electrification of the Metropolitan and Metropolitan District Railways, and to suspend the running powers of the London and North-Western, the Great Northern, the Midland, the South-Eastern, and London, Chatham, and Dover, while the process of conversion from steam to electricity is being effected.

Digitized by Google

William Douglas, Limited.—This Company has been registered at Edinburgh with a capital of £1,000 in £1 shares, the object being to acquire the business carried on under the name of William Douglas, 11, Picardy-place, Edinburgh; to carry on the business of telephone and electrical engineers in all its branches and departments.

Institution of Engineers and Shipbuilders in Scotland.—Vol. xliv., Part 1, of the *Transactions*, issued November, 1900, contains the presidential address by Mr. Robert Caird, LL.D., F.R.S.E., and papers on "A New Gas Producer" by Mr. John A. Purves, D.Sc., F.R.S.E., and on "Marine Engine Shafting" by Mr. J. D. M'Arthur.

Teddington.—Mr. Edgcome, electrical engineer for the Kingston Corporation, has been asked to furnish the District Council with a scheme and report for the purposes of the application by the Council for an electric light provisional order. Mr. Edgcome has obtained permission of his Corporation to prepare the scheme and report.

Croydon.—At the last meeting of the Rural District Council the Clerk read a letter from the clerk to the Wimbledon Urban District Council asking for an interview with the Council in respect of the scheme for laying tramways from Wimbledon to Tooting Permission was given, and plans and estimates were laid before the Finance Committee.

Southend.—At the last meeting of the Town Council the borough engineer's report on the proposed lighting of the town by electricity was agreed to. He estimated that the cost of the installation would be £36,030, and that there would be a profit for the first year of £698. 15s, the income being put at £6,746, and the expenditure at £6,047. 5s.

Lowestoft.—At a meeting of the Town Council on the 28th inst. a resolution will be proposed in favour of the promotion of a Bill to make further provision in regard to the electric light undertaking of the Corporation, and, amongst other things, to empower them to supply electricity in bulk beyond the borough, and to supply electrical fittings.

Long Eaton.—After hearing Mr. Crowther's report on the Mond producer-gas plant and gas-engines last Monday, the Council instructed him to prepare detailed plans, specifications, quantities, and estimates for the Long Eaton electric supply, with a view to applying to the Local Government Board for permission to borrow the sum that may be required.

London Electric Warehouse Co.—This Company has been registered with a capital of £1,000 in £10 shares, the object being to carry on the business of electrical engineers, electricians, suppliers of electricity, manufacturers of and dealers in electrical machinery, plant, and apparatus, producers of light, sound, and power by electricity and otherwise, dealers in iron, indiarubber, etc.

Grangemouth.—The Burgh Commissioners have been advised not to allow any company to obtain electric lighting powers within the burgh, and have informed the North British Electricity Supply Company that they would not consent to their obtaining a provisional order, and that in the event of their proceeding with an application to obtain an order the Commissioners would oppose same.

Skipton.—At a recent special meeting of the Urban District Council a communication was read from the Yorkshire Electricity Supply Syndicate, Limited, who wished to include Skipton in their application to Parliament for a Bill empowering them to supply certain Yorkshire towns with electricity. It was resolved to reply that the Council had themselves decided to apply for a provisional order.

Walton.—In reply to the Urban District Council's notice of intention to oppose their application for a provisional order, Messrs. Edmundson's Electricity Corporation, Limited, have informed the Council that under the circumstances they would not proceed with the order this year, as they were not disposed to undertake the electric lighting of Walton unless they had the support of the Council.

Barnsley.—The Council commenced supplying the electric current on Feb. 17 last, and had 48 consumers equivalent to an output of 380 8 c.p. lamps; on Nov. 20 they had 177 consumers, equivalent to an output of 1,200 8-c.p. lamps, so that they have increased in that short period of about nine months, in every way, about threefold. The borrowing powers being exhausted, sanction for a new loan for extensions is to be applied for.

Victorian Coal.—At the Imperial Institute on Monday, Mr. James Stirling, Government geologist, and mining representative of Victoria, mentioned that in the Latrobe Valley, in Gippsland, alone, he estimated that there could not be less than 31,144,400,000 tons of light-coloured coal, which various analyses had proved to be superior to the average "German brown." Coal extended over an area of 7,000 square miles, and seams 267ft. thick had been found.

Dalkeith.—The Commissioners have under consideration the question of the introduction of electricity into the town in connection with an offer made them by Messrs. Crompton and Co., Limited. By their proposals the town would be supplied with electric light for the streets at a charge of 3d. per Board of Trade unit. The present charge for gas is 4s. 5d. per 1,000 cubic feet, with a reduction of 5d. on the total quantity used for the public lamps.

Carnarvon.—The Town Council have passed a resolution authorising Mr. E. W. J. Peterson, at his own expense in all cases, to apply to the Board of Trade or other proper authority for sole power to construct electric works, and to supply electricity for lighting and other purposes within the limits of the borough of Carnarvon, subject to the order prayed for being submitted to the Council for approval as to details from time to time as occasion may require.

Yarmouth.—At the last meeting of the Town Council the following resolution was proposed: "That the time has arrived when electricity should be substituted for gas in the streets and roads where electric mains have been laid, and that the committee should consider the advisability of extending the mains to such streets and roads as are not now provided with them." The Mayor ruled that the resolution was of such a character as required notice to be given of it.

Obituary.—We regret to have to announce the death of Prof. George Frederick Armstrong, M.A., F.R.S.E., who died at his residence at Grasmere, Westmoreland, on Friday last, in his fifty-ninth year. The deceased has held the chair of engineering in Edinburgh University from 1885 but was unable to be present at the opening of the current session owing to illness. He was for a long period on the engineering staff of the Great Northern Railway, and was professionally associated with railway undertakings in the Isle of Man.

Selsey.—On Thursday last week the installation of electric light was inaugurated at the new Marine Hotel. It is generated on the premises by a 5½-h.p. Otto gas-engine, driving a 4½-kw. dynamo, which in turn feeds 57 E.P.S. cells of the L type, supplying an installation of 110 lamps, the same power being utilised for supplying the tanks with water for domestic purposes. Messrs. Bowerman Bros., of Southsea, have carried out the works, incorporating all the latest improvements in electrical science. The installation is voted a great success.

Mexborough.—The Urban District Council is about to take advantage of an electric lighting provisional order which was secured about 18 months ago. An engineer has been appointed, and the Electric Lighting Committee have worked out the details of a scheme for supplying the town with electricity. The generating station is to be erected on land adjoining Station-lane, where a refuse destructor is also to be placed. The Council has applied for sanction to borrow £13,400 for the purpose, and £4,600 for a refuse destructor, and an enquiry has just been held.

Switchboard Instruments.—We have received from the British Thomson-Houston Company, Limited, a copy of their pamphlet No. 79, which was published on Nov. 7. This pamphlet deals with the Thomson astatic instruments for continuous current switchboards, and information is given concerning their action, and the accuracy with which they are calibrated. Specimens of the dials of the instruments are shown full and half size, and it can be seen that they are easily readable from a convenient distance. A number of illustrations of the instruments are also shown.

Bangor.—The Council have decided to provide an additional engine and dynamo, equal to the supply of 200 kw., owing to the extraordinary demand for the light. It is estimated that 6,000 lights would be required, this being 2,000 in excess of the number the plant is now capable of dealing with. The total amount paid up to date is £15,800, but certain amounts have to be deducted, including about £400 received for land near the refuse destructor. The plant was originally intended to supply 4,000 lights, and 50 consumers were guaranteed. The committee, however, started with nearly 80 consumers.

Blairgowrie.—We understand that the Commissioners are considering an offer from Messrs. Crompton and Co., Limited, by which the company undertakes to pay the Commissioners a sum of £25 annually and one half of profits after 7 per cent. had been distributed to the shareholders; also to pay all costs of provisional order, and give option to take over the undertaking at the expiry of 21 years or at the end of every seven years thereafter at a valuation. The company would utilise the present lamps for public lighting free of expense to the Commissioners, and it was estimated that the annual charge for public lighting would be reduced about £60 or £70.

Tottenham.—A special meeting of the Urban District Council has been held for the purpose of considering a recommendation from the joint committee for the promotion of the joint Bill on the subject of electrical power supply, and if approved to rescind or vary the following resolution passed by the Council on Sept. 18, 1900—viz., "That this Council do apply to the Board of Trade for a provisional order under the Electric Lighting Acts to supply electricity within the urban district of Tottenham." It was decided that the solicitors to the Council be authorised to discontinue the proceeding relating to the application for a provisional order if they deemed it expedient.

Ham.—The Drainage and Highway Committee reported at the last meeting of the District Council that they had had an interview with a representative of the Richmond (Surrey) Electric Supply Company, who intended to apply to the Board of Trade for a provisional order enabling them to supply electricity in various parishes in the Thames Valley, including Ham. The charge for supplying the current would be 6d. per unit. It was stated that Hampton Wick Council has consented to the application. The committee recommended that the Council consent to the application. The Council decided to consent to the application on the understanding that the maximum charge should be 6d. per unit.

Shields.—A syndicate which has recently been formed with a capital of £130,000 propose to apply for parliamentary powers to erect an aerial bridge across the Tyne between the foot of Howard-street, North Shields, and Mile End-road, South Shields. The engineers are Mr. G. H. Godsby, of Westminster, and M.

Digitized by Google

Arnodin, who has constructed several bridges of a similar type. The proposed bridge is to be 200ft. high, with a clear span of 640ft. It will be erected on the principle of a platform suspended by cables, and will provide accommodation for the transit of horses, carriages, tramcars, and 200 passengers. The bridge will be worked by electricity supplied by the Corporations of Tynemouth and South Shields.

Dollar.—At the last monthly meeting of the Burgh Commissioners the Clerk submitted agreement with the electric light company. He said that the alterations which he had suggested had not been given effect to, but he thought the alterations should still be insisted on. One, for instance, was the protecting of the Commissioners against claims from the gas company. His own opinion was that they could have no claim, but he thought they should as well be protected against any possibility of a claim. Another thing he suggested was that a plan of any works which the company proposed to erect in the burgh should be submitted to the Commissioners. It was agreed not to sign the agreement until the alterations proposed by the clerk had been given effect to.

Proposed New Bills.—The following notices of intention to apply for Bills have appeared in the *London Gazette*:—*Electric Lighting:* Northwood and Ruislip (Northwood Electric Light and Power Company, Limited), Wellington, Salop (U.D.C.), Ilkley (A. H. Gibbings), Beverley (Corporation), Neath (Corporation), Notting Hill (Notting Hill Electric Lighting Company), Northfleet (U.D.C.), Aberavon (Corporation), London, alteration and readjustment of the areas of supply (R. H. Wyatt, Westminster, S.W.), Lyndhurst (Lyndhurst Electric Lighting and Traction Company, Limited) Brighton (Corporation), Rhondda (U D C.), East Middlesex (Joint Board of the U.D.C.'s of Edmonton, Enfield, Southgate, Tottenham, and Wood Green), Ebbw Vale (U.D.C.), Cheeham (U.D.C.), Bournemouth (Corporation), Royton (U.D.C.), Ross (J. Parker), Faversham (Corporation), Abertillery (U.D.C.), Burgess Hill (U D.C.), Handsworth (U D C.), Paddington B.C. (Metropolitan Electric Supply Company), Teddington (U.D.C.), Widnes (Corporation) *Electric Tramways and Railways:* Devonport (Corporation), Wrexham (National Electric Traction Company), Brighton (Corporation) Glossop (Urban Electric Supply Company, Limited), Bournemouth (Corporation), Burton-upon-Trent (Corporation), Bury (Corporation), Handsworth (U.D.C.), Hyde (Corporation), Chester (Corporation), Sheffield (Corporation).

Manchester.—The Electricity Committee are at present experiencing great difficulties from the obligation they are under to supply motive power for tramway purposes by specified dates. They hope to be able to supply the current necessary for running the cars on three main roads—Cheetham Hill-road, Bury New-road, and Rochdale-road—on Jan. 1 next. The contractors will work night and day if necessary. Two new engines have been constructed by Messrs. Ferranti, and are in course of erection at the Dickinson-street station at the present time. One of these is practically completed, and has been running on trial. Directly the two additional generators, each of 1,000 h.p., are in full use the committee will be able to quickly proceed with the building and equipment of the station in Bloom-street. That work is far behind, and the committee have no place wherein to put the machinery, which has been ready for months. A sub-committee has been appointed with instructions to devote themselves wholly to the work of getting the new station ready, while another is looking after the new station to be built in Stewart-street. The ground was secured three years ago, but none of it has yet been turned up It is feared, with reference to the agreements made with neighbouring authorities, that the committee will not be able to carry them out within the periods agreed upon. Great changes in the staff will shortly be made. The chief engineer is going next March, and the second engineer has already left, having been appointed chief engineer at Bolton. The superintendent of mains has resigned, and will leave at the end of the year.

Fulham.—At Wednesday's meeting of the Borough Council the Lighting, etc., Committee presented the following report: "We have received a letter from the London County Council, stating that the Parliamentary Committee of the Council have had under consideration the proposal that the Council should promote legislation for empowering metropolitan local authorities to borrow money to enable them to wire consumers' premises for electric lighting purposes, but regret that they are unable to see their way to recommend the Council to promote legislation in the next session of Parliament in the direction indicated. We are informed that in some provincial towns the authorities have undertaken the free wiring of premises, and we have instructed the clerk to write to various councils who have adopted schemes of free wiring, asking them under what powers they have acted and for full details of their schemes." The consulting engineer submitted the following report: "Since the last meeting of the Electric Lighting Committee of the late Fulham Vestry work has been progressing somewhat slowly, both at the station in Townmead-road and in the streets. The Horsfall Company have still to complete the mechanical stokers and the weighman's house, and connect up the water service to their water-cooled dampers. They have also to construct their clinker tramway. The cells have had fires in them for some time past. The General Electric Company have now completed two of the main steam alternators ready for steaming, and will have the third ready this week in all probability. The three exciter sets have been ready for some time. The company is, however, very backward with their pipework and switchboard connections in the station, and also with the cable work in the streets. These matters will delay the starting-up of the station. I am again bringing pressure to bear upon them.'

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

Directors: Sir James Pender, Bart. (chairman); G. B. Byng, M.I.E.E; R. E. B. Crompton, M.I C.E., M I.E E., etc; H. Hirst, M I E.E; Roger W. Wallace, Q.C. Managing director in Berlin: Geheimer Regierungsrath Prof. Dr. Hermann Aron; Dr. Julius Juttke.

Report of the directors (with abstract of accounts) to be submitted to the third ordinary general meeting of the shareholders to be held at Winchester House, Old Broad-street, E.C., on Dec. 13 at 3 p.m.

The directors are highly gratified with the result of this year's working, which marks a considerable further improvement on the previous satisfactory progress. The balance to credit of profit and loss for the year ending Sept. 30, 1900, amounts to £23,915. 0s. 10d. To this is added the amount of £2,522. 13s. 11d. carried forward, making a total of £26 437. 14s. 9d. The directors propose to deal with the above available sum of £26 437. 14s. 9d. as follows, which is in accordance with Clause 5 of the memorandum of association of the Company: £7,493. 15s. 2d. for dividend of 6 per cent. per annum on the preference shares, of which an interim dividend of £3,746. 17s. 7d. was paid on April 1 last; £980. 6s. 5d. bonus to preference shareholders of which it is proposed to carry £355 16s. 10d. to the credit of preference shareholders for next year, and to declare an additional ½ per cent. per annum for the present year, thus making a total dividend of 6½ per cent. on preference shares; £15,000 for dividend of 12 per cent. on ordinary shares; leaving an amount of £2,963. 13s. 2d. to be carried forward to next year. The business of the Company continues to prosper, and the outlook is brighter than ever. The Aron meter is being adopted in the principal central stations in the United Kingdom, the Continent of Europe, and the Colonies, and this has necessitated the adoption of means for the extension of manufacturing resources. The Company has successfully competed at the exhibition in Paris, and has obtained the Grand Prix, which is the highest award. Two of your directors (Messrs. R. E B. Crompton, M.I.C.E., M.I.E E., and Hugo Hirst, M.I.E.E.) retire from office by rotation this year, but being eligible offer themselves for re-election. Messrs. Price, Waterhouse, and Co. have acted hitherto as auditors, and offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Directors' fees	1,260	0	0
Managing directors' salary and bonus	3 693	18	6
Managers' bonus	450	0	0
Secretarial, office, and general charges in London	892	3	9
Legal charges, and audit fee and expenses	317	9	1
Travelling expenses	40	16	1
Maintenance of patents	661	8	11
Preliminary expenses, amount written off	113	8	0
Balance, net profit carried to balance-sheet	23,915	0	10
	£31,344	5	2

Cr.	£	s.	d.
Gross profit on trading	30,976	1	2
Interest and exchange	327	11	6
Transfer fees	40	12	6
	£31 344	5	2

NEW COMMITTEES.

(*Second List.*)

The following Standing Committees have been appointed:

ABERYSTWYTH.—*Public Lighting*: Messrs. R. Peake, C. M. Williams, J. Jenkins, I. Hopkins, J. P. Thomas, J. T. Davies, and G. F. Roberts.

ASHTON.—*Highways and Tramways*: The Mayor; Aldermen Heginbottom, Hulme, Marland, and Siddall (chairman), Wilson; Councillors Andrew, Fletcher, Grime, Hall, Kelsall, Newton (deputy chairman), Oldham, Pollitt, J. Pownall, and Whitehead, Wilkinson, Yoxall, Catlow. *Electricity*: The Mayor; Aldermen Andrew, Hilton, Marland, Siddall, Wilson; Councillors Andrew, Barlow (chairman), Catlow, Grime, Hall, Kelsall, Newton (deputy chairman), Oldham, Phillips, Yoxall, A. Shaw, Wilkinson, and Brrrett.

BARNSLEY.—*Park and Lighting*: Aldermen Holden and Wray; Councillors Brady, Atkinson, Carter, Charlesworth, Foulstone, Maddison, and Rose.

BASINGSTOKE.—*Lighting*: The Mayor; Alderman Smith; Councillors Edney, Burberry, Hillary, Gerrish, and Kingdon.

BIRMINGHAM.—*Tramways*: Alderman Beale, chairman.

BLAIRGOWRIE.—*Lighting and Cleansing*: Ex-Bailie Hill, convener; Messrs. H Quin, J. L. Ford, and A. W. Bennett.

BOLTON.—*Electricity*: Councillor Dr. Panton, chairman; Councillor Berry, vice-chairman. *Tramways*: Alderman Nicholson, chairman; Councillor Smith, vice-chairman. A list of the other members was given in our last issue.

BO'NESS.—*Lighting*: Messrs. Calder, Thomson, Law, Welsh, Barrowman, and Grant (convener).

Digitized by Google

BOOTLE —*Electric Power and Lighting*: The Mayor; Aldermen Brewster (chairman), McMurray (deputy-chairman), Mack, and Morton; Councillors J. Blundell, Brown, Hall, Pearson, Rafter, Westerton, and Wilson.

BOURNEMOUTH — *Tramways and Parliamentary*: Aldermen Davis and Mattocks; Councillors Abbott, Allen, Beckett, Gunning, Hoare, Mate, Stockley, Roker, and Webber. *Lighting*: Alderman Davis; Councillors Beale, Beckett, Cory, Frost, M.D., Gunning, Hoare, Lane, Mate, Parsons, Robson, and Stockley.

BRADFORD.—*Electricity*: Mr. T. H. Shaw, chairman; Mr. J. Akam, deputy.

BURNLEY.—*Tramways*: Alderman Armistead, chairman; Alderman West, vice-chairman. *Electricity*: Councillor H. Emmott, chairman; Councillor Beecham, vice-chairman. *Electricity Sub-Committee*: Councillor Bibby, chairman.

BURY.—Last year's committees have been reappointed.

BURY ST. EDMUNDS —*Electric Lighting*: The Mayor and Alderman Lake.

COVENTRY.—*Electric Light*: Messrs. Calcott, Slaughter, and Webster.

DERBY.—*Electric Lighting*: Aldermen Ann, Bennett, Fletcher, and Woodiwiss; Councillors Butterworth, Eaton, Foster, Haslam A Ottewell, Simpson, and Wilkins. *Tramways*: Aldermen Doherty, Duesbury, Fletcher, and Spriggs; Councillors Butterworth, Dean, Eaton, Gandy, Johnson, A Ottewell, and Wilkins.

DUKINFIELD.—*Electric Lighting and Traction*: Councillor Wood, chairman; Aldermen Pratt and Pickup; Councillors Cooke, Kenyon, McFarlane, Grime, Ashworth, Cooke, Bardsley, Booth, Heathcote, and Whitehead.

EXETER.—*Electric Lighting*: Messrs. Domville, Hawke, Hodson, Jarman, Munro, Perry, Reid, T. B. Rowe, Stocker, Taylor, Kelland, and Wreford.

FALMOUTH —*Lighting*: Messrs. Thuell, E. A. Banks, E Williams, Grose, and Bullen.

FULHAM.—*Lighting, Electric Lighting, and Dust Destructor*: Mr. T. Davies, chairman; Mr. R. Harris, vice-chairman.

GREENOCK.—*Electricity*: Bailie Cameron, convener; Mr. John Anderson, vice-convener.

HACKNEY.—*Electric Lighting*: Messrs. E. H. Bassett, Berry, Beurle, Coles, Denham, Hasemer, Howitt, Lashmar, Penfold, Richmond, Sheehan, Steel, Watford, Wells Holland, Whiter.

LIVERPOOL —*Electric Power and Lighting*: Mr. S. W. Higginbottom, M.P., chairman; Mr. R. Dart, deputy.

LUTON. -*Electric Lighting and Power*: The Mayor; Aldermen Huckleby and Smith; Councillors Wilkinson, Cumberland, Jennings, Staddon, Ordish, and Garrard.

LYNN.—*Electric Lighting*: The Mayor; Alderman Jermyn and Miles; Councillors Affleck, Carpenter, Chatterton, Floyd, Miles, Sadler, and F. W. Savage.

NEWARK.—*Lighting and Fire Brigade, and Castle Gardens and Playgrounds*: Aldermen Smith, Crossley, and Harp; Councillors Davy, Harston, Perfect, Hatter, Lacy, Milthorp, Slater, Heming, and Doubleday.

NEWBURY.—*Watch and Lighting*: Alderman Lucas; Councillors A. Jackson, Davis, Stradling, and Wigington.

SHREWSBURY. — *Lighting*: Aldermen Cross and Herbert; Councillors Brace, Crump, Deakin, Downes, How, Froggatt, and Withers.

SOUTHEND.—*Light Railways*: Alderman Brightwell, Burrows, and Dennis; Councillors Allen, Berry, Doody, Hudson, Jones, Martin, Millican, Roberts, and Wilkinson.

SOUTHWARK.—*Electric Lighting*: Aldermen Haynes, Hawkins, Mather, Redman, and Vernon; Councillors Bryan, Chell, Attenborough, Edwards, C. Hibble, Hilton, Revitt, Sharp, Wagner, and Hamel.

SURREY C.C.—*Lighting*: Councillor Sprunt has been added to last year's committee.

SWANSEA —*Electric Lighting*: Aldermen Gwilym Morgan, Howel Watkins, Wm. Evans, and David Harris; Councillors J. H. Lee, Thomas Freeman, Odo Vivian, David Williams, A. Sinclair, E. G. Protheroe, B. Freedman, David Jenkins, T. Merrells, George Payne, W. H. Morris, Griffith Davies, H. A. Chapman, Richard Martin, and Morgan Tutton.

WAKEFIELD.—*Electric Lighting*: Alderman Bolton; Councillors Childe, Cradock, Driver, Fallas, Hammond, Harrison, Judge, Rhodee, W. H. Smith, Wigham (chairman), and Powell (vice-chairman). *Street Lighting*: Councillors Driver, Harrison, Hudson, Judge, McInnes, Saville, S. Smith, W. H. Smith, and Ramsden (chairman); Alderman Harrap, vice-chairman.

WANDSWORTH.—Until the Highways, Sewers, and Lighting Committee is appointed, the representatives of each district will act as local committees.

WIGAN.—*Electric Light and Tramways*: Councillor T. Worthington, chairman; Councillor G. Sutherland, vice-chairman; the Mayor, the ex-Mayor, Messrs. T. Ashton, J. Ballard, W. J. Lamb, J. Hilton, R. Layland, W. Livesey, J. Paxton, S. Taylor, S. Wood, and R. Richards.

WORCESTER. — *Electricity*: The Mayor; Mr. Maund, high sheriff; Aldermen Millington, Ernest Day, Holland, Harry Day, Perrins, and W. Caldicott; Messrs. Campbell, Darling, Kershaw, Cook, Parker, Williams, Kay, and Gray.

PROVISIONAL PATENTS, 1900.

NOVEMBER 12.

20311. Improvements in electrical cushions for tables and the like Oscar Thomas Banks, 49, Mortimer-street, Cavendish-square, London.

20357. An improved self-contained portable electric lamp. James McHardy, 38 Chancery lane, London.

20362. Improvements in renewing the filaments of electric incandescent lamps Charles Howard, 70, Palace-chambers, Westminster, London. (Complete specification.)

20383 Improvements relating to alternating-current induction motors. Benjamin Garver Lamme, Westinghouse-building, Norfolk street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 14, 1900, being date of application in United States.)

20384 Improvements relating to systems of electrical distribution. Benjamin Garver Lamme, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 14, 1900, being date of application in United States.)

NOVEMBER 13.

20439. Improvements in electric fire-alarms. Oscar Freymann, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

20466. Improved electric apparatus for exploding mines. Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

20471. Improvements in or relating to connectors for electric wires and the like. John Rymer Jones, 111, Hatton-garden, London. (Complete specification.)

NOVEMBER 14.

20493. Improvements in and appertaining to distributing boards for electrical circuits. Alexander Munro Taylor and Robert Steel, 141, West George-street, Glasgow.

20507. Improvements in sparking plugs for electrically-fired internal-combustion engines. Robert Frederick Hall, 24, Temple-row, Birmingham. (Complete specification.)

20510. An improved vacuum tube for X-ray production. Alfred Ernest Dean, 73, Hatton-garden, London.

20522. Improvements in high-potential line switches for electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States) (Complete specification.)

20540. Improved device for indicating the movements of a mariner's compass. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.)

20558. Improvements in and relating to combined telephone and electric bell circuits. The Berliner Telephone Manufacturing Company, 322, High Holborn, London. (Joseph Berliner, Germany.) (Complete specification.)

20573 Improvements in electric controllers. William Horatio Harfield, 4, South street, Finsbury, London.

20576. Improvements in apparatus for signalling by wireless telegraphy. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

NOVEMBER 15.

20590. Certain improvements in carriers for portable electric cables in combination with holder for lamps. Richmond Smith, 47, Chester-street, Birkenhead.

20631. Improvements in automatic electric carriages and appliances for the transport of light goods or traffic. Hans Dubs and Léon Laffitte, 65, Chancery lane, London.

NOVEMBER 16.

20662. Cap or cover for the handles of brakes on electric and other cars and machinery. Charles Symes, Ellerslie, West Derby, Liverpool.

20707. Electric exercising machine. Michael Bartholomew Ryan, 12, Salomonsgasse, Cologne.

NOVEMBER 17.

20757. Improvements in apparatus for generating pulsative constant electric currents. Edmund van Haanen, 4, Corporation-street, Manchester.

20758. Improvements in machines for generating constant electric currents. Edmund van Haanen, 4, Corporation-street, Manchester.

20761. A new method of constructing electrical cells of the Leclanché type. Digby Francis Baynes Cotes, 62, Union-street, Burton-on-Trent.

20764. Improvements in shade fittings for incandescent electric lamps. Arthur Albert Guest, 24, Temple-row, Birmingham.

20765. Improvements in or relating to electric lampholders. Clifford William Kemp, 24, Temple-row, Birmingham.

20778. Improvements in electric arc lamps. John Allen Heany, Norfolk House, Victoria-embankment, London. (Complete specification.)

20779. Improvements in electric arc lamps. John Allen Heany, Norfolk House, Victoria-embankment, London. (Complete specification.)

Digitized by Google

29797. Improvements relating to sound-magnifying appliances for telephones, phonographs, and the like. Otto Rieger, 36, Chancery-lane, London.

29809. Manufacture of a primer for producing ignition by electricity. Richard Kändler, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

29808. Improvements in or connected with electrical burglar alarms. John Henry Pennington and Virgil Yates, 55, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Dec. 8.

1899.

18664. Electric railways on closed-conduit systems. Purvis.

22089. Electric tramways or railways on the slotted-conduit system. Hewer.

23315. Electrolytic meters. Wright and Mutual Electric Trust, Limited.

23316. Electrolytic meters. Wright and Mutual Electric Trust, Limited.

24138. Coin-controlled electric meters for motors or the like. British Thomson-Houston Company, Limited. (Holmes.)

24960. Method of producing electrodes for electrical accumulators. Luckow.

24968. Process for the production of thermo-electric batteries. Jonas.

25576. Resistance switches and automatic cut-outs for starting, regulating, and protecting electric motors and their circuits. Veritys, Limited, and Steele.

1900.

400. Electric arc lights or lamps. Lee.

10210. Electrical apparatus for closing steam-supply valves from a distance and giving an audible signal. Dahl.

10176. Adjustable electric igniter or spark producer for motors. Braun.

10606. Electrical fuse boxes. Smith.

13613 Wireless telegraphy. Maréchal, Michel, and Dervin.

14769. Coin-freed apparatus for the supply of electric power. Lake. (Earle.)

14913. Switchboards for telephone stations. Baird.

15312. Apparatus for stopping, starting, and reversing electric motors. Wise. (Skodawerke Actiengesellschaft.)

16082. Combined reversing switch and automatic maximum current interrupter for multiphase current motors. De Kandó.

16290. Electric circuits for the transmission of energy by variable currents. Campbell.

16408. Electrodes of electro-chemical accumulators. Von der Poppenburg.

16704. Adjusting brush-holders for electric machines. British Thomson-Houston Company, Limited. (Reist.)

18175. Advertising clock either combined or not with an electric alarm or call. Royer.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Nov. 17	594	474	+ 120	17,500	15,070
Birmingham Trams.	,, 17	4,387	3,826	+ 561	201,694	191,566
Blackburn Corp'rat'n	,, 17	418	402	+ 16	18,395	20 689
Blackpool Corporatn.	,, 15	204	151	+ 53	26,986	19,883
Blackpool-Fleetwood	,, 17	156	172	- 6	19,413	19,415
Bolton Corporation..	Oct. 28	1,254	—	—	42,293	—
Bradford City Trams	Nov. 18	747	348	+ 399	17,690	13,161
Bristol Tramways Co.	,, 16	2,860	4,897	* - 2,037	—	—
Carlisle Tr'mw'ys Co	,, 17	143	—	—	3 772*f*	—
Central London Ry.	,, 17	5,406	—	- 293	82,167*e*	—
City & South London	,, 18	1,866	1,046	+ 820	32,108	19,473
Cork E. T. and L. Co.	,, 15	351	359	- 8	18,995*c*	17,501
Dover Tramways ...	,, 17	170	159	+ 11	9,600	9,149
Dublin & Lucan E.R	Oct. 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	Nov. 16	3,319	2,805	+ 514	—	—
Dublin S.D. Electric	,, 16	687	699	- 12	—	—
Glasgow Corporation	,, 17	9,057	8,855	+ 202	—	—
Halifax Corporation	,, 17	677	571	+ 106	26,118	20,664
Hull Corporat'n E.S.	,, 17	1,361	631	+ 730	43,017*a*	—
Liverpool Corporat'n	,, 10	8,619	7,356	+ 1,263	356 376	310,249
Liverpool Overhead	,, 18	1,553	1,438	+ 115	33 549	32,799
St. Helens Tramwys.	,, 14	—	—	+ 217	—	—
Sheffield Corporation	,, 18	2,579	—	—	—	—
Southampton Trams	,, 8	691	344	+ 347	—	—
Southport Corporat'n	,, 10	367	373	- 6	—	—
Swansea Tramways..	Oct. 5	447	263	+ 184	7,093	4,462

a Since April 1. *c* Since Jan. 1. *e* From July 30. *f* From June 30.
* Queen's visit.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	3-3
British Insulated Wire, Ord., 1-40,000	5	—	10⅝-11¼
——— 40,001-70,000	5	—	10 9/16-10 11/16
——— 6 per cent. Cum. Pref., 1-40,000	5	..	5⅞-6¼
——— 5 per cent. Mortgage Debentures	100	—	96-100
British Electric Works, Ordinary, 50,001-95,000	1	—	⅞-1
——— 6 per cent. Cum. Pref., 1-50,000	1	—	⅞-1
——— 4½ per cent. First Mortgage Debentures	100	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5⅛
Brush Electrical Engineering, Ordinary	2	—	1⅝-1⅞
——— Non. Cum., 6 per cent. Pref.	2	—	2-2⅛
——— 4½ per cent. Debenture Stock	100	..	108-111
——— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures	100	—	110-114
——— Ordinary	5	—	12½-13½
——— 5 per cent. Pref.	5	—	6-6½
Crompton and Co.	2	—	3½ 4
——— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	2	—	1⅞-2⅛
——— 5 per cent. Debentures	5	—	3¾-4¼
——— 4 per cent. Deb. Stock, Red.	100	—	90-92
——— 5 per cent. Second Deb. Stk., Prov. Crts.	70	—	96-100
Electric Construction	2	—	2-2⅛
——— 7 per cent. Cumulative Pref.	2	—	2⅜-2½
——— 6 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-13½
——— 4½ per cent. Preference	5	—	5½-6½
——— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	20½ 21½
——— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	12	—	36 41
——— 5 per cent. Bonds	100	—	101 104
Telegraph Manufacturing, Ordinary	5	—	10½-11¼
——— 5 per cent. Cum. Pref.	5	—	5½-6½
Willans and Robinson, Ordinary, 1-30,000	5	—	10⅜-11⅛
——— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6½-7¼
——— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	—	⅞-1
Bournemouth and Poole, Ordinary	10	..	12½-13½
——— 4½ per cent. Cum. Pref.	10	—	10-11
——— Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	—	7-8
——— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6½-6¾ xd
Charing Cross and Strand	5	..	9¾-10¼
——— 4½ per cent. Cum. Pref.	5	—	5¼-6
Chelsea Electricity Supply	5	—	6-6½
——— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	8½-9½
——— 6 per cent. Cumulative Pref.	10	—	7⅞ 8½
——— 5 per cent. Debenture Stock	100	—	125- 130
County of London and Brush Provincial, Ordinary	10	—	8¾-9½
——— 6 per cent. Cum. Pref.	10	—	11-12
——— 4½ per cent. Debentures Prov. Certs. All pd. Red.	—	—	108 111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¾-5
——— 4½ per cent. First Mort. Deb.	100	—	101-104
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	—	5¼-6
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10½
London Electric, Ordinary	2	—	1⅞ 2¼
——— 6 per cent. Pref.	5	—	4¾-5¾
——— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-102
Metropolitan, Ordinary	10	—	13 14
——— 4½ per cent. First Mortgage Debenture Stock	100	—	112 115
——— 3½ per cent. Mortgage Debenture, Red	100	—	97-100
Notting Hill Electric Lighting	10	—	14½ 15½
Oriental, 1879	1	—	1¼ 1⅜
——— £5 Shares	5	—	7-7½
——— £4½ Shares, New	4½	—	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	—	180 200
——— 4½ per cent. First Shares Mortgage Debentures	$100	..	102 104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
——— 4 per cent. Debenture Stock	100	—	85-95
South London, Ordinary	2	—	2½-3⅛
St. James's and Pall Mall, Ordinary, 101-30,080	5	—	15-16
——— 7 per cent. Pref.	5	—	8-9
——— 3½ per cent. Deb.	100	—	100-103
Westminster, Ordinary	5	—	12 13
——— 30,001-109,437	5	—	11½-12½
Electric Railways.—			
Central London, Ordinary	10	—	10½-10⅝
——— Pref. Half-Shares	5	—	5-5½
——— " " deferred	5	—	5 5½
City and South London, Consolidated Ordinary	100	—	54-58
——— Ordinary	10	—	4½-5¼
——— 4 per cent. Debenture Stock	100	—	118 122
——— 5 per cent. Pref. Stock '91	100	—	138 143
——— " " " '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	12-12½
Waterloo and City, Ordinary	100	—	92 95
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9¾-10½
British Electric Traction, Ordinary	10	—	13½-14½
——— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
——— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4¾-5¼
——— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4-4¼
——— 5 per cent. Deb. Stock, Red.	100	—	104-107
——— Prov. Cert., all paid	—	—	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9¾-10½
New General Traction, Ordinary	5	—	3¾ 4
——— 6 per cent. Cum. Pref.	5	—	4¾-5
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17½
——— 5 per cent. Cum. Pref.	10	—	10½-10⅞
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11-12
——— 5 per cent. Cum. Pref., 1-20,000	10	—	9¾-10¼
——— 4½ per cent. Debenture Stock	100	—	102-105 xd
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4¾
——— 6 per cent. Cum. First Pref.	10	—	13-15
——— 6 per cent. Cum. Second Pref.	10	—	13-15
——— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
——— 4 per cent. Deb. Stock, Red.	100	—	101-104
——— 3½ per cent. Deb. Stock, Red.	100	—	96 99
Oriental Telephone and Electric Company	1	—	⅞-1⅛

Digitized by Google

NOTES.

The Electrical Engineers Volunteers.—We are pleased to note that the Secretary for War has approved of the corps of Electrical Engineers Volunteers borrowing £6,000 from the Public Works Loan Commissioners for the construction of headquarters buildings. From this it will be seen that the value of the corps appears to be fully recognised in official quarters.

Alaskan Cables. — Telegraphic communication has now been established between Nome and St. Michael's. The cable in question was laid by the Alaska Commercial Company, who used the side-wheel steamer "Sadie" as a cable ship. The charge for transmission of messages over this line is 8s. 4d. for 10 words. The new line will be of great value to North Alaska. It is reported that the telegraph line from Skagway down the Yukon to Dawson is nearly completed, but will not be open for traffic this winter.

Milking Boosters. — The *West Sussex Gazette* is responsible for the following interesting note: "What is a 'milking booster'? Some members of the Worthing Corporation are curious to know. They have ordered two for their electric light undertaking, and don't believe in buying pigs in pokes. The chairman of the special committee was asked for a definition. He says a 'milking booster' occupies the same position at electric lighting works as champagne at a public dinner. A prominent teetotaller who sits on the Council thinks that, if such is the case, the town might spend their money much more profitably than on 'milking boosters.'"

The Manufacture of Cordite.—The Government of India, having recognised the greater advantage and safety of electricity in the manufacture of cordite, have, we learn, recently advertised for tenders for the supply of a complete electrical installation at their cordite factory in the Nilgivi Hills. The power is to be obtained from one of the numerous waterfalls in the neighbourhood of the factory, and the generator is to have about 500 kw. capacity. The installation is to include a complete plant of generators, motors, transformers, cables, transmission line, etc. The distance over which the power will have to be transmitted is about three miles. An hydraulic plant is also to be installed, the power which it will be required to develop being equal to 500 h.p. from a waterfall about 600ft. in height.

The Negro Question.—The recent attempt made in the New Orleans City Council to pass a street-car regulation to provide for the separation of negroes and whites in the tramcars of the town, shows how strong is the feeling over the negro question in certain parts of the States. The attempt was abandoned, and we are informed by the *Electrical World* that it has been tried without success in other southern towns. The usual effect was to prevent negroes from travelling on the cars, thus causing considerable loss of revenue. There was also the difficulty that a white man would not wait if he was in a hurry, but would board a car reserved for negroes only. The greatest trouble, however, seems to have been that the conductor of the car was made responsible as to the colour of his passengers. Reading between the lines, we suppose that errors of judgment were likely to lead to funerals.

Electric Belts.—The following is an extract from the *Lancet* of last week, and raises the question as to whether an advertisement constitutes a warranty: "In the Westminster County Court on Tuesday last, before Judge Lumley Smith, Messrs. Pulvermacher, Limited, electric belt makers, of Regent-street, W., brought an action for four guineas, the balance of the purchase money of an electric belt supplied to Mr. H. Mott, of Oxford. Mr. Mott was led to write to Messrs. Pulvermacher by advertisement, and paid one guinea on account of a five-guinea belt described as 'doubly concentrated.' The belt in no way relieved his symptoms of migraine and irritability, but rather, in his opinion, made him worse. So he returned it. Judge Lumley Smith held that the advertisement of their belt issued by Messrs. Pulvermacher was a warranty to cure 'all the ills that flesh is heir to.' As the defendant was not benefited by the belt, he found in his favour, but did not give him costs."

London Electric Lighting Committees.—We are pleased to see that the new metropolitan borough councils are, in the election of their electric lighting committees, striving to preserve a certain amount of continuity. We think we can safely say that in every case where possible the members of the old vestries who served on the electric lighting committees have been placed on the similar committees of the new councils, if they were qualified by election. Of course, with the great reduction in the number of representatives, a number of old electric lighting committee men have fallen out of office. We are very pleased to note that the electric lighting committees are being reduced in number; sometimes this reduction is nearly as much as 50 per cent. We are quite sure that the smaller committees will be much more efficient than the old vestry committees used to be. A small working committee is much less likely to fall into personal wrangling than is a large one, in which there is no actual work for the great majority of the members to do.

Automobile and Cycle Exhibition. — We are informed by Mr. G. Rives, the president of the organisation committee, that an international exhibition of automobiles and cycles is to be held in Paris early next year. The exhibition is being organised by the following associations jointly: La Chambre Syndicate du Cycle et de l'Automobile, La Chambre Syndicate de l'Automobile, Le Syndicat des Fabricants de Cycles, Le Syndicat Français de l'Industrie General des Cycles, and the Automobile Club de France. All these have joined in promoting the success of the exhibition, which will be held in the Grand Palais des Champs-Elysées. The exhibition is to open on Jan. 21, and will last until Feb. 17, 1901. Applications for space will be received up to Jan. 3, and on Jan. 8 the various positions to be allotted will be determined by ballot amongst the various applicants. We think this is an exceedingly fair way of deciding who shall have the more prominent places. All communications should be addressed to the Commissionaire Général, Automobile Club, 6, Place de la Concorde, Paris.

Electrical Engineers Volunteers.—We are pleased to hear that the Electrical Engineers (Royal Engineers) Volunteers are organising a dinner to their South African detachment, which is soon expected home. All being well, the dinner will be held at the Trocadero Restaurant on Saturday, Dec. 15, and it will be followed by a smoking concert. The South African detachment will, of course, be the guests of the evening. The committee having the matter in hand are: Messrs. R. S. Erskine, major commanding E.E.R.E.V.; S. B. Marshall, Q.M.S., hon. treasurer; G. A. Poynton, C.S.M., chairman; and H. A. Barnett, sapper, hon. secretary. On the Monday following, another dinner in the Prince's Restaurant is to be given to the detachment, which dinner is being organised in the same way as the send-off dinner. Mr. Henry Edmunds, of 2, Queen Anne's-gate, is hon. treasurer, and will be glad to receive the names of gentlemen who wish to act as hosts in place of any of the original hosts who may be unable to attend.

Digitized by Google

The subscription of each host, covering the cost of his own dinner, inclusive of wine, will be two guineas.

Acetelyne Flame as a Standard.—An interesting paper on the above subject by Dr. E. N. Nichols appears in the Franklin Institute's *Journal*. The author has undertaken a vast amount of work in order to prove the advantages and disadvantages of the acetelyne flame as a standard for photometric work. The whiteness of the flame makes it a very suitable standard to compare arc lamps with. The author, however, shows that the gas loses its illuminating qualities when stored, and that the illuminating qualities are largely dependent on the construction of the generator in which the carbide of calcium is converted into acetylene—*e.g.*, he shows that in one case acetylene gas was stored for five months in a gas-holder over water, and that at the end of that time it only retained 6 per cent. of its illuminating properties. He also found that the gas obtained by what is known as the wet process, was much more efficient as a light giver than that produced from the dry process. In spite of these drawbacks, Prof. Nichols thinks that good use may be made of the acetylene flame if simple precautions are taken.

Electric Fire Risks.—It is a curious thing that the same week that the editorial on the dangers of the electric light appears in the *Lancet* we should receive from another source a pamphlet on "London Fires and the Electric Light." This is prepared by Mr. John Bate, of Hammersmith, and contains extracts from the annual report of the London Fire Brigade for 1899. These extracts show that there were 312 fires caused by the use of gas, 292 fires from the use of oil lamps, and 18 fires from the use of the electric current. Mr. Bate also calls attention to the fact that there is a great increase in the use of electricity during the year, which, with a corresponding increase in the risks in view of the above figures, he considers should induce insurance companies to reduce their heavy risk rates upon warehouses, factories, and shops where electricity is the illuminant. With a view of bringing pressure to bear upon these companies to that end, he suggests that combined insurance by corporations should be started. We would commend this pamphlet to the editor of the *Lancet*, and wonder how he will be able to reconcile it with his opinion so publicly expressed.

Institution of Electrical Engineers.—We hear from the secretary of the Institution of Electrical Engineers that if the discussion on Mr. Langdon's paper on "The Supersession of the Steam by the Electric Locomotive" was not completed last night, another special meeting is to be held next week. The Institution of Mechanical Engineers have kindly offered the use of their lecture theatre again for Thursday, Dec. 6, when the discussion would be resumed. We also hear from the secretary of the Students' Section of the Institution of Electrical Engineers that the visit of students to the electrical laboratory of the Board of Trade is intended for those who are not attending any London technical colleges. The number of a party who will be shown over this laboratory is strictly limited to six. Mr. L. R. Lester, the honorary secretary of the Students' Section, therefore requests that applications from those who wish to attend this visit should be sent in before the 6th proximo. The laboratory itself, situated at 8, Richmond-terrace, Whitehall, is well worthy of a visit, and we shall be surprised if the applicants do not amount to several times the number which can be admitted.

Bradford Electricity Department.—On the 16th inst. the first smoking concert in connection with the Bradford Corporation electricity department was held at the Queen's Hotel, under the chairmanship of Mr. R. H. Chattock, the electrical engineer of Bradford. The employés of the department were responsible for the programme, which was a very extensive one, including no less than 22 items. Mr. A. H. Gibbings, the late electrical engineer of the town, took the vice-chair, and a number of the Electricity Committee were also present. All classes of the employés of the department were represented, but all could not be present, as all were not free from duty at the time the concert was held. Other two concerts are being arranged in order that every member of the staff shall have an opportunity of being present. The works at Bradford are now so large that it is necessary to run three shifts, and this is the only way that the concert committee were able to ensure that all members of the staff should have an equal chance of deriving benefit from the entertainment. The annual subscription is fixed at 1s. Undertakings like this do much to promote friendship amongst the staff, and are, in consequence, to be highly recommended.

American Electro-Therapeutic Association.—We have received from the secretary of the above the list of officers of the association for the ensuing year. These appointments were effected at the tenth annual meeting held in New York in September last. The president is Dr. Ernest Wonde, while Dr. F. H. Morse is the vice-president. The secretary is Dr. G. E. Bill. The offices of the association are at 17, South Third-street, Harrisburg, Penn. We notice that the association has appointed a good number of committees for the ensuing year, and we should say that the idea is a good one if the gentlemen will give up any considerable amount of time to the subjects on the committees concerning which they are appointed. There is a committee on induction coils and alternators, another on electrodes, a third on meters. Amongst the list there are also other sub-committees on static machines and condensers, on electric lighting apparatus for diagnosis, etc., on cotopheresis, on constant-current generators and controllers. The remaining four committees deal more with the internal arrangements of the society itself. The long list of names makes one rather inclined to doubt whether in England an equal number of medical men could be found to give up their time to the advancement of electro-therapeutic treatment.

Sir William Preece on Telegraphy.—On Monday last Sir William H. Preece delivered a lecture in the new physical laboratories at Owens College, Manchester, taking for his subject "Intercommunication by Means of Electricity." This lecture is the fourth of a series which have been arranged at Owens College to illustrate the principal advantages which have been derived from physical science during the nineteenth century. Sir William Preece's name and reputation as a successful lecturer resulted in a crowded room, a number of those present being unable to find seats. The lecture, which was ably delivered, covered the history of the telegraph from its earliest days. The credit of discovering the principles of the telegraph was given to Faraday, and Sir William Preece proceeded to detail the various stages of improvement which had been made since the first line was set up on the London and North-Western Railway between Euston and Camden Town. The telephone was also alluded to by Sir William, who gave statistics as to the growth of this, and also of the increase of telegraph messages during the last 50 years. He showed how the various duplex, quadruplex, and multiplex systems of telegraphy had enabled the line wires already erected to be used for a largely extended service. The last portion of the lecture was devoted to wireless telegraphy, but Sir

Digitized by Google

William Preece's views on this are so well known to our readers that we will not refer to those details.

The Bucking of Large Shunt-Wound Motors.—There being comparatively few shunt-wound motors in use of over 100 h.p., the action of such large machines is not at all familiar to electricians. The Metropolitan Street Railway of Kansas City, however, uses a 300-kw. motor which operates cable machinery pulling about 24,000ft. of cable. There are two motors of this size, one being held in reserve. When the company built its new power-house it was reckoned that a considerable amount of money might be saved by doing away with the steam plant which was then running the Ninth-street cable, and which was proved to be very uneconomical, and operating the cable by electric motors supplied with current from the new central station. When the motors were installed, however, a great difficulty arose in connection with them. The load on the tramway service was naturally very variable, and when sudden loads were thrown on, the motor promptly bucked and sparked considerably at the commutator. The difficulty was so great that had not a remedy been found for it electrical driving would have had to be discontinued. The remedy consisted in the use of a series winding on the field magnet of such direction as to strengthen the fields with increasing load on the motor. The result of this winding is that the motors are almost sparkless in running, and give no trouble from bucking. The phenomenon of "bucking," according to Mr. C. Grover, the company's electrician, is caused in the following way: The brushes are, of course, set at sparkless position for light loads. When the sudden heavy load comes on, the great rush of armature current tends to overbalance the field magnetisation, which is constant, to such an extent that the field flux is greatly distorted. So much is this so that the effect is the same as if the brushes were suddenly taken away from the neutral point, in consequence of which the machine bucks.

Porto Rico Telegraphs.—At the next regular session of the United States Congress the question of the telegraph and telephone service in Porto Rico will probably be taken in hand. The need for a thorough overhauling of both systems is great, as, when the place was taken over by the Americans after the Hispano-American war, the service was in a most dilapidated condition, and it was only owing to the great efforts made by the Army Signal Corps that communication was at all possible between the various important points on the islands. The Army Signal Corps still have the lines under their charge, and General Greely, chief signal officer, has, in a report addressed to the chairman of the Committee on the Pacific Islands and Porto Rico, made several suggestions as to their disposal. In his report General Greely gives an outline of the history of the telegraphic and telephonic undertakings in Porto Rico. Thus, in November, 1866, after some five years of consideration of the estimates, the construction of the lines was started, and after 14 years from the first movement towards obtaining a service—*i.e.*, in 1874—the service, with about 800 miles of lines, was completed. This service was the one in operation when the Americans came on the scene, and the work was taken over by the Signal Corps. Working with the Signal Corps would naturally be the cheapest method of operation, but owing to a cyclone and to the small amount of business done, the lines have not paid their expenses. General Greely thinks that there are three courses open for the disposal of the lines. The first is the operation of the lines by the Post Office, as was done by Spain in the past; the second, the transfer of the lines to the insular Government, with a view to their operation and maintenance at the expense of Porto Rico; and the third, their operation and maintenance, as at present, as military telegraph lines. The first and second plans do not recommend themselves to General Greely, as they would both entail a large expenditure of the public money of the United States, but the third method seems to him the easiest and most natural solution of the question, as Porto Rico must be garrisoned by regular troops, and as it is a detached island, it is desirable to have the telegraph and telephone lines in the hands of the army. The sale and condemnation of lines which are not of military importance and of no real public value, would then gradually be carried out.

Berlin Electricity Works. — The progress of electric lighting and power in Berlin continues apace. During the financial year just ended, the Berlin central stations proper have alone generated an aggregate of 52,014,612 units of electrical energy, which represents an increase of 53 per cent. over the figures for the previous year. The number of consumers has increased from 6,093 to 6,683, the latter representing a connection of 303,304 incandescent lamps, 12,396 arc lamps, 4,964 motors, and 676 miscellaneous current-consuming apparatus, or a total equivalent of 36,350 kw. Compared with the figures for the previous year, the actual increases have been 35,100 incandescent lamps, 1,384 arc lamps, 1,106 motors, and 109 miscellaneous apparatus, or a total equivalent of 4,920 kw. The Berlin tramways accounted for a further 8,000 h.p. of the energy generated. The demand for lighting, power, and tramway purposes represented respectively 28, 24, and 48 per cent. of the total output accounted for. For supplying the outlying suburbs of Berlin, two stations, situated respectively in Spandau and Pankow, have been erected, in addition to the Oberspree works. From these stations current is distributed to 13,080 incandescent lamps, 915 private arc lamps and 800 motors, representing an aggregate output of 6,322 h.p., besides to 1,245 incandescent lamps and 34 arc lamps used for public lighting, these several items not being included in the figures relating to the supply in Berlin proper given above. The prevailing high price of fuel has given rise to the serious consideration of an increased scale of charges for motor power in Berlin, but it has been decided to refrain for the present from such a step in anticipation of an early drop. How seriously a rise in the price of electrical energy for power purposes in Berlin would affect local industries may be judged from the very large number of motors connected. Large extensions of plant are in progress at several of the generating stations, and in this connection it is interesting to note the very large unit of plant which has been generally adopted for these extensions. Of three new 4,000-h.p. steam alternators for the Oberspree works, two are already running, while the third is nearly completed. Three sets of similar capacity are being mounted in another of the stations, while a fourth set is on order for each. The machines, it may be mentioned in conclusion, are being supplied by the Allgemeine Elektricitäts-Gesellschaft.

Society of Arts.—At the opening meeting of the new session of the Society of Arts, held on Wednesday week, Sir John Evans, K.C.B., F.R.S., delivered his inaugural address. He chose for his subject "The Origin, Development, and Aims of our Scientific Societies." He showed that the earliest records of the collective action of individuals for the promotion of science showed that amongst the Greeks and Romans there were colleges formed with this object. The guilds of the Saxon times and the livery companies of London also acted somewhat as scientific societies, as they were formed to promote special trades and industries. The first learned society in England to

Digitized by Google

receive a Royal charter was the Royal Society, which was incorporated in 1662; the Society of Antiquarians had a later history, dating back to 1572, but this society had not had a continuous life. Sir John Evans showed that these earlier societies partook rather more of the nature of clubs than did the societies of the present day. Some interesting facts were culled from the records of the early years of the Royal Society after its incorporation, in order to show what great progress had been made since then—*e.g.*, at that time magnetism and electricity presented almost untrodden fields; the variation of the compass had indeed been observed, but little else was known about terrestrial magnetism. Sir John Evans proceeded in his address to sketch the inauguration of the present Society of Arts and the formation of the various other scientific and engineering societies, which were in their early days intimately connected with one or other of the three above-mentioned societies. There was no doubt, he held, that individual effort could not do alone what the collective efforts of a number of individuals interested in the same subjects had been able to accomplish; thus, while the prominent members of any society were responsible for the progress made, there was also a reflex action. Thus, "without Davy, Faraday, or Tyndall, the Royal Institution would never have become the important body it now is. But without the Royal Institution neither Davy nor Faraday would have had any opportunity for carrying out their scientific work, and of obtaining their scientific reputation, and perhaps the same may be said to a certain extent of Dr. Tyndall." In conclusion, Sir John Evans expressed his view that it was better for a society to do regular and consistent work than to be subject to a fitful energy, which would devise new ways instead of gradually improving the old. The meeting closed by a vote of thanks to the chairman for his address, which vote was proposed by Sir John Wolfe Barry and seconded by Sir Fredk. Bramwell.

New South Wales Electric Tramways.—We have received the report of the Railway Commissioners of the New South Wales Government on the railways and tramways in the colony for the year ended June 30, 1900. We are pleased to note that the electric tramways are being rapidly extended, and are meeting with every success. During the past year 43 steam cars in Sydney alone have been replaced by electric cars, and 133 new electric cars have been obtained for use on the various lines throughout the country. In Sydney particularly the electric cars and the regular service have greatly increased the traffic; on one line alone an average of 70,000 persons are carried each week-day (the route in question is between the railway station and the Circular Quay). These figures can be compared with interest with the traffic returns on the Central London Railway, which are not so very much greater. The return shows that the total number of passengers conveyed by the electric trams since the opening of the George and Harris street line on Dec. 8, and the conversion of the Dulwich-hill and St. Peter's line on April 2 last, was over 13,000,000. The result has been a certain amount of overcrowding in the early morning and in the evening. This overcrowding was prevented to a certain extent by running steam trams amongst the electric, but they were poorly patronised, the public preferring the inconvenience of the overcrowding rather than go on the steam cars. New lines are proposed to be constructed to avoid this overcrowding on routes in which the services cannot be increased, and the Commissioners urge that the construction of these lines should be pushed forward with all possible dispatch. On other lines also recently converted from steam to electric traction, and on which at the same time reductions in fares were made, satisfactory results have been obtained, but they are not always run at a profit. This is not likely to be the case in the first instance, but we are sure that the policy of the Commissioners is the correct one. It is more advantageous to the population that a large number should be served with good means of intercommunication at a cheap rate than that a small profit should be made out of a dear service to a few only. Since the running of the tramways by electric traction an unusually large number of street accidents have occurred, but the Commissioners add that in almost every instance these have been due to want of care on the part of the injured persons. This same result as regards accidents is to be found in every town directly after tramways are introduced, or have the speed and service increased, whether they are run by steam, electricity, or cable.

The St. Lawrence Power Scheme.—Special interest centres round the St. Lawrence Power Company's scheme, in that English engineers have been retained to advise the company on their electrical plant. We gather from the notices in the American Press that a number of technical papers were recently invited to send representatives to view the works as already constructed. From the reports of the various representatives we learn that good progress is being made, and that of the canal which is to convey the water of the St. Lawrence River to the Grasse River, the greater portion has been constructed. Thus, out of about 6,000,000 cubic yards of excavation, 4,500,000 have been removed, and it is thought that the canal will be ready for use next spring. The concrete work at the power-house is completed, and the building is roofed in; the turbines and generators are now being erected. It will be remembered that at the time when the company was first started, Messrs. Kincaid, Waller, and Manville, the consulting engineers in England, furnished us with the details of the plant to be supplied. These details have not been varied to any appreciable extent, but great care has been bestowed on the designing of the switchboard. With generating units of 5,000 h.p., the section of cables required for each generator of the size of the switch gear becomes somewhat excessive. To group all this switch gear together on the one switchboard would result in this board being too big to be conveniently operated. It would also be so large that the engineer in control could not readily grasp what was being done by the various machines in the station. To avoid this difficulty the switch gear for each individual machine is placed near it, and is controlled from a central spot by means of compressed air. The operator, then, has the various electrical instruments connected to each machine placed round in a conveniently small circle, so that they are all under his eye, and he can control the switch gear or regulating rheostat of any alternator much more easily than if he worked it direct. These pneumatic relays have been raised to great perfection by the Westinghouse Manufacturing Company, who are supplying the plant. It will be remembered that in this instance the civil engineering works are comparatively simple compared to what has had to be undertaken in other cases where large water power is available. About 75,000 h.p. will be the capacity of the present works, but they can be easily extended to give twice that output. Although the situation is one from which transmission is economically possible to a number of towns, the main object of the company is to supply power at such low rates as to induce new manufacturing establishments to be started in the near neighbourhood.

The "Lancet" Editorial.—We have elsewhere in this issue referred in terms of approbation to an editorial appearing in last week's *Lancet*, but we have now to express

Digitized by Google

our regret that the editor of an important and influential paper like the *Lancet* should write such utter rubbish as appeared in its editorial last week headed "The Dangers of Electric Light." That there are dangers from electric installations if wired in a bad way by irresponsible firms we should be the last to contradict, but still, if all the installations in London were carried out in this way, they would be better than those in an average Continental town, where electricity is still safer than any other illuminant. Even as the word "electricity" has been used by the daily Press as one to conjure with, even so it is now used where possible in notes of another character. For instance, electric tramcar accidents in which electricity plays no part whatever are being prominently advertised throughout the country, and one hears from untechnical people statements as to the danger of electric traction. If a man is killed in the London streets by a dray it finds no mention in the daily Press, but if a man falls off an electric tramcar electricity is blamed. To return to the editorial article in the *Lancet*; the writer displays a complete want of knowledge, as will be gathered from the following extracts: "It is common knowledge now that an otherwise innocent current—that is, one of low voltage—may through certain defects become an exceedingly dangerous current of enormous voltage. Earthing is, of course, the main source of trouble and the generally offered excuse, but if electric lighting is to be our mode of obtaining artificial light earthing must be overcome, and it seems to us that earthing has not been overcome—it is happening on all sides, and in several instances with most alarming results." The article then comments on a case in Regent-street, where in a photographic studio the electric current was said to be sufficient to light St. Pancras Station. The writer proceeds to compare this large current to a large reservoir of water, and concludes that there ought to be some means in restricting the quantity of electricity allowed on the premises. We suppose he knows what he means, but it is quite impossible to tell what this is from what is written. Reverting to the question of earthing, the article goes on to say: "In our own experience, earthing is constantly happening, and it is well known that in this manner a very high and dangerous current may be tapped by telephone wires, gas-pipes, or ordinary voltage electric cables." The climax is reached when the editor asks for Board of Trade regulations to be made and rigidly enforced, and for all cables and wires to be placed in separate tubes and return wires provided. One can only conclude that the editor thinks electric light installations in London are run on an earth return. He would perhaps be surprised to hear that most effective rules have been issued by practically all the fire insurance companies and by the Institution of Electrical Engineers. It is only the carelessness of the individuals using the electric light which prevent these rules being enforced. We repeat that we are exceedingly suprised that such an incompetent article should appear in the *Lancet*, and trust that its editor will see fit to apologise to the electrical profession for the misleading conclusions he has published.

Liquid Fuel.—At the ordinary meeting of the North-East Coast Institution of Engineers and Shipbuilders, Mr. E. L. Orde read a very interesting paper on "Liquid Fuel." In this he said that as new oilfields had been recently discovered and the cost of transit cheapened, it had become a serious question for shipowners to consider whether it would not be economical to use oil instead of coal on vessels trading towards the East. The solution of the question, he thought, lay, first, in the cost of the fuel and its practical calorific value as compared with coal; secondly, in its effect on the life of the boiler furnaces in which it was burnt; and thirdly, and perhaps the most important of all, its immunity from danger. The first point was, of course, constantly varying, and the other two practically resolved themselves into one—the efficient combustion of the fuel. The existing appliances designed for the purpose might be broadly divided into three—viz., those in which the liquid fuel was injected into the furnace in the form of a spray by purely mechanical means; those in which the spray was produced by the introduction of a gaseous medium; and where the liquid fuel was introduced into the furnace in the form of vapour. The experiments carried out by the author were made with crude Borneo oil, which was good fuel oil. The flash point of this oil was 211deg. F., and its calorific value 18,831 British thermal units. In the first type of apparatus for burning the oil, the mechanical spray, the oil was discharged under pressure into a burner, made so that the oil jet was broken up so as to burn readily at the firing point of the fuel. The advantages of this system were its simplicity and noiselessness. The best results with this type of apparatus showed an evaporative efficiency of about 12·5lb. of water per pound of fuel at 212deg. F. With the Borneo oil this gave a fuel efficiency of 64·6 per cent. In the second type, in which the oil is introduced into the furnace in the form of a spray in the presence of a gaseous medium, either steam or air, the best evaporative efficiency was between 13lb. and 14lb. of water from 1lb. of oil at 212deg. F. The third class, in which the liquid is introduced as a vapour, the author thought promised the best results, as an evaporation of from 15lb. to 16lb. at 212deg. F. should always be obtained with dry Borneo oil. The general conclusions produced from the investigations the author made were that liquid fuel of good quality, such, for instance, as Borneo oil, used in boiler furnaces, if efficiently treated, should show a reduction in consumption of about 40 per cent. as compared with coal; a reduction in bunker space of about 15 per cent. for the same weight of fuel could be made, and a reduction of about 50 per cent. for the same radius of action. There could also be a reduction in the stokehold staff of at least 50 per cent. The advantages of liquid fuel in case of manipulation, cleanliness, absence of smoke, reduced temperature of stokehold as compared with coal, increased life of boilers owing to constant temperature, improved performance of engines owing to constant steam pressure, were obvious, but the question of immunity from danger required some consideration. With a fuel oil of which the flash point is 200deg. F. or over there should be no risk of explosion whatever, and unless there is want of ordinary care in the management of the burning apparatus and the fuel supply, the danger of fire ought not to exist. Still, fires had occurred, and it might be well to consider the causes from which they had originated. The most fruitful cause appeared to be intermittent action of the burning apparatus. This might arise from dirt in the oil or from the presence of water. To get rid of the dirt it is only necessary to provide an efficient filtering apparatus, and this should form a part of all liquid fuel installations. The second cause, the presence of water, presented a more difficult problem. All crude oils had a certain proportion of water intimately mixed with them, and as the specific gravity of most fuel oils was from ·9 to ·98, and in the case of some shale oils even higher, it was obviously exceedingly difficult to eliminate this water by gravitation unless the temperature of the mixture was comparatively high. The expansion of oil under increase of temperature was considerably greater than that of water, and some arrangement whereby heat could be applied to the contents of the bunker seemed to be necessary where crude oil was used.

Digitized by Google

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Continued from page 736.)

It has been shown that by inserting an iron core into a solenoid the magnetic effect of the solenoid is very greatly increased, this being due to the fact that iron offers an easier path to the lines of force than air does; now the inductors lying in a slotted drum, surrounded on three sides by iron, and only separated on the fourth by a very short air-gap, the self-induction will be enormously increased, as the lines travel along a path of small reluctance. Fig. 23 shows the difference in the two paths for a slotted and smooth core, and it is self-evident that the self-induction effects would be still further increased if the armature be made of the perforated or tunnel type, which is sometimes adopted. We have seen that one of the fundamental principles is that $C = \frac{E}{R}$, and that this holds good in every case; and we have further seen that, owing to the very small amount of resistance which any individual armature coil has, a very low number of lines of force cut per unit time is sufficient to induce an E.M.F. which is of ample value to cause a large short-circuited current to flow round the coil. This E.M.F. may be produced either by the inductor cutting the forward lines of force, or from the effects of self-induction. If, however, the resistance of the coil were increased, there would be a great reduction in the value of the induced current, although the E.M.F. induced would be the same as previously was the case, and

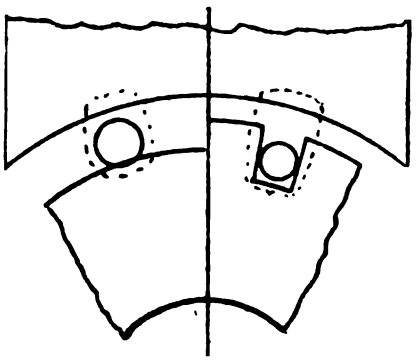


FIG. 23.

R would not require to be of very great dimensions before the value of the induced short-circuit current would be negligible.

The formula given previously, that $\frac{E \times 10^8 \times 60}{N \times C_a} = \phi$, may be written $E = \frac{\phi \times N \times C_a}{10^8 \times 60}$. Now if we assume that the self-induction is equivalent to each active length of a single complete coil inductor cutting 10,000,000 lines of force per second, and we substitute these values in the above equation, we shall get $\phi = 10{,}000{,}000$, $C_a = 2$, $N = 1$, or $E = \frac{2 \times 10^7}{10^8} = 0.2$ volt.

Mr. A. E. Wiener, in his "Dynamo-Electric Machines," gives an example of an armature wound with 84 complete coils and having a resistance of 0·0146 ohm. The resistance of each individual coil will be equal to $0.0146 \times 4 \div 84 = 0.0007$ ohm approximately. Inserting the two values $E = 0.2$ and $R = 0.0057$ in the equation, we get $C = \frac{0.2}{0.0007} = 285.7$ amperes. If an external resistance, say, equal to 0·05 ohm, were added in any way to the circuit, we should get $C = \frac{0.2}{0.0507} = 4$ amperes approximately.

Since the watts lost in the armature are equal to $C_a^2 R_a$, where C_a = the total armature current and R_a = the total armature resistance, it would not be advisable to increase the resistance of each coil to the amount stated above; for, taking the same example, and assuming that the current output is 300 amperes, we should have $R_a = 0.0507 \times 84 \div 4 = 1.0647$ and the watts lost 90,000 $\times$ 1·0647 = 95,823 = 129 h.p., in place of watts lost $90{,}000 \times 0.0146 = 1{,}314 = 1.89$ h.p.

It will be seen from Fig. 24 that the armature windings offer a completely closed circuit for the passage of a current, and that the current would only flow down to the commutator in order to pass to the external circuit, but that in order for a coil to be short-circuited on itself by the brush, the path of the current must be down lug *a*, through the corresponding commutator section, through the brush into the next commutator section, and thence along lug *b* into the coil proper again, and hence if the extra resistance of 0·05 ohm were placed anywhere in this external part of the circuit, the total resistance of the armature would only be increased by a very small amount. Now the question arises, where shall this extra resistance be placed? In the brush, either directly or by means of the brush contact; in the commutator sections; or in the lugs? It is often placed in the brush, which is done by utilising carbon in place of gauze brushes, but as the use of these opens up another issue, the adoption of this type will be treated separately. The commutator sections have been made of iron and other high-resistance metals, but the writer believes that the use of these metals for this purpose has now been entirely abandoned; any additional resistance placed in an electrical circuit will increase the heating effect at that point, and, as has been pointed

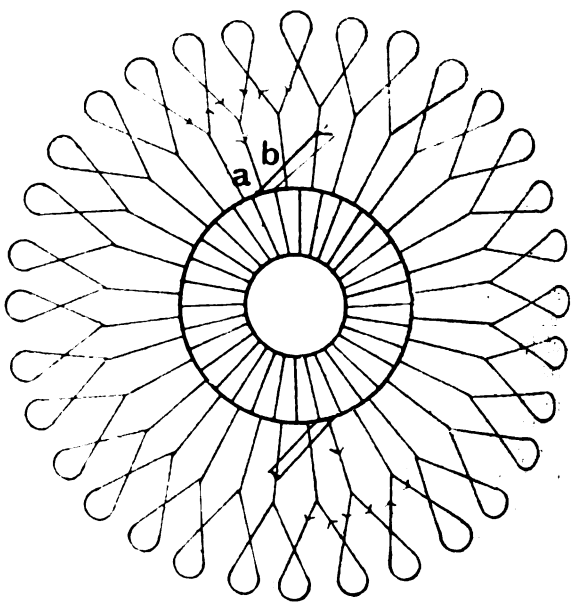


FIG. 24.

out when treating of the mechanical construction of the commutator, it is most inadvisable to do anything which will increase the heat of the commutator. The employment of reostene and other high-resistance metal strips has been suggested for the commutator lugs, and has given good results upon trial. If the lugs are made to have a resistance of 0·05 ohm each, the total increase in the resistance of the armature will be 0·05 ohm, because the current passes to the commutator at the positive brush, as we have seen, through two lugs which are in parallel to each other, and from the commutator to the armature through two lugs at the negative brush, which are also in parallel with each other, but are in series with the two positive lugs. The use of these lugs made of some high-resistance material will then largely damp the self-induction effects; and considering again Fig. 20, if owing to the increased resistance in the circuit of the *d* coil the short-circuited current has not risen to the normal of the *b* series—viz., 100 amperes—it will readily take the additional current required without sparking ensuing between Section 1 and the brush, because not only will there be an increase in the resistance of the path of the main *b* current, but also because the increased resistance of 0·1 ohm (because there are two lugs in the circuit of the *d* short-circuited current) in the *d* coil will prevent the self-induction from offering any great resistance to the growth of the current. Hence, as it will not now be necessary, in order to fulfil the requirements for

Digitized by Google

sparkless commutation, that the *d* coil shall carry exactly 100 amperes at the moment when it passes from under the influence of the brush, and is thrown into the *b* series; and there will be a certain amount of variation in the amount of current which can be sparklessly commutated with the brushes in one position, and a large amount of fixity of lead will be established. It may be necessary to warn the student that the inserting of high-resistance lugs may easily be carried too far, and that it should not be done to any great extent without the warranty of experience.

The substitution of carbon for gauze brushes adds to the resistance of the circuit of the short-circuited coils, not so much because of the increased resistance of the carbon brush as compared with that of a gauze brush, but owing to the imperfect contact of the brush and the commutator.

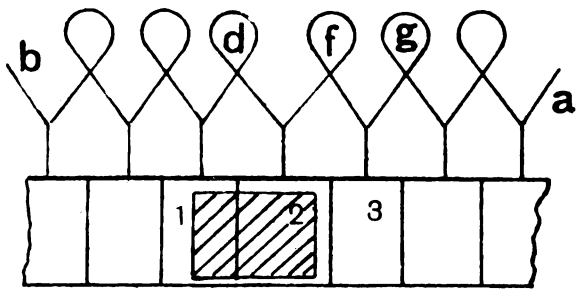


FIG. 25.

However well ground the contact area may be, the resistance of the contact area between copper and carbon is very great. That this has been found to be so in practice is evident from the fact that it has been found necessary to deposit a film of copper on the contact area of any carbon which forms part of any electrical circuit, such as the carbon plates used in batteries, and the faces of the carbon brushes which make contact with the brush-holder.

Now it has been already stated that if the path of a current bifurcates so as to give two parallel paths during part of its length, the current will flow down these paths in a ratio inversely proportionally to the resistances of the two paths, and it is evident that if the resistance of one path were gradually increased, while that of the other remained constant or even decreased, the flow of the current would gradually transfer itself from the path with the increasing resistance to that with the constant resistance, until when the resistance of the first path reached infinity, the current would have all been transferred to the other path. This is what practically occurs with the use of carbon brushes.

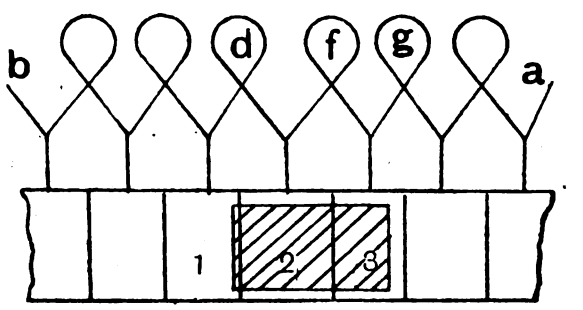


FIG. 26.

Considering again Fig. 20, the *b* main current, were self-induction eliminated, would flow to the brush through lug *w* and through coil *d* and lug *x* in amounts inversely proportional to the resistances of these two paths. Now we have shown that by the use of carbon brushes the self-induction is to a great extent eliminated, and therefore the *b* current may be considered as flowing freely through these two paths; and we have also stated that the resistance added by the use of carbon is not so much due to the specific resistance of the material as to the contact resistance of this substance and copper. Hence the resistance to the flow of any current from a copper plate to a carbon contact will vary inversely as the area of contact. If, then, we assume that the resistance of coil *d* (Fig. 25) to be negligible, the current from *b* will flow to the carbon brush equally through sections 1 and 2; but as the commutator revolves the brush will gradually cover less of section 1 and more of section 2, so that the resistance of the path through section 1 will increase and that through section 2 decrease, and the current will follow the path with the decreasing resistance, until when the condition of affairs shown in Fig. 26 is reached very little current will be flowing through section 1, and this will dwindle away to zero, as section 1 breaks contact with the brush, and there will be no current flowing either from the commutator to the brush or *vice versâ* to break, and hence there will be no sparking.

Although the self-induction has by the insertion of this high resistance been to a large extent overcome, it has not been entirely annihilated, and it will still oppose to a certain extent the increase of the main current through the coil, *d*, and will thus tend to increase the amount of current which flows through section 1, so that if we were to consider the carbon brush as built up of laminations insulated from each other, but making contact at the top of the brush, the current from section 1 would flow through the leading laminations, and that from section 2 through the trailing laminations; then the effect which this weakened self-induction would exercise would be to increase the current density in the leading laminations, and these would have a tendency to increase in temperature more than the trailing sections. This is the result which obtains actually in practice, and shows that the effects of self-induction have not all been removed by the employment of carbon brushes.

It has often been found that the substitution of carbon for gauze brushes has made all the difference between a

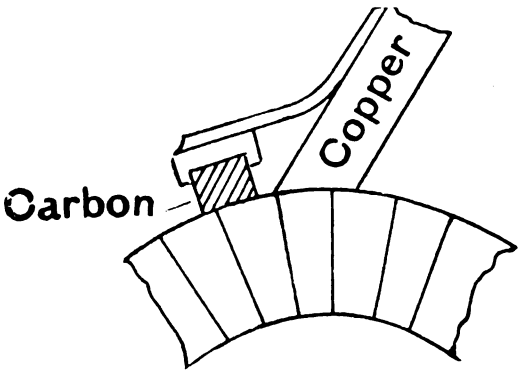


FIG. 27.

sparkless and non-sparkless commutation, but it is not always possible to make this substitution. The current density of the contact area for gauze brushes should be about 125 amperes per square inch, although anything up to 250 amperes per square inch may be permitted, but for carbon brushes the current density per square inch of contact area should be from 30 to 35 amperes, and should in no case be allowed to exceed 50 amperes, otherwise the brushes will get very hot, and the leading edge will soon begin to burn, so that it will be seen that considerably more length of brush line is required for carbon than for gauze brushes. With bipolar machines, this brush line can only be obtained by adding to the length of the commutator, which is a costly matter, but with multipolar machines, especially those for high E.M.F. and low current, the brushes being fixed at each pole, the length of the commutator is not unduly increased. When the length of the brush line is not sufficient to enable carbon brushes to be used, sparking may be sometimes cured by using a gauze brush having a carbon tip on the leading side. Fig. 27 shows one arrangement of this type where the carbon tip is carried by a thin spring copper or brass strip in front of the brush, and it will be readily seen that such a device will act to a great extent similarly to a carbon brush.

When carbon brushes are used, it is most imperative that the commutator be kept free from any superfluous oil or grease. If this is allowed to accumulate it will gradually collect under the soles of the brushes, where it forms a film of a more or less insulating nature, and so prevents the current from being properly collected, and arcing will take place from the commutator to the sides of the brushes,

Digitized by Google

and disastrous sparking, together with bad burning away of the commutator (which is positive to the brush), will ensue. If, however, the brushes are taken off in time, the commutator and the soles of the brushes cleaned, the sparking will disappear. It is also most important, in order to obtain the best results, that the soles of the brushes be properly cut to the curve of the commutator, and that before the machine is run with full load the brushes are properly bedded.

(To be continued.)

THE ARRANGEMENT OF THE DISTRIBUTING NETWORK.

BY CHAS A. GILLIN

The fact that the distributing networks of electricity supply stations do not receive that amount of attention which their circumstances and peculiarities would seem to claim has upon several occasions been referred to in papers and discussions by municipal electrical engineers and others interested in this particular branch of supply station practice; and although it is now receiving far more attention than was formerly the case, yet in many instances there appears to be a great want of system and foresight in the designing and arranging of these networks. This is especially noticeable at the commencement of supply, and the reason is probably not far to seek.

As a general rule, a clerk of works or a resident engineer is appointed to superintend the installation of the whole of the plant, its accessories, and the general equipment of the supply undertaking. This, of course, includes buildings, boilers, engines, generators, switchboards, and the distributing network, besides the usual business connected with the office work, etc.; and it can scarcely be expected that one man in every case can possess the intimate knowledge and experience necessary to lay out each of these essentially different branches of his profession so as to give the maximum amount of satisfaction and efficiency for all time, and the minimum amount of trouble in years to come. Of course, it will be said that this has all been arranged by a consulting engineer, but as a rule he designs only the *general arrangement* or the *scheme* of the undertaking, and merely specifies the majority of things in a general way (although there are consulting engineers who go thoroughly into the whole question).

In the case of the network, it frequently happens that the consulting engineer merely arranges for the distributing mains to be carried along a few of the principal thoroughfares, and arranges the feeding points, without any regard to the future, in places which suggest themselves to him after a few moments' thought as being convenient, and therefore the whole of the work of designing the network devolves upon the resident engineer. Thus when we find all the detail work, and, indeed, a large share of the heavier work, left to a man who has probably had very little experience in that direction, it need scarcely be a matter for astonishment when it is found years later that certain contingencies have arisen which have been unprovided for, but which would undoubtedly have been foreseen by a man experienced in this class of work; and that mistakes were made in expecting certain developments to take place which the man of experience would never have thought of expecting. It is in view of these facts that the writer will endeavour in the following pages to point out what he considers from experience to be the best method of arranging the network in the first instance, and in the system of extension afterwards.

It is not intended to enter into any of the advantages and disadvantages of any particular systems of distribution or to discuss their relative merits, nor is it necessary to enumerate and dwell upon the various conditions, depending upon the nature of the district to be supplied, under which certain systems of distribution are much preferable to others, information upon these points being readily obtainable from papers which have been recently read before the Municipal Electrical Association and other scientific bodies. We will confine ourselves exclusively then to the question of the *arrangement* and *design* of the distributing network, and to deal with the subject in a convenient manner we will consider it under the following heads, some of which are made compulsory by the Board of Trade rules and regulations, the remainder appealing to the engineer either from a purely business point of view or from the standpoint of good engineering practice: (1) uniformity of pressure; (2) maximum variation of pressure; (3) continuance of supply of electric energy; (4) facility in fault localisation.

1. *Uniformity of Pressure.*—The question of the uniformity of pressure is a very important one, not only on account of the Board of Trade regulations, but also from the business point of view, for the effect caused by the contrast produced by the fact of one consumer receiving current at several volts higher pressure than another in close proximity, is neither pleasing to the senses nor conducive to the extensive adoption of the electric light. Perhaps the most common cause of a difference in degree of light in adjacent premises is due to a want of balance in a three-wire system, thus causing an abnormal drop in the neutral wire, and a corresponding difference between the pressures on the positive and negative sides of the system.

Fig. 1 is a diagrammatic sketch illustrating a hypothetical case of this nature. F_+, F_0, and F_- represent the positive,

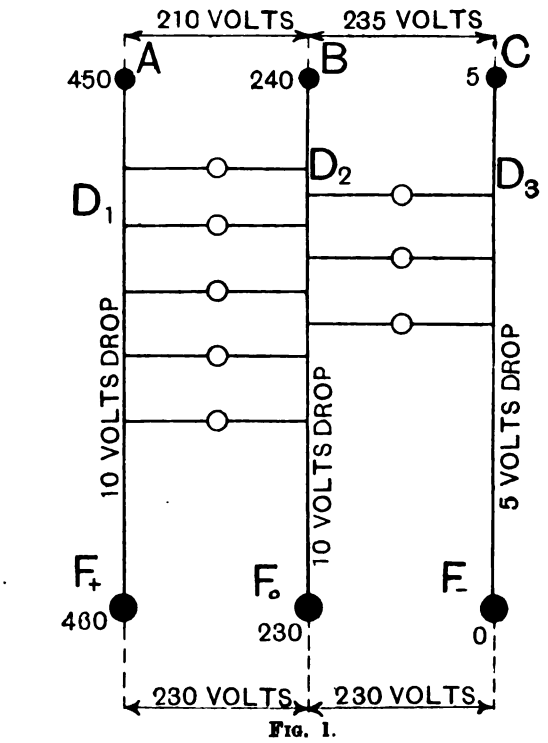


FIG. 1.

centre, and negative feeding boxes respectively, at any feeding point at which the voltage is maintained constant. A, B, C represent distributing boxes at some distance away from the feeding point, and it will be noticed that on the negative side the voltage across the distributors at B and C is higher than that at the negative feeding point. At first sight this appears somewhat paradoxical, but, referring to the sketch, we find that the total voltage across the two outers, A and C, is lower than the total voltage across F_+, F_- by the drop in pressure in the two outers, the drop in the neutral wire making the difference between the pressures across A, B and B, C. By studying the diagram (Fig. 1) the reason will appear obvious, as the voltage is marked at all points, and the drop in volts along the distributors, D_1, D_2, and D_3, is also shown. The only way to avoid want of balance is to observe great discretion in the connecting up of consumers by noticing particularly the probable time of demand and the nature of the load, and balancing consumers against one another in accordance with these observations.

The best method of effecting a good balance over the whole system and its integral parts may be explained by turning to Fig. 2, which illustrates diagrammatically the area of supply, each small square (as further explained in Section 2) representing a section of the network, each section being supplied with current by one feeder at or

Digitized by Google

near its centre—*i.e.*, the centre of the square. Consumers on the same side of each street in each section should be balanced against one another, and any difference in balance on one side of a street should be arranged to be compensated for by any opposing difference in balance on the other side of the same street or in one of the adjacent streets. It is important that the consumers on the same side of the street be balanced against each other, and not the consumers on one side against those on the other side, for by adopting the former method we obtain the minimum

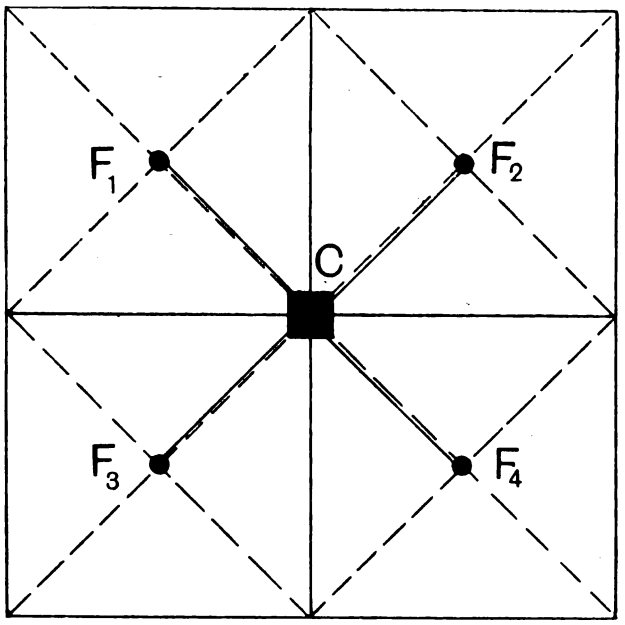


FIG. 2.

of drop of pressure in the distributors. The streets being thus balanced, the whole section containing these streets is, therefore, also well balanced, and, consequently, the load on each side of the feeder for that section should be nearly equalised, thus giving the minimum of drop of pressure on the whole system by the adoption of a systematic method of balancing consumers.

Another cause of a difference in degree of light in adjacent premises is found in towns supplied by a number of isolated networks, each of which networks is supplied by separate feeders; for although the pressure at each feeding point may be the same, yet there may be a great

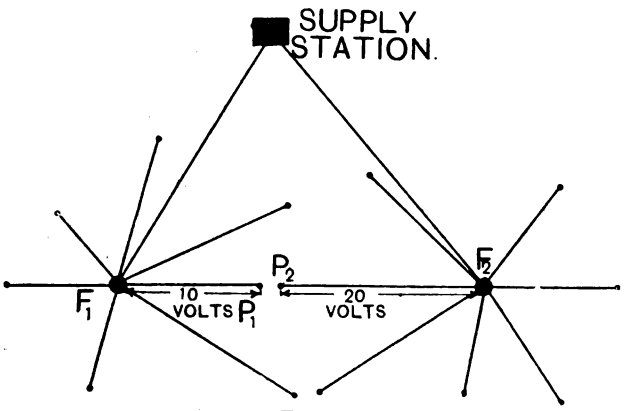


FIG. 3.

difference between the respective pressures at the contiguous ends of the various networks. This will be seen by reference to Fig. 3, where the pressure at the two feeding points, F_1 and F_2, is shown to be the same, but the drop in volts along the distributor, $F_1 P_1$, is greater than the drop in the distributor, $F_2 P_2$, owing to a difference in the amount of current carried by each of these cables, whose sectional areas are equal. The remedy for this state of affairs is purely one of design, and consists of a judicious interconnection of the various distributors of each network, combined with an exercise of judgment with regard to the terminations of the cables of each network relative to the terminations of the cables of the other networks.

2. *Maximum Variation of Pressure.*—This section should have been treated under the heading of "Uniformity of Pressure," but it was thought advisable to treat it separately, as it involves factors which do not really come under that heading.

The maximum variation of pressure in any network, according to the Board of Trade regulations, must not exceed 3 per cent. ($2\frac{1}{2}$ per cent. in high-tension systems) of the declared pressure—*i.e.*, the pressure which the supply company or corporation declares to be that at which the current is supplied to the consumers connected to the network. Complaints very often come to hand from various consumers, who state that shops or houses in one part of the town are better lighted than their own premises which are situated in a different quarter of the town, and it is therefore incumbent upon the undertakers to keep the percentage variation of pressure as low as is compatible with economy, and by so doing to give complete satisfaction to everybody as far as possible.

One of the questions to which we must give our attention at the commencement of supply is, therefore, how to so design the arrangement of the network as to keep within the Board of Trade limit of variation, not only at the present time, but also at any future time when it may be necessary to make extensions to various parts of the town and its environs. In dealing with this point, a knowledge of the district with which we are concerned is really necessary, but the general method of procedure may be set down in such a manner as to meet the requirements of any ordinary town. Variation of pressure depends upon drop in volts, and drop in volts depends upon three principal items—viz., the length of the conductor, the sectional area of the conductor, and the amount of current carried by the conductor. Of these three items, it will be comparatively simple for a man experienced in this work to very soon estimate one of them—the amount of current to be carried. Having obtained this, we are in a position to find the sectional area of the conductor required, for the question of safety precludes us from loading the cables above a certain density per square inch of section, say 500 or 600 amperes. But there is another factor to consider in this connection—viz., the most economical section of conductor, compatible with safety, to use. The results of the investigations of Lord Kelvin, Profs. Ayrton and Perry, Mr. Kilgour, etc., into matters relating to the sizes of feeders and distributors, have been exhaustively treated upon by the authors themselves in the technical journals, in their own publications, and in papers read before scientific associations.

The formulæ deduced by them cannot, however, be used without some definite data to work upon; and in the case of new supply undertakings it would be wise to take the sizes of their cables from those adopted by other undertakings, working in similar places, and under similar conditions, until they are in a position to supply their own data, when they can, before the works assume very large proportions, reorganise their network to suit their own cases. Assuming that the above-mentioned data are available, the most economical section of conductor to employ can be calculated by methods for the explanation and elucidation of which the reader is referred to the publications mentioned above, and especially to Mr. Kilgour's contribution on this subject in "Practical Electrical Engineering," as it is impossible in the space available here to do justice to the subject, and any abridgement of it would only be confusing without serving its purpose.

It is advisable to carefully study the area of supply and its probable extensions, and if the necessary data be available, to make the required calculations which, aided by experience, will enable several standard sizes to be adopted for the cables for the distribution of the current. These standard sizes should then be adopted throughout the system. The sizes of distributors vary, as a rule, between ·3 square inch and ·04 square inch. That portion of the area of supply which may be designated by the name of city or town, as distinguished from the outlying districts, can now be divided into squares, of which half the length of the diagonal is such that the drop in pressure in an equivalent length of the predetermined size of cable, at what is estimated to be the maximum current which will flow through any one

Digitized by Google

of the distributors, at the working pressure, is slightly lower than the variation of pressure allowed by the Board of Trade. The diagram shown in Fig. 2 represents this portion of the area of supply of any town or district into which a system of distribution of electric energy is to be introduced. C indicates a point situated at the centre of this portion of the area, and straight lines intersecting each other at right angles are drawn through it. The maximum length of the distributors from any feeding point—*i.e.*, half the length of the diagonals of the squares—as obtained above, is marked off from the centre, C, along each of these lines, giving the points F_1, F_2, F_3, and F_4 as the centres of the squares. The most convenient places near these points will then be our prospective feeding points.

The sizes of the feeders, as in the case of the sizes of the distributors, are perhaps more a matter for the dictates of experience than for the results of calculations, although having already agreed upon the sizes of the latter, we are in a better position for the determination of the sizes of the former, except in so far as the drop in pressure and economical working is concerned, for in the former respect the length of the proposed feeder will obviously have a great bearing on its section, especially when no device is used at the supply station for maintaining the standard voltage at *each* feeding point. Any such device, however, is quite unnecessary in the majority of well-designed networks, and their employment should be rigorously avoided, unless absolutely essential to the proper maintenance of the correct voltage, as it is unwise to complicate the switching arrangements at the supply station more than necessary. In some instances, as, for example, when the supply station itself is used as a feeding point, a regulating device for adjusting the voltage at the feeding point is absolutely necessary, the section of the feeder being then determined only by the amount of current it has to economically transmit. It will undoubtedly become advisable at some future time to extend the cables into the outlying districts, and when this becomes imperative, each of these districts can be treated in the same manner as was the more important central area of the town in the first instance; a sub-station, fed from the main supply station, being employed to receive current at high pressure, which would here be transformed down to current at low pressure for distribution among the consumers in the district.

The sub-station might be used as a distributing centre if more than one feeding point should be found to be necessary, or a sub-station and transformers could be placed at each feeding point if circumstances involving economical factors, such as distance, etc., rendered it expedient to adopt such a course.

It will be seen that in any distributing system arranged on the lines indicated above, extensions may be made in all directions without very much danger of large variations in pressure occurring at different parts of a town and its environs.

(*To be continued.*)

RELATIVE ADVANTAGES OF DIRECT-CURRENT AND THREE-PHASE DISTRIBUTION FOR SMALL INSTALLATIONS.*

BY H. A. EARLE.

When accepting an invitation to read a paper before this Institution I was for some time in doubt as to what subject I should choose; none was particularly uppermost in my mind as one upon which I wished to discourse, but I came to a decision while travelling abroad; the question covered by the title of my paper being brought most prominently before me, owing to the competition and different statements I met with, with regard to the relative advantages of three-phase and direct-current machinery for small and medium sized installations. Owing to this it occurred to me that a comparison between the two systems would be of interest and likely to give rise during its discussion to points which would be a guide for the future. Competition is not always, especially in some countries, carried on on strictly commercial lines, and I have experienced instances where a competing firm, finding it could not secure an order for direct-current machinery, has offered polyphase machinery as an alternative, singing its praises at great length, setting forth advantages without number, and naturally ignoring the other side of the question; this is not as it should be, but with inexperienced purchasers, with no one to guide them, it is at times successful.

I have found the title I first adopted for my paper somewhat too limited in its scope, and have briefly considered questions which relate to the distribution from sub-stations, as well as that of the choice of machinery and distribution for small installations. The type of machinery, and the system to be adopted for supply and distribution, are in the case of large plants most carefully considered, simplicity of design, first cost, and subsequently economy being among the most important of the many factors. In the case of small installations, however, such as are put down to supply light and power for mills and factories, the question is not infrequently decided irrespective of theoretical considerations. The purchaser in England is very usually in the hands of the consulting engineer, but in countries where this commodity does not exist he is often guided by the persuasive power of the seller, and sometimes by fashion. For the lowest price may mean but little as regards cheapness when there is no specification. There are many ways of preparing a low tender, and the omission of something in one which is included in another, the adoption of different voltages, various groupings of lamps and motors, different speeds for generators and motors, may give one system an apparent advantage over another which it does not in reality possess.

Many firms have, up to the present, given their chief attention to direct-current work, and this has met the wants of the smaller installations as well as those of the greater portion of the large central stations. Single-phase supply at high voltage, with distribution from transformer stations, has competed keenly with direct current, but lamps of higher voltage, together with three-wire distribution, has given the latter a long lease of life, and has enabled it to be employed for large areas without undue loss or a prohibitive cost of copper. We have seen 50-volt and subsequently 100-volt lamps in regular use for large installations, but now 200 up to 230 volt lamps are quite the accepted standard, and this higher pressure has so largely reduced the first cost of copper that in many stations where the use of alternating currents was formerly warranted, direct-current machinery is being put down, and even in some instances the alternating-current machinery being taken out. Running and driven balancers, together with feeder boosters, are required as auxiliary machines for direct-current three-wire distribution, from sub-stations dealing with large powers, and feeding over a considerable area; but it is more than probable that in the future 400-volt lamps will be available, which, with a two-wire distribution, would render the two first-named machines unnecessary, and eliminate the cost of the centre wire. As polyphase and monophase machinery live on the price of copper, it can be fairly assumed that every saving in this respect will take away their livelihood and reduce their utility. Where lighting constitutes the largest proportion of the load, the copper required is proportional to the watts per candle taken by the incandescent lamps; any reduction, therefore, in this respect is of great importance. Lamps are, I understand, shortly to be put on the market consuming two watts per candle, or even less, and every advance in this direction is, I again hold, to the advantage of direct current, and will enable it to cover a wider field, for who will use high voltages and transform down if they can use low with equal economy, or include complications when they may be omitted? All auxiliary machinery and apparatus has only one object, and that is, to reduce the price of the mains, or, as I have seen it stated, adopted in the vain endeavour to cheat Ohm's law out of its due tribute of copper. There are some who blindly champion alternating and polyphase systems, call commutators excrescences, and quote experiments, which claim to show that polyphase weigh a mere fraction of direct-current machines. A statement in Herr von Dobrowolsky's remarks in the discussion on a paper read by Herr Görges in 1892, was quoted in the first

* Paper read before the Manchester Section of the Institution of Electrical Engineers.

Digitized by Google

edition of a book, and has again appeared in the second edition—namely, that a certain multipolar continuous-current machine gave 11,000 watts, but that when a three-phase armature was run in the same fields, it gave an output of 33,000 watts. I doubt this test being one which one could consider upon a commercial basis. On turning, however, to the paper in question, I find that Herr von Dobrowolsky also said: "An alternating-current machine is so totally different in its construction to a direct-current machine, that such comparisons cannot be fairly made, and that it is equivalent to saying that a spoon has an efficiency of 100 per cent. when used for soup, but only one of 50 per cent. when used for cutting." Notwithstanding all this the polyphase system is at the present time the most satisfactory solution of long-distance transmission, and will be utilised more and more to transmit large powers into the centre of towns, and to cope with the many difficulties which present themselves, but the chief point I desire to raise is, whether the distribution from the sub-stations should be by polyphase or direct current, and whether for smaller installations one system offers such advantages over the other as to warrant a preference being given. Notwithstanding the existence of several eminent advocates of single-phase machinery I do not propose to consider it, nor have I had to deal with it in connection with the competition I have experienced, especially abroad.

With regard to the two remaining rival systems, the commutator seems to be the red rag of polyphase exponents, but any trouble that has been experienced on this behalf is merely a passing nightmare, and has only occurred with machines of large power running at high speeds, in connection with which considerable experience is required and very high-class workmanship demanded in order to enable carbon brushes to maintain good contact on a surface running sometimes as high as 40 miles an hour. This difficulty has been experienced by most of us, but is being rapidly overcome, and in a short period it will be a thing of the past; it is, however, much to be desired that the high engine speeds which have been saddled upon us for plants of 1,000 h.p. and upwards, may in the future be reduced some 20 per cent. With reference to the comparative weights of direct-current and polyphase generators, we may take as a good example of the latter one of the 32-pole three-phase generators built for the Central London Railway, and which has an output on full load of 850 kw. at 94 revolutions; this machine has a weight of 37 tons, or with exciter, say, 39 tons. As an example of a large direct-current traction and lighting generator, we may take one of a number of 10-pole machines, now being built at Salford Ironworks, having an output of 900 kw. with fixed load, and running at 95 revolutions per minute. This machine has a weight of 45 tons, or correcting for the increased output, it equals 42 tons; this machine could, however, have been built lighter as a shunt generator, with the compound windings omitted, and with the smaller range of voltage than necessary, the magnets would have been lighter, and probably with advantage more in number; the weight would then have been practically identical with the polyphase generator, with which it has been compared. With regard to the weights and prices of still larger generators, I have compared a 1,400-kw. $\times \cos \phi$ polyphase generator running at 93 revolutions with a direct-current one of the same output, and for the same speed; the former with exciter would weigh approximately some 64 tons and the direct-current generator approximately the same. Comparing the prices of the above machines, the polyphase has the advantage, and is approximately some 12 per cent. cheaper to build, this being chiefly due to the cost of the commutator on the direct-current machine. There is, however, one point which cannot be passed by unnoticed, and that is the small safety clause attached to the output of the polyphase machine—namely, cosine ϕ. What is this? Why, it means that on an inductive load this apparent 12 per cent. advantage is wiped out, and may even, and very probably will, put the boot on the other foot; but more of this later on. With regard to smaller sizes of 200 kw. to 400 kw. I do not find that there is much difference—in fact, the figures I have tend to show that the advantage is on the side of direct current; but I will not press this point. Respecting the weights of the two types of motors, the polyphase type with squirrel-cage rotor is considerably lighter, but the large motors of 50 h.p. to 100 h.p. with wound rotors weigh about the same. Comparing the price at which the smaller sizes are sold, the polyphase have an advantage of about 5 per cent.; but figures I have carefully examined for motors from 10 h.p. to 100 h.p. with wound rotors show a good average of 10 per cent. in favour of continuous-current when compared with polyphase motors imported into this country, and the cost of importation does not amount to 10 per cent.

Considering next the cost or weight of mains, the advantage is on the side of three-wire direct-current distribution, as may be seen from Table A, in which it is assumed that the various systems are for incandescent lighting as well as for power, and that the voltage is limited by the lamps, the circuits being so arranged that each lamp can be switched on singly. As regards the voltage, column 1 gives the virtual volts between any two wires when lamps of the same pressure—namely, 200 volts—are employed on each system, but this figure may certainly be taken exception to in the case of the alternating systems, for it must not be forgotten that their maximum voltage is the $\sqrt{2}$ times their working voltage, or 1·41 times as great. And this cannot be lost sight of when taking into consideration the questions of insulation and risk from shocks. I have accordingly given in column 2 the maximum voltage between any two mains on this basis. There is also another point to be borne in mind in connection with the mains for polyphase systems which contain many motors, and that is for equal loss they must be increased in section at least 10 per cent. above that given in the table, and required for continuous-current systems, in order to allow for the loss due to wattless currents, and this figure may have to be still further increased to 20 per cent., or even more should many of the motors be put down to deal with very variable loads; in fact, the section of the mains in the table must be increased in the inverse ratio of the power factor of the system, taking into consideration both motors and lamps. In the comparison, a third or common wire has been included, where necessary, to fulfil the condition of individual control, but the systems are assumed to be in balance—*i.e.*, there is no loss in the centre wire, which has been taken in all cases as 25 per cent. of the weight of an outer. It is seen that continuous-current three-wire systems are only beaten by one—namely, in the case of the three-phase star with common return, but then the saving by having only three wires instead of four to fix and insulate would cancel this small difference, not to mention the better regulation which can be obtained with continuous-current machinery. With regard to this small difference of one, the three-phase star has, moreover, no right to, for it is entirely eliminated, and the tables are turned, by what I have said respecting the loss due to wattless currents when motors are used; and the three-wire direct-current system is then found to be at least 10 per cent. the best of all, as regards the weight of copper. From the way I have drawn the diagrams of the three-phase star circuits, it can readily be seen why, when lamps are used, the fourth or common wire is necessary to maintain proper regulation of voltage on the lamps, for without it the system would be comparable to a continuous-current two-wire system with three lamps in series.

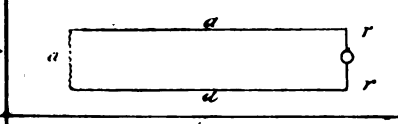
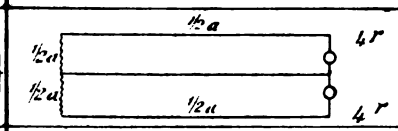
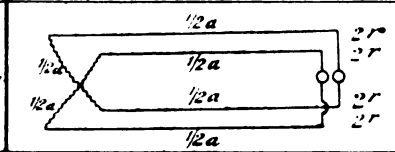
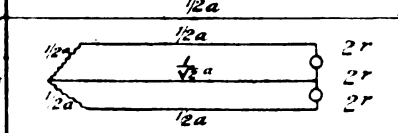
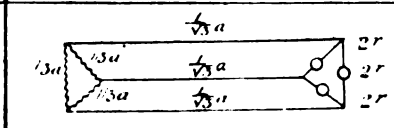
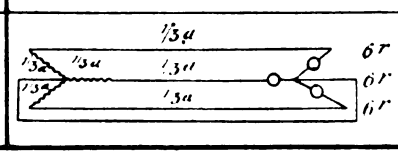
Turning next to the question of running motors upon the circuits, the points to be considered are: (1) starting torque; (2) regulation of speed; (3) constancy of speed; (4) efficiency. Polyphase motors are essentially constant-speed machines, and the speed of the smaller sizes is high, the arrangement of the winding is limited, and in this respect they do not so readily lend themselves as continuous-current motors do to windings by which any desired speed can be obtained. Various ingenious methods have been adopted to meet the requirements, which are more or less satisfactory, but there is still considerable room for further development.

1. *Starting Torque.*—A continuous-current motor even when shunt wound exerts its full torque, with a small increase of current over the full-load current, and is capable of satisfactorily dealing with any work for which it may

Digitized by Google

TABLE A.

EQUAL PRESSURE ON THE LAMPS. EQUAL POWER TRANSMITTED. EQUAL LOSS IN THE LINE

System.	Diagram of System. ~~~ represents Dynamo windings. —o— „ 200-Volt Lamps.	Virtual Volts between any two wires = V.	Maximum Voltage.	Current in outers for equal total power = 200a.	Resistance of each outer for equal total Loss = $2a^2r$.	Weight of each outer. — No current in centre wire.	Weight of the centre wire taken as ½ of each outer.	Total copper for equal lamp pressure power and loss.	Weight of Copper cc. = 100.
Continuous Current 2 wires		200	200	a	r	1	—	2	100
Continuous Current 3 wires		400	400	¼a	4r	¼	1/16	9/16	28
2-phase 4 wires		200	V√2 283	½a	2r	½	—	2	100
2-phase 3 wires		200√2 283	V√2 400	½a	2r	½	½ same as outer	1½	75
3-phase mesh		200	V√2 283	$\frac{1}{\sqrt{3}}a$	2r	½	—	1½	75
3-phase star		200√3 346	V√2 490	⅓a	6r	½	1/16	1 1/16	27

be employed. Small three-phase motors with squirrel-cage rotors, starting with full torque, require a momentary rush of current, approximately equal to 2½ times the full load current. This is an undesirable feature, and to obviate it motors of larger powers are started up with a resistance in the rotor circuit. This minimises but does not remove this defect. This behaviour would prevent a three-phase power installation being arranged so that all motors may start up with the generator. With respect to this, I arranged a power installation of 850 e.h.p. in a large spinning and weaving mill abroad, in which are included some 10 compound-wound continuous-current motors, placed long distances apart, and ranging from 220 h.p. to 230 h.p. In this installation all the motors can start up simultaneously with the generator on practically full load the starting current required being not more than some 50 per cent. in excess of the full working current. In cases where the running torque is constant, but where a great starting torque is required, series-wound continuous-current motors offer the best solution. I have one case especially in my mind, in connection with a polyphase installation in a cotton mill, where a large number of motors of 8 b.h.p., with squirrel-cage rotors, were put down, each to run a line shaft driving 24 narrow looms. In this case trouble was experienced in starting up, belts coming off, or the motors, especially on Monday morning, when everything was stiff, refusing to start at all. Larger motors were in some instances put in, and in others fast and loose pulleys were added: a 7-h.p. direct-current motor would have done the same work, and have given better results. One method of increasing the torque of polyphase motors on starting is to increase the voltage on the stator by means of a booster transformer. Another method is to alter the connections of the stator windings from star to mesh, this increasing the pressure in the ratio of 1·73 : 1. Another arrangement is to change the connections of the stator coils from series to two sets in parallel. The requisite starting torque can, however, be obtained from a direct-current motor, whether shunt or series wound, without any of these devices.

2. *Speed Regulation.*—The regulation of speed, either of continuous current or of polyphase induction motors, is effected by somewhat similar means. The speed of an ordinary shunt motor can be varied in three ways, either by inserting a resistance in the armature circuit, by altering the voltage of supply, or by varying the strength of the fields. Like shunt or series direct-current motors, polyphase motors, except the smallest sizes, require a resistance to be inserted in the rotor or revolving windings to keep the starting current within bounds; merely by the use of such a resistance any desired variation of speed can be obtained with either type. With this method of regulation, however, the input remains practically constant, and it is, therefore, too wasteful to be adopted where a high average efficiency is imperative throughout the whole range of speeds. A direct-current motor running on a three-wire system with two voltages available, combined with regulation of the field, can be made to yield a very high mean efficiency equalling 83 per cent. for the whole of the working range—that is, for some 66 per cent. of the speeds and an average of 75 per cent. throughout the whole range. Weakening the field by introducing resistance into the stator circuit of a polyphase motor increases the slip and the motor runs slower, but as the field supplies the rotor current in the same manner as the primary of a transformer supplies the secondary, the torque falls off very rapidly. By doubling the number of poles in the stator winding the speed can be halved; this necessitates, however, an inconvenient number of windings, increases the complication of the switch, etc., and is rather impracticable. Considering the various devices as a whole, one cannot but be drawn to the conclusion that the direct-current motor on a three-wire system, with two voltages available, or on a two-wire system with double-wound armature, together with the provision for some field regulation, is the simplest and most desirable, for it gives all variations of speed most economically, and it can be easily arranged so that there is no jump whatever between one speed and another. Three or four instances have come to my notice where power has been transmitted to a works from a considerable distance by polyphase current, but in connection with which

Digitized by Google

motor-generators have been added to supply direct current to motors requiring to be operated through a large range of speed at a high mean efficiency.

3. *Constancy of Speed under Varying Loads.*—In this respect a shunt-wound continuous-current motor acknowledges no superiority to the polyphase: the slip on the latter increases with the load, but shunt-wound motors are available which can maintain constant speed from no load to full load. For tramway work a polyphase motor will maintain a more constant speed when climbing hills than a series-wound continuous-current motor, but as this is at the expense of current, a high speed on the level and a slower speed on hills seems more to be desired, and likely to reduce the maximum current demanded from the station.

4. *Efficiency.*—I have compared the efficiencies of direct-current motors, which have been most accurately tested, with figures which I consider are fairly representative of what can be obtained with polyphase, and give the comparisons below:

B.H.P.	3½	6	10	25	50	100
Direct-current ...	82%	85%	86%	91%	92%	92%
Polyphase	75%	80%	84%	88%	90%	91%

This shows a large superiority for direct-current motors of small power, and a small advantage on the larger sizes. The power factor of polyphase motors, as far as any published figures go, as well as those which are obtained from various makers, vary more widely than seems at all necessary, and in order to obtain a fair average I dotted all the power factors I could get upon a sheet of paper, and then drew a curve through the lot, and I give you below the readings which resulted from this curve. Power factor for polyphase motors on full load:

B.H.P.	5	10	15	25	50	100
	·76	·79	·81	·83	·86	·88

With regard to the above, it is needless to remark that the power factor of continuous-current motors is unity. Having considered how the various operations are effected for changing either the speed or torque, or both, let us consider the conditions under which motors have to work. These may be divided under four heads, and stated as follows: (1) constant speed with constant torque; (2) constant speed with variable torque; (3) variable speed with constant torque; (4) variable speed with variable torque.

Constant Speed with Constant Torque.—This condition is one which exists when motors are used to drive lengths of shafting, from which again are driven a considerable number of small machines, such as are found in a cotton mill or a large machine shop. In this instance the load is fairly constant, possibly not varying more than some 10 per cent. It is in such cases that a polyphase motor is at its best, and endeavours to rival the shunt-wound direct-current motor, which, however, is just as good for the purpose, or probably a little better.

Constant Speed with Variable Torque.—This second condition occurs in cases where large portions of the load are being frequently thrown on and off; the shunt-wound motor is all that can be desired as regards speed on such work, and the current taken is in fair proportion to the load. The polyphase motor is also satisfactory as regards speed, but the current is high on the lighter loads; a considerable percentage is certainly wattless current, but it adds up the $C^2 R$ losses, and at the same time decreases the capability of the generator for useful work; and this is a point which must be borne in mind when comparing a polyphase generator with a direct-current one. We have seen how a power factor less than unity for the motors necessitates an increase in the size of the mains, and this acts in a similar manner upon the generator. If the current were in phase with the E.M.F.—that is, if the power factor were 1, in place of averaging, say, ·85—the polyphase generator could do 17½ per cent. more work than it would be able to do under the latter condition. But, again, with many motors working on a system, a power factor of ·85 cannot always be relied upon, and one of ·75 or even lower may have to be reckoned with. We see from this that the first cost of an installation may be considerably increased by this consideration, and besides this the wattless currents exercise a very bad effect on the regulation of a three-phase machine, very much more so than if the currents were in phase, necessitating very much heavier windings on the magnets to deal with a low power factor than a high one.

Variable Speed with Constant Torque.—This third condition is met with very frequently—for instance, when driving callenders, paper-making machinery, and in pumping, etc. To meet it with polyphase motors the regulating switches are more complicated, and to effect many changes of speed the groupings of the winding become many in number, and efficiency is sacrificed. In this respect the continuous-current motor is more easily managed, and will yield a higher mean efficiency.

Variable Speed with Variable Torque.—The fourth condition is especially present when driving calico printing machinery. An eight-colour machine, for instance, may be utilised for printing any desired number of the eight colours, the torque increasing practically in direct proportion to the number of rollers in use. The speed of printing the goods at the same time varies in accordance with the number of colours being printed, and with the class of work the machine is doing. For this class of work a very even turning moment is necessary; one must be able to run up to any desired speed without jumps or jerks, and the contemplation of a three-phase motor arranged for high efficiency at all speeds and to comply with the requisite conditions, is not a taking one.

I have heard the point raised that for factories where there is much inflammable dust about, a chance spark from the commutator might set the place on fire, but perfectly satisfactory entirely enclosed direct-current motors are at work, not considering the thousands on tramcars, but also in factories of all descriptions; fireproof gauze covers are also employed for motors—these do not exclude all ventilation, and render the motor quite reliable even where spirit vapours are present. The facility for the use of batteries on direct-current systems is one which must receive careful consideration. These are continually improving in quality, give excellent results in the hands of those that understand them, and offer great advantages, both as a stand-by and as regulators; they can therefore frequently be utilised to assist direct-current supply, and at times to effect considerable economy, whereas a three-phase battery has yet to be invented. Polyphase motors appear specially suitable for long lines of railway where considerable distances are travelled without a stop at a uniform rate of speed, and where crossing-points which would complicate the conductors do not exist, for beyond a comparatively limited distance high voltage must be used, and then, whichever system is employed, transforming apparatus is necessary; in such instances polyphase supply, with polyphase motors on the train, would not call for rotating transformers, stationary transformers along the line being the simplest and cheapest arrangement. Such a system is, however, unsuitable for use in towns with frequent stops and a very variable rate of speed; besides this, I am sure that it would create a great commotion among the inhabitants of a town not 100 miles away if it were proposed to erect two trolley wires in place of the one, which to some already appears distasteful. Judging from what some of the larger firms on the Continent are doing with respect to polyphase machinery, I understand that, although they have given it the very greatest attention, they find that the volume of their direct-current work exceeds that of the polyphase.

I have endeavoured to consider the chief points which should guide us in the choice of a system for use for the smaller installations. In cases where lighting alone is required, the first cost of polyphase or direct current would appear to be very similar; the simplicity of the latter system, both as regards the wiring and the regulation of the voltage to my mind, gives direct current the preference. Where a number of motors are on the circuit for whatever purpose they may be required, and whether the system includes lighting or not, I consider that direct current shows a very decided advantage, except in a few very special cases. Moreover, the use of batteries is all but excluded with polyphase systems, even for a night load, and this is frequently of considerable importance. I have, doubtless, to some minds,

Digitized by Google

left unsaid many things I ought to have said, and to others said many things I ought not to have said, but this may be more an advantage than otherwise, for it will admit of those shortcomings being criticised during the discussion, and may enable me to fill the gaps and correct my errors.

Discussion.

About 120 members and friends attended the meeting at which the above paper was read. Dr. Edward Hopkinson took the chair. The discussion was very much interrupted by the hissing of an arc lamp, and the **Chairman** said although he believed in continuous current for arc lighting, he did not think he could take the present lamp as an ideal example of good work.

During the reading of his paper **Mr. Earle** said that he had recently found that from 25 to 30 per cent. more power was required to start up shafting on a Monday morning than was required on any other morning.

Mr. Miller, who opened the discussion, said that he would have preferred to have spoken later on in the evening. He, however, generally agreed that for small installations direct current was the proper thing, especially for motors, as the speed could so easily be varied. He gave an instance of a shipyard that had come under his notice where in one or two yards polyphase distribution was employed which worked very well, while in the other yard continuous current was employed, which, in his opinion, worked much better. He also gave another instance, in which the Helios Company had been asked for their opinion as to which was the better plant to instal where a pressure of 230 volts was required, and they had replied that for this pressure and particular job three-phase distribution could not be recommended, as it was only of use in cases of long-distance transmission. Mr. Miller went on to say that many installations of polyphase distribution had been put in merely on the recommendation of the seller, and that there were many people in this country holding the idea that nothing was good in the way of electrical machinery unless it came from the Continent or America. He had lately been reading Mr. Fedden's report to the Sheffield Committee, and he took it that the report was mostly in favour of single-phase distribution. As to three-wire distribution for small installations, he did not think it was necessary, as it involved complications, and small installations should be kept as simple as possible, so as to secure good work being put in. In America polyphase transmission was much used, but not for ultimate distribution. On the larger question of town lighting, no offhand statement could be made as to whether polyphase or direct current was the best to use, as each case must be considered on its own merits.

Mr. Sayers congratulated Mr. Earle on his paper, which he had read with interest. He considered that they could not attach too much importance to the question of speed regulation, and it was not always easy to make a case out for electricity when considering the question of steam-engine *versus* electricity for driving machines, as the question of convenience and facility for turning out work depended on speed. He thought it would pay generally to put in motors with variable shunt resistances where variable-speed motors were used, and if a machine will commutate properly, it would maintain its speed fairly evenly with a variable torque.

Mr. Wood said he had no doubt that continuous-current semi-enclosed type motors were the best. He had known of a case, on a combined motor and lighting installation, where alternating current was used, and when switching on the motors the voltage was reduced from 110 to 70. He had, however, found no difficulty in starting up an installation of three-phase motors, if all the motor switches were first closed, and then the generator started up with a strong field. He thought that three-phase motors would be more advantageous on the question of price when compared with dust-proof continuous-current motors, and that such motors could be advantageously used in coalmines and very dusty places generally. On the Continent he had seen three-phase motors in use with cone pulleys so as to get variable speed.

Mr. Lacey said that Mr. Earle's paper had put all the points in favour of direct current, and that he agreed with him where variation of speed was necessary. He had known of a case in a printing works where it was desired to regulate the speed of motors from the foreman's box, without the actual user knowing anything of it, and he thought it would be difficult to do this with polyphase motors. For tram work direct current was much more advantageous. He had only seen Mr. Earle's paper just as he had come into the meeting, and would have liked to have had time to study it at leisure.

Mr. Lindley said he thought that a polyphase motor was mechanically perfect, and that the absence of a commutator was a very great benefit. Change of speed he knew was a great question, especially for machine tools, but it was surely not hopeless to expect that something could be done in this matter with polyphase currents. As to engine speeds, he thought that in the long run the higher speeds must win.

Mr. Richardson said that there was probably no greater advocate for three-phase currents than himself, but he thought there was no surer way of killing the system than by indiscriminate recommendation. No doubt central-station engineers would be very pleased to see 400-volt lamps on the market. He could not agree with Mr. Miller as to the use of three wires, as he thought that the complications were of very small moment where two voltages were available. At the Niagara station, out of 40,000 h.p. he had found that 14,000 h.p. was actually used as continuous current against 8,000 h.p. or 9,000 h.p. as alternating.

Mr. Whalley said that this was the only country that had not committed itself to the manufacture of polyphase machinery. In St. Petersburg there was one station distributing polyphase currents and running in competition with two others using single-phase. Polyphase currents were in use to a large extent abroad, and were often used not only for distribution, but in workshops using small motors. He thought they had more work than they could tackle with continuous-current manufacture, and suggested that the Institution should issue a standard table of efficiencies, as there were too many motors turned out which were not properly tested.

Mr. C. H. Wordingham said he was very much interested in the paper, and approached it from a central-station point of view, but he had hoped to hear more about distribution from sub-stations. He still stuck to his old idea—that continuous current was the thing to sell to consumers, but that for transmission over long distances multiphase generation was essential. Mr. Earle had made no reference to rotary transformers. Four hundred-volt lamps would solve many difficulties, but they must not forget that they had that very important body the Board of Trade to deal with, and he was pretty certain that they would not allow the use of 400-volt lamps with 800 volts across the outers of a three wire installation.

Mr. Earle said he referred to the use of 400-volt lamps on two-wire installations.

Mr. Wordingham, continuing, said that the question of trouble with commutators depended upon where the motors were bought, but he thought the difficulties were negligible. The complications of switch gear with three-phase currents was a very important question, but could be avoided by using low-pressure currents.

Mr. Ritchie said they must consider the small consumer, and it was advantageous to him to have a motor without a commutator. For regulation of speed, direct-current motors were now favourable. As to the figures from Niagara Falls, the current was mostly used for tramways and a lot for electrolytic purposes, which must, therefore, be continuous.

The **Chairman** said that the last year's president of the Institution was very much in favour of alternating currents, and that this meeting was of quite the other opinion. There were very serious objections to alternating currents, and he had no doubt that continuous current was the proper thing. He was afraid there was an evil day in store for three-phase users, when current, which would be continuous, came to be generated direct from coal. Parallel running with alternating currents presented considerable difficulties. For arc lighting, direct currents were much more favourable. They could not do without continuous currents if they tried. They must have exciters in an alternating station, and these must have commutators. If they looked at some of the metropolitan companies' works costs, they would see that those for continuous current were much lower than those for alternating.

Mr. Earle, in reply, said that on the Continent, where he had lost an order for direct-current machinery, owing to the fact that the firm were intending to use alternating current, on going back to the same place a year after he had found the alternating machinery replaced by direct-current machinery. When starting his paper he had a view in favour of three-phase currents, but the more he went on with it the more he saw that direct currents were right, and had therefore changed his views at the end.

The meeting concluded with a vote of thanks to the author.

ELECTRIC OSCILLATIONS.

The first of a series of four Cantor lectures on "Electric Oscillations and Electric Waves" was delivered by Prof. J. A. Fleming at the Society of Arts on Monday last. There were a goodly number present, and we would recommend all electrical engineers who wish to become *au fait* with this subject to make an effort to attend the remaining lectures of the course. The experiments arranged by Prof. Fleming were most successful, and conduced to the ready understanding of the subjects dealt with. After a brief reference to the adoption of electric oscillations to wireless telegraphy, Prof. Fleming commenced his subject by explaining that his lectures would deal with oscillations of a frequency of very much higher value than were employed in alternating-current distribution; instead of a frequency of from 25 to 100 complete periods per second, frequencies of from 100,000 up to millions per second would be dealt with. With this great increase of frequency it would be shown that resistance loses much of the importance which it exercises with ordinary electric lighting currents, and that induction and capacity became much more important. Again, it would be shown that the crystallised idea of some with respect to conductors and non-conductors, and with respect to the current being the same in every part of the same circuit, would be rudely upset. The usual methods of producing the low-frequency currents were quite useless when one required to generate these electrical oscillations. There was only one method known by which this could be done, and that was by the discharge of condensers. In order to get the oscillatory discharge, well-

Digitized by Google

known rules had to be followed, first enunciated mathematically by Lord Kelvin in 1851. He showed that the discharge would be oscillatory if

$$R^2 < L\frac{L}{C};$$

where R = the resistance of the circuit;
L = the self-induction;
C = the capacity of the condenser.

The fact that the discharge could be oscillatory was first discovered by Joseph Henry in 1842, when studying the magnetising of needles by means of a discharge from a Leyden jar. The varied result of this operation led this experimenter to a belief that in certain cases the discharge must be oscillatory. Later on, Mr. Boys, by means of photography and revolving mirrors, obtained records of these oscillatory discharges, and studied the causes which varied the number of actual oscillations which occurred. One of the great essentials for producing an oscillatory discharge was the very sudden release which took place when the discharge passed through air; the breakdown of the air from a perfect insulator into a fairly good conductor was a most marvellous and hitherto unexplained phenomenon. Prof. J. J. Thomson had shown that the electric pressure between the points was not sufficient to start the discharge. A list of dielectric strengths in kilo-volts per centimetre was then given. The figures were:

Micanite	4,000
Mica	2,000
Ebonite	540
Linseed oil	83
Cotton seed oil	67
Air film 2mm. thick	57
,, 16mm. ,,	27

He and several others had tried to use oil as an insulator, but the breakdown was not so sudden as when the discharge took place through air. The formula for the frequency of the electric oscillations which was most convenient for use in ordinary work was the following:

The frequency equals $\frac{5{,}000{,}000}{\sqrt{C\,L}}$,

where C is the capacity of the condenser in microfarads, and L the induction of the circuit in centimetres. It must be remembered, however, that the induction of a circuit to an oscillatory discharge was not the same as for ordinary alternating currents. The following formula would be found accurate for ascertaining the induction of these high-frequency waves, as expressed in terms of the length and diameter of the wire used:

$$L = 2\,l\left\{2{\cdot}3026\,\log_{10}\frac{4\,l}{d} - \alpha\right\}$$

where L = the length of the wire in centimetres;
d = its diameter; and
α is a constant depending on the form of the circuit.

For a straight wire $\alpha = 1$, for a circle of a single circular conductor $\alpha = 2{\cdot}45$, and for a circle of square conductor $\alpha = 2{\cdot}6$. It was then impressed upon those present that when one spoke of a frequency of 1,000,000 of these electrical oscillations, it was not meant that there were 1,000,000 oscillations each second. What really took place was that there were a few, say 10 to 15, oscillations of that frequency, and then a pause in which no discharge took place, then another discharge, etc. The experiment was shown that a transformer could be constructed for these oscillatory currents, and that a zinc screen, even of the thinnest zinc, was quite sufficient to cut off the effect of the primary on the secondary. With the apparatus exhibited there were 12 turns in the primary, and three in the secondary, which lighted up a four-volt lamp. This was a step-down transformer. To construct a step-up transformer, Prof. Fleming showed that the ordinary method of transformer design must be avoided. It was most important to have a considerable space between the adjacent convolutions of the primary in order that the self-induction of the primary circuit should be kept low. This was clearly demonstrated by an experiment. These transformers were accordingly constructed with a few turns on the primary, wound with a considerable insulation space between the adjacent turns of the spiral, and a single layer of secondary wire was placed over the primary. It was found that a glass insulation was the best to use; it was also found that it was better to make the transformer long rather than to try more than one layer. Experiments were also shown that iron cores in a coil did not much affect this induction as far as these electrical oscillations were concerned. This was intimately connected with the fact that with these high frequencies the current was almost carried by the skin of the wire. The lecturer explained that the ordinary formula for ascertaining this effect did not apply to these high-frequency currents. A most interesting experiment was made by Prof. Fleming to show how these oscillatory currents could be set up in a poor vacuum without any exterior conductors; for this purpose a bulb similar to that used for the large Sunbeam lamp, but with a comparatively poor vacuum, was placed inside a coil of wire through which these electric oscillations were being passed. The result was a circulation of electric discharges round the rarefied air in the bulb, which produced a most brilliant illuminating effect.

ELECTRICAL CONTACTS.*

BY FRANK C. MASON.

It is curious that the subject of electrical contacts has received so little attention in the literature and discussions of the general subject of electrical application. At the basis of nearly every variety of electrical apparatus, whether for signalling with small currents or for the larger work of heating, lighting, generating, and developing electric power and the application of electricity to chemical processes, the contact or point of discontinuity in the circuit is found as an essential part of the apparatus or of the method.

It is well at this point to say that this paper will be limited to those uses of electricity employing relatively small currents, as in telephony, telegraphy, and signalling, and will not touch on the larger field that its subject embraces in the utilisation of heavy currents. However, the line of demarcation between the light current and the heavy current is now by no means so sharply drawn as it was in the days when the primary battery, in one form or another, was the sole dependence of the telephone and telegraph engineer. When we see the dynamotor and the storage battery used as the central source of energy for a telegraph, fire-alarm, and telephone system, we naturally wonder for how long we can speak of the light current applications of electricity as a distinction from those employing large and powerful currents generated by dynamos.

Contacts may be roughly grouped into three classes: those that are intended to be permanent (such as joints in wire and cables); those that are semi-permanent (such as contact between wire and binding posts) and operative contacts; or those that are intended to be opened and closed at will, as in keys, switches, etc.

To all these kinds of junctions, two enemies exist constantly tending to destroy efficient electrical contact—chemical action and dirt. It is scarcely necessary to speak of mechanical strains, which are guarded against naturally by the exercise of common sense. Chemical action, as it applies to contacts, is generally due to the remnants of some compound or chemical used in soldering, and to the action of air and moisture (either singly or in conjunction), producing oxidation of the surfaces in contact. This action is enormously enhanced by the formation of sparks at contacts of the operative kind, the resultant film of oxide being generally a non-conductor, and interfering greatly with the operation of the contact. Dirt, as Emerson says, is merely "matter out of place." In electrical work dirt means any non-conducting substance that interferes with good electrical contact. It is often dust, but in operative contacts is more frequently the products of oxidation of the points of contact themselves, where (as is too often the case) these are of the baser and more oxidisable metals.

Permanent joints, or contacts, are used both in line conductors and in instruments. Nowadays, the general introduction of hard-drawn copper wire for overhead line

* Extract by the *Electrical Review* of New York of a paper read before the International Association of Municipal Electricians, Pittsburg, Pa., Sept. 26, 1900.

Digitized by Google

work has reduced practice in this kind of jointure to a question of the best way to handle that material. Experience has shown that soldering such joints draws the temper of the wire, making a point of mechanical weakness, while the ancient habit of linemen of twisting the wire at the joint into tight spirals, leads to the same result. For these reasons the twisted and soldered joint must necessarily give way to one of the various and excellent types of tubular joint now manufactured for the purpose. In cable work especially, where paper insulation is used, the best practice now, strangely enough, is to use merely the twisted joint without solder. The wire being soft and subject to no strains, the joint is abundantly strong, while its sheathing, after jointing fully, protects it from the harmful action of the atmosphere and moisture. To solder such a joint would add the danger of corrosion from the dissolving action and slow electrolysis of the fluxes used.

Permanent joints in switchboards and instruments, being protected from the weather, are generally soldered. The wires used should be tinned, so as to leave no excuse for the use of the mischief-making chemicals sold as "soldering solutions." Tubular solder having resin or stearine flux in its hollow part should be used, and the utmost watchfulness employed to keep acid and "salts" away from the work. One easy joint made by these means may plant the seeds of trouble to be reaped later, and, by the peculiar provision of fate, almost invariably just when trouble or breakdown is most to be feared.

Semi-permanent contacts are, practically, of only two kinds, binding posts and fuses. The average American binding post is a piece of metal with a hole drilled through to receive the wire and another drilled and tapped to receive a set screw, which may or may not have a pointed end. The design of this type of binding post is utterly vicious. The screw may shear the wire nearly in two, leaving it so that the slightest strain will break it off, or it may not come down to a tight bearing on the wire, leaving a loose joint ready to collect dirt and become inoperative. Much the better type is that variety of binding post in which the wire is firmly held between two flat surfaces, thus ensuring a large area of contact, and which is provided with a lock-nut so as to avoid any danger of the binding washer working loose. In instruments having binding posts of the other type, considerable improvement can be introduced by putting small hexagonal nuts a little larger than the driving heads of the binding screws on the latter, and setting them down firmly on the top of the post to act as lock-nuts.

In fuses, which are an absolutely necessary part of any installation in a modern city traversed by electric light and railway conductors, an excellent opportunity for bad contacts presents itself. The practice of securing the fuse wire under a washer or the head of a screw is very bad, as the wire is strained, is apt to be reduced in section at some point, and cold flow of the fuse may take place. To obviate these troubles it is usual to attach pieces of copper to the ends of the fuse wire, screwing these down tightly under the binding washers. If the fuse, as is too often the case, is merely squeezed into the copper end, the trouble is only transferred to another point. Hence the best solution of the fuse difficulty is to use copper lugs, to which the fusible wire is securely soldered, held down by screws provided with lock-nuts. Care should be taken in installing fuses not to set them in place under strain, as their expansion and contraction under temperature changes produce crystallisation of the metal or reduction of its cross-section at some point.

While the two classes of contacts already referred to are, in a large measure, in the hands of the operating force of a fire-alarm, telegraph, or telephone installation, the third class, and the most important of all to us—the working contacts of instruments—are confined to these structures, and their nature is determined by the manufacturer. In keys, relays, vibrating gongs, the switching apparatus of the telephone station and in all other places where signalling circuits must be made and broken, sparks will be formed, and no practical device known to the art can prevent their formation. While dust, always inimical to good contacts, can be excluded from such places by proper construction of the instrument, nothing will prevent the formation of oxides at the point of sparking, which is also the point of contact, except making these points of some material that will not oxidise.

For this purpose, the only substances known that are at the same time good conductors of electricity and possess the necessary qualities of mechanical strength, are platinum and a few other of the rarer metals, such as iridium and gold. The consensus of opinion and experience has shown platinum or certain of its alloys to be the only substance commercially available for the construction of contact points of this character. Unfortunately, platinum is a material of such great value that the expense of such contacts is greater than that of any other kind, and, therefore, the temptation of the manufacturer to replace such contacts with those of cheaper material, or to skimp the size, has been very great, and too often has he fallen before it. He has introduced contact points of the baser metals in his instruments, and this has far too often invited, if not assured, disaster.

Blame for such substitution of cheap contacts cannot rest entirely upon the manufacturer so long as the users of electric signalling apparatus fail to recognise the value of the higher-priced article, or, recognising it, fail to specify its use when awarding contracts, and to see that this vitally important detail has been honestly and intelligently executed in the completed instruments.

In municipal work, more than in any other, the electrical equipment must be absolutely reliable. A bad contact, sticking together or full of oxides, may mean loss and danger of the gravest sort to the community. Through failure of the fire apparatus to respond to an alarm, or of the ambulance to answer its call, or of the police to appear promptly when summoned, a bad contact may exact a fearful toll in conflagration, or death, or riot; and in the saving of a few cents' worth of platinum the vast expenditures of municipalities for fire and police protection, and of the generous public for hospitals, may be *nullified*. There is no room for economy of this wasteful kind in instruments upon which so much depends, and to which, owing to the careful and conscientious superintendence of the members of this association, the public looks with perfect confidence for perfect results.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution held on Thursday, Nov. 22, Mr. John Gavey read his paper on "Telegraphs and Telephones at the Paris Exhibition," an abstract of which appeared in our last issue. In the discussion,

Sir W. H. Preece said it did his heart good to see such a large audience to hear an address which had telegraphs and telephones for its text. It reminded him of the early days of telegraphy, when sensation after sensation was described, and ringing applause from such full audiences was heard. He wondered if the younger members of the Institution ever read of the early days of telegraphy; they would learn a great deal by so doing. This was not the first time that a paper had been read at the Institution dealing with the exhibits at an exhibition. He himself had brought before it papers dealing with exhibits at the Paris, Chicago, and Philadelphian Exhibitions. He hoped the practice would continue, and that by hearing of the improvements and inventions carried out in other parts of the world they would not let the profession in this country fall behind the practice in others. It was a remarkable fact that the growth of a business was in proportion to its capacity for carrying out that progress. Mr. Gavey had shown them some great improvements in telegraphs, but this axiom or maxim was not confined to telegraphy. It was true of the telephone, of electric traction, and of every branch and application of electricity to the industries. It was never more strongly shown in England and America than by the fact that as the length of telegraph wire increased, there also increased in arithmetical ratio the carrying capacity of the line, and at the present time a circuit would carry 10 times as much as it carried when first the Institution made use of that room. It was some 23 years since the telephone was first shown at Plymouth, and it was still questionable if telephony in England was flourishing. They saw a sort of triangular duel going on. They saw a company which was striving hard to give a good service to the public, and they saw municipalities trying to emulate their competitor. There was another small department, called the Post Office, which was also trying to do its duty, and it had the advantage over the other competitors that its back was broad enough to bear all the abuse put upon it. He thought that such a business as telephony should be manipulated by one concern only, and that it should be conducted upon one principle

Digitized by Google

only. He had once hoped to see a telephone in almost every house, but he was afraid he would never see his hopes realised. As to wireless telegraphy, they were getting tired of it. The papers still took it up wildly, but there did not seem to be any progress made with it. If there was a single circuit now working practically, he hoped that someone would read a paper to them on it. The most beautiful thing which Mr. Gavey had brought to their notice was the microphonograph. He thought it was a thing which was coming to stay, and it was marvellous. It was not only based on beautiful principles, but it was one of those things which was going to open the eyes of physicists as to the character of molecular magnetic operations. There was nothing to his mind so wonderful as the molecular magnetic action in steel. As to the altering of the names of the constants, Mr. Gavey had not mentioned the names given. Thus the name given to the unit of magnetic field was the "gauss," and to the unit of magnetic flux the "maxwell." He did not think the "maxwell" would come into general use, although it might be shortened to "max." He thought, however, that the name "gauss" would be taken up for the unit of magnetic field.

Mr. W. J. Hammer, of America, said that while on the Continent he had seen one thing spoken of by Mr. Gavey, and this was the "telephonograph." He had recently been in touch with some of the people connected with the invention, and they expressed a strong desire that the name "telephonograph" should be used. In Berlin he had also seen some modifications of it and some interesting experiments, but he could not say anything further concerning them, as he had seen these experiments in a peculiar way. He had had considerable experience in working with phonographs and their modifications, but had never heard anything in the way of a speaking machine which was so clear as the telephonograph. There was no scratching sound as with an instrument where the record was made with a style. He had the pleasure of seeing the Nernst lamp in operation in Paris, but the subject was one which hardly came under the heading of the paper. In Budapest he had seen the Pollak and Virag system of telegraphing, and in the present form it was a most beautiful thing, and seemed to work satisfactorily.

Mr. M. F. Roberts said that the author had mentioned the difficulty he had in explaining certain apparatus by the request made that he would not publish diagrams of it. This was one of the difficulties he himself had experienced in the Paris Exhibition. The exhibits in most instances were placed in the charge of attendants who either did not understand them or who had been told to give no explanation of them. The catalogue was also a great difficulty, many people being unable to obtain information owing to its bad preparation. He thought that the improvements spoken of, with one or two exceptions, were points of detail. He would have been glad if Mr. Gavey had extended his remarks with reference to the improvements since the 1878 exhibition. He thought the improvements in the telegraph were mainly in the higher finish of the instruments, and in the telephone they were chiefly the simplification of the design of the parts. The standardisation which appeared in the telephone parts was mainly, he thought, due to the influence of one or two firms and to the employment by these firms of men who made a study of certain apparatus—such as switchboards, dynamos, telephone instruments, etc. By this means men were obtained who brought the special part to its highest efficiency. The author had also called attention to Rowlands's apparatus. From the earliest exhibitions there had always been some such machines, but they had not made much headway. He hoped the successful exhibits of the Rowlands Company would have the effect of popularising the typewriting telegraph in this country.

A communication was then read from **Mr. A. W. Heaviside**, president of the Newcastle Section, thanking Mr. Gavey for his paper, and asking questions on certain of the points raised.

Mr. Dane Sinclair said the improvements in telegraphy which were described were very beautiful. He thought it possible that Mr. Gavey might be too enthusiastic over the central battery system. As to the microphonograph, or telephonograph, as another gentlemen called it, he would say, in justice to Mr. Gavey, that it was called a microphonograph at the Exhibition. For once in his life he had been ahead of his good friend Sir W. H. Preece, and had seen the apparatus at work. It gave a distinct record of speech, so distinct that it could not be compared with any record he had hitherto heard. The sounds came back pure without the grating sounds usual in the ordinary phonograph. The Post Office, under Sir W. H. Preece, had erected heavy copper wires all over the country, but if only a telegraphic relay could be obtained these would soon get out of date.

Mr. J. E. Kingsbury, in referring to the Bell system, said that while they gave every credit to the professor for his invention, it was yet rather early to remark upon it. He would like to say one word as to the application made by the Post Office of automatic signalling. The Post Office had installed this automatic system, and, much to the surprise of some people, had stuck to it. The central battery system was not a system of to day, for 20 years ago a patent had been taken out for it. Mr. Sinclair had thought Mr. Gavey too sanguine. He should like Mr. Sinclair to give his reasons for thinking so. With regard to the telephonic repeater, he would remind Mr. Gavey that the question was of an earlier date than 12 years ago, as Mr. Gillman took out the first patent for a repeater in 1879. The first repeater seemed to have been a more practical working instrument than the present one.

Dr. S. P. Thompson said there were three points of interest. The new magnetic units with which the Paris Congress had endowed them were certainly a great boon in speaking of magnetic quantities. They were able to say definitely that a magnetic field had an intensity of ·18 gauss, instead of saying ·18 alone, which seemed to hang on nothing. He was not sure that the "maxwell" would be such a success. They already had a good word for the field of the magnetic flux in the magnetic line, and the word "line" was easier to use. He had had the pleasure of inspecting the Slaby-D'Arco system in Berlin, and to witness its working from Berlin to Oberweide. He did not think that the diagram shown, which looked like two sausages hung up, gave one a good idea of the apparatus. Each of those sausages was a wire cage consisting of six or eight wires about 150ft. long, and hung up from a tall chimney perhaps. It was a remarkable thing that one could get messages recorded on the apparatus when both terminals were earthed. He would like to bear testimony to the extraordinary goodness of the recording phonograph and telephone which he saw in Paris. When he saw the instrument in Paris it was called the telegraphon.

Mr. J. Gavey, in reply, said Mr. Roberts referred to the desirability of giving more detail of the improvements in telegraphs and telephones which had taken place since 1878. In composing this paper he had rather tried to make it suggestive than to state definitely what the improvements were. It would take a treatise on telegraphy and telephony to do this in detail. Much apparatus which was prominent in the Paris Exhibition of 1878 had not found a place this year, and *vice versâ*. One improvement he thought was wanted. Their good friend and servant the Morse system had served them long and well, but he thought it hardly up to the present requirements. He was rather looking forward to something of the Rowlands type, by which the messages could be received in a condition to be sent out, and without the necessity of transcribing. He had no wish to depreciate Prof Hughes's beautiful instrument, but he thought they would admit that it was preferable to have the message ready printed or typed. Mr. Roberts's remarks were true in that the improvements had been in matters of detail, but the speaking instrument must consist of a transmitter, line, and receiver, and when these were had, improvements could only be in matters of detail. He ventured to think that the improvements in detail during the last four or five years had amounted almost to a revolution. Prof. Thompson had referred to the sausage-like appearance of the cages in his Slaby and D'Arco diagram, but these were almost exact reproductions of those on the pamphlet supplied by the inventors at the Paris Exhibition.

Prof. Perry then asked for the usual vote of thanks, which was unanimously accorded.

Several pieces of apparatus were shown on the table.

The following is a list of the candidates balloted for:

Members.—J. Franklin, telegraph superintendent, B.B. and C.I. Railway, Bombay, India; R. Robertson, B.Sc. (Edin.), M.I.C.E., 154, West George-street, Glasgow, N.B.; W. H. Trentham, 39, Victoria-street, S.W.

Associate Members.—L. J. Aron, Aron Electricity Meter, Limited, 46, Upper Thames-street, E.C.; M. H. Bennett, 71, Queen Victoria-street, E.C.; R. Beveridge, Messrs. Powlesland, Beveridge, and Co., Plymouth; J. Bowden, Sheriff-mount, Gateshead-on-Tyne; G. D. Dauncey, Suffolk-road, Sheffield; J. Lambert, Electric Light Station, Dundee, N.B.; J. T. Morrison, Victoria College, Stellenbosch, Cape Colony, S.A.; W. E. Pennefather, Electric Power Station, Second Basin, South Esk River, Launceston, Tasmania; H. N. Thomas, 42, Luck-lane-marsh, Huddersfield.

Foreign Members.—Prof. R. Arnó, Instituto Tecnico Superiore, Milan; Prof. M. de Châtelain, Wasili Ostrow 10 Line, No. 5, St. Petersburg, Russia; G. Semenza, Società Edison, Milan; W. G. Thomsen, Jydsk Telefon, Aktieselskab, Aarhus, Jutland, Denmark.

Associates.—W. J. Baker, 327, Blackburn-road, Bolton; G. E. Cummins, 4, Williams-terrace, High-road, Chiswick, W.; A. J. Drakes, Chief Engineer's Office, G.P.O., Capetown, S.A.; E. G. Fenning, 3, St. Matthew's-road, St. Leonards-on-Sea; W. Gaye, Eastern and South African Telegraph Company, Capetown, S.A.; J. O. G. Gibbons, 451, Shelford road, Old Trafford, Manchester; G. Gordon, 4, Haddon-terrace, Mowbray, Capetown, S.A.; I. B. Hadaway, Metropolitan District, G.P.O., Capetown, S.A.; E. P. Harvey, Purland Chase, Ross, Herefordshire; A. Henry, 8, Kimberley-terrace, Observatory-road, Capetown, S.A.; C. F. M. Hibberd, 44, Dewhurst-road, Shepherd's Bush, W.; F. Holland, 178, Ashton New-road, Manchester; R. H. Kent, 54, Darley-road, Stamford Hill, N.; G. K. Nowlan, Sirdar House, 79, Valley-drive, Harrogate, Yorks; D. Page, 33, Bedford-street, Strand, W.C.; W. H. Ridpath, 41, Princess road, Kilburn, N.W.; F. H. Rippon, 7 and 8, Queen-street, Exeter; E. L. Rossiter, Elsteinwick, Victoria; A. R. Turner, c/o Messrs. W. Denny and Bros., Dumbarton, N.B.; H. Wragg, 176, London-road, Sheffield.

Students.—E. R. Alexander, 35, Birdhurst-road, Croydon; D. R. H. Browne, King's College, London, W.C.; O. H. Browne, the Court House, Kingsthorpe, Northampton; H. L. Churton, Hillside, Chester; R. C. Creasey, Star and Garter Royal Hotel, Wolverhampton; E. De Lautour, 34, Aldridge-road-villas, Westbourne Park, W.; C. H. Fisher, Highfield, Hamlet Court-road, Westcliff-on-Sea, Essex; R. B. Forster, Wynnstay, Roebuck, Milltown, co. Dublin; R. W. Gregory, 26, Great Peter-street, Westminster, S.W.; S. H. Harris, 2, Capel-road, Faversham, Kent; A. L. Kavanagh, Mercers' Hall, Ironmonger-lane, Cheapside, E.C.; R. M. Longman, 26, Great Peter-street, Westminster, S.W.; F. O. Mills, 31, Lansdowne road, East Croydon; L. Romero, 2, Norwood-villas, Waterworks-road, Edgbaston, Birmingham; H. W. Taylor, 8, Elphinstone-road, Avenell-road, Highbury, N.; W. B. Thompson, Ewhurst, Hendon.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	757	On the Supersession of the Steam by the Electric Locomotive	776
The Philosophy of Dynamo Design	762	Light Railways	780
The Arrangement of the Distributing Network	764	Forthcoming Events	780
Relative Advantages of Direct-Current and Three-Phase Distribution for Small Installations	766	New Committees	780
Electric Oscillations	770	Questions and Answers	781
Electrical Contacts	771	Physical Society	784
Institution of Electrical Engineers	772	Legal Intelligence	784
Municipal Undertakings and Income Tax	774	Companies' Meetings and Reports	785
Correspondence	775	Contracts for Electrical Supplies	785
London County Council Tramways	775	Traction Notes	786
Opening of the Beckenham Electric Light Station	775	Lighting Notes	788
		Proposed New Bills	790
		Provisional Patents	790
		Traffic Returns	792
		Companies' Stock and Share List	792

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

MUNICIPAL UNDERTAKINGS AND INCOME TAX.

Income tax was in the first place imposed as a temporary expedient to raise money urgently needed; it has, however, become a permanent institution without much tendency to shrink in poundage. If municipal undertakings are to be looked upon as profit-making concerns, such undertakings will have to pay income tax. Before discussing this phase of a professedly difficult problem, we must once again revert to the opinions previously put forward in these columns. We have urged that no very great difficulty ought to be found in classifying the work to be carried out by municipalities. There is one class of work not containing many items, about which there is no contention as being best carried out by the local authority. Another class with extensive items is well outside their sphere of operations. The third and smallest class consists of items either on the border line, and debatable as to which of the other classes they belong, or whether to be undertaken or not according to questions of expediency. Another point is that no municipal undertaking whatsoever should be carried on in order to obtain a profit. We feel perfectly certain that municipal profit-making is wrong in principle and will prove wrong in practice. The father of a family does not play off some of the members of the family against the others. The municipality is a family, its council the city fathers; yet these fathers seem lately to forget their fatherhood, and to differentially treat their children. But our desired Utopia is not yet, and meanwhile "profit-making" is a rampant certainty. It is but just, then, say the Income Tax Commissioners, that "profits" should bear income tax. "But," say some of the municipal wranglers, "these are really not profits. The money may be called profit, but that is really a euphemism to mislead the ignorant ratepayer, and to induce him to vote for us, who, on paper, seem to be doing so much for him." "What we do," say these sophists, "is to differentially rate the ratepayers. Those of the householders who deal with us pay a little more for their goods than they ought in justice to pay, and this extra payment is redistributed both to those who do deal with us and those who do not, thereby making our customers pay part of the rates that should legitimately fall upon non-customers. There is no income tax levied upon rates, hence there should be no income tax levied upon our profits." Unfortunately, the Income Tax Commissioners will not listen to this sophistry, but demand their pound of flesh. Under these circumstances, the poor municipalities have to pay; and their trouble is to pay as little as possible, while the Commissioners, having no bowels of compassion, are somewhat exorbitant in their demands. Assuming that the undertakings carried on by the municipalities are purely business concerns, how ought they to be taxed? To answer this question, let us first consider some of the features of municipal finance. A year or two ago some of the seaside townships had to consider the building of temporary hospitals, and in some cases applied to the Local Government Board for powers to borrow and repay the outlay over a short period

Digitized by Google

of years. Such powers to repay were almost without exception refused. Again, during the past few years large sums have been borrowed for improving the streets and paving with wood, etc. It is permitted to borrow and repay over a term, but the term of repayment is decided by the probable life of the material to be used for paving. If a seven years' term for repayment is granted, it is because the material is expected to last for seven years, and not to require replacing till after that time has passed. We may be sure that a Government office does not err in granting too long a period; indeed, all the critics we have heard indicate that the period allowed is too short. It has always seemed to us that this compulsory periodic repayment as regards municipalities served in place of depreciation and reserve in the case of companies. Income tax is not levied upon depreciation, and if one Government department says depreciation must be so much, and will not hear a whisper to the contrary, and will not extend the time for repayment—which, of course, would lessen the annual account for depreciation—surely another Government department can hardly be right when it imposes some other and less percentage for depreciation in order to increase its own bill. That is our point for the present. A municipality has no power to say what is the proper depreciation. The department decides that, and yet, we believe, another department not infrequently steps in and says, "Tommy rot. The depreciation we allow is 'so and so,' and you must pay up." This is a sample of the business-like capabilities of Government departments. Of course, there is no logic in the system. You pay all the same.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE BRITISH ELECTRIC STREET TRAMWAYS COMPANY, LIMITED.

SIR,—In one of the London evening papers of the 27th inst. there are remarks in an article relating to the prospectus issued by the British Electric Street Tramways Company, Limited, coupling the name of Thomas Parker, Limited, with that company. We beg to say Thomas Parker, Limited, has nothing whatever to do with the British Electric Street Tramways Company, Limited, and has no interest whatever in its promotion. We should be obliged if you would publish this letter to avoid any misapprehension.—Yours, etc.,

H. AND J. E. UNDERHILL AND THORNEYCROFT,
Solicitors to Thomas Parker, Limited.

24, Darlington-street, Wolverhampton, Nov. 28, 1900.

LONDON COUNTY COUNCIL TRAMWAYS.

At the meeting of the London County Council held on Tuesday last, the plans of Prof. A. B. W. Kennedy for three sections of tramlines came up for approval. The sections in question are those tramway routes between Westminster Bridge-road and Upper Tooting, between Kennington Park-road at its junction with Kennington-road and the terminus in Blackfriars-road, and between St. George's-circus and the terminus in Waterloo-road. According to the regulations of the London County Tramways Act of 1900, a certain routine has to be gone through before electricity can be used as the motive power on the lines within the county of London. For instance, the approval of the Board of Trade to the system which is to be used has to be obtained. Before this consent can be given, the road authority has to have an opportunity of being heard, so that any objections this authority may have may receive the due consideration of the Board of Trade. On Tuesday last three resolutions were passed by the London County Council. The first approved of the system devised by Prof. A. B. W. Kennedy, the next authorised the Council to submit to the Board of Trade the requisite plans and description of the system of electric traction proposed to be used, and the last resolution was to the effect that the same description and drawings were to be supplied to the Councils of the metropolitan boroughs of Lambeth, Southwark, and Wandsworth. These plans are up to the present not to be made public, but we are quite sure that such an eminent engineer as Prof. Kennedy will have devised a system which will safeguard the other users of the public streets. This being the case there should be little delay over obtaining the formal consents of the local authorities and of the Board of Trade. In such a large matter as the conversion of the whole of the London county tramways to electric traction it is well not to hurry the engineer responsible for the construction at first, but we trust that when the system has been approved and tried the conversion of the rest of the sections will be proceeded with as a matter of extreme urgency. Electric trams through the streets of the London suburbs will, of course, play havoc with the traffic of a number of suburban railways. The loss of income which will occur in this way will do more to wake up the control of these lines to their defective service than anything we know of. The record of what has been done in Sydney by electric traction is worthy of careful study by our London county councillors. When one considers that one section of the tramways in Sydney successfully carries 70,000 passengers per day, the possibilities of our London lines will be realised.

OPENING OF THE BECKENHAM ELECTRIC LIGHT STATION.

On Thursday the 22nd inst., was witnessed the opening ceremony of the electric lighting station and dust destructor works at Beckenham, the company present including members of the Urban District Council, many leading residents, and a good sprinkling of ladies. The station was open for inspection prior to the ceremony, and very great interest was taken in all that was to be seen.

Mr. T. C. COLE, J.P., chairman of the Urban District Council, presided over the opening proceedings, and after a few preliminary remarks he called upon Mr. W. H. Lendon, the chairman of the Electric Lighting Committee, to explain what, he said, was undoubtedly the most important enterprise which they as a Council had yet undertaken.

Mr. LENDON then gave a mass of information respecting the inception and carrying out of the scheme, in the course of which he pointed out that the electric lighting provisional order was bequeathed to the Council by the old Local Board. It was obtained in 1893 on the strength of a report from Mr. Gisbert Kapp, the eminent electrical expert. He referred to the decision of the Council to combine with the scheme a dust destructor, and commended their action in keeping the scheme in their own hands, and thus preventing the creation of a private monopoly, which would prevent the ratepayers from ever deriving any benefit that accrued. The total cost of the scheme was estimated at £37,000, and the Local Government Board's sanction to a loan was obtained on June 5, 1899. He traced the subsequent course of events, and specially referred to the tender from the British Insulated Wire Company as most advantageous. The main feature of this tender was, he said, that whilst the Council should erect the station and provide the electrical plant, in accordance with other tenders accepted, the British Insulated Wire Company would, at the completion of the works, take over and work the undertaking for a period of five years,

Digitized by Google

including the destruction of house refuse; the Council being relieved of all payments for sinking fund and interest, working expenses, and all other financial liabilities whatsoever during the said term, whilst, on the other hand, the contractors received the income accruing from the sale of the current. The installation would revert to the Council, without payment of any premium, at the end of the contractor's period of working. The advantages of this arrangement, said Mr. Lendon, were that there would be no loss to the Council during the five years, an assured income accruing to the Council subsequent thereto, and private monopoly would not be created. The tenders which had been accepted were as follows: erection of the engine and boiler house, chimney shaft, and approach roads, Messrs. Nightingale, £9,500; destructor and flues, Messrs. Horsfall and Co., £2,500; bringing the total cost of the buildings to £12,000. For the alternators, engines, and switchboard, Messrs. Fowler and Co., £6,600; three water-tube boilers, Messrs. Babcock and Wilcox, £3,300; cables, the British Insulated Wire Company, £14,400; arc lamps, Messrs. Lucy and Co., £600; crane, Messrs. Chatteris and Co., £160. The total cost of the contracts for electrical plant amounted to £25,000. Mr. Lendon alluded to the sagacity, forethought, and energy of Mr. R. P. Wilson (consulting engineer), Mr. A. J. Hedgcock (resident engineer of the British Insulated Wire Company), Mr. J. A. Angell (the Council's engineer and surveyor), and Mr. Fredk. Stevens (clerk to the Council). Concluding his statement, he said the electrical system adopted was that known as the high-tension alternating system, current being generated at the station at 2,000 volts and transformed to 400 volts at the various transformer stations, whence it was conveyed by low-tension distribution on the three-wire system to the houses at a pressure of 200 volts. Forty-two miles of lead-covered cables, protected by stoneware troughs filled with bitumen, had been laid in 18 miles of trenches, and 16 arc lamps would be placed in the High-street. He said the future prospects of the undertaking were most promising.

After a short interval Mrs. Cole, wife of the chairman of the District Council, switched on the light amidst the cheers of the company, and this part of the proceedings then terminated.

Later in the evening the chairman of the Council and the chairman of the Electric Light Committee entertained their brother councillors, officials, and others at a dinner at the Public Hall, Mr. T. C. Cole presiding, and among the visitors were Mr. H. W. Forster, M.P. (Sevenoaks division of Kent), Mr. G. E. Dodson, J.P. (chairman of the Penge Urban District Council), and Mr. T. Davis, J.P. (chairman of the Bromley Urban District Council). The tables were brilliantly illuminated by the electric light.

The toast of the evening, "Success to the Beckenham Lighting Undertaking," was proposed by Mr. LENDON in one of his characteristic speeches, in the course of which he said it should be known that the ratepayers were indebted for the successful inauguration of the scheme to the ability, unflagging energy, and astuteness of those who had advised them.

Mr. R. P. WILSON, the consulting engineer, replied. He said that in the early days of the consideration of this scheme, Mr. Angell and he concluded that it would be a safe estimate to put the total number of lamps connected with the main as being 11,000, or thereabouts. As a matter of fact, before long there would be 7,000, and at the end of 12 months this would increase to 12,000. But the unfortunate part was that these 12,000 represented approximately a 500-h.p. station, whilst their station was only equipped with a 400-h.p plant. The refuse destructor was really the most interesting part of this combination. The difficulty was to ascertain the calorific value of the refuse, because no two samples of refuse gave the same results.

Mr. J. A. ANGELL also replied, and in the course of his remarks said that many people had thought the Council were much too precipitate in this matter. Having regard to the fact that they had had the electric lighting order for something like seven years, and there were outside companies trying to obtain the order, and that they were informed that the Board of Trade would revoke the order if they did not make a move, he thought that this charge fell to the ground. They had no sooner started the work than people said they were exceedingly slow. But during the 15 months the work had been started they had, by an arrangement with Bromley, given Shortlands and South Hill the electric light. The Council had also introduced a dust destructor, and provided the remainder of the district with the electric light. In addition, they had solved the very difficult problem of free wiring, which was one of the finest schemes ever presented by a district council of this country. Having regard to the fact that this was done without any charge on the rates, with an assured income at the end of five years without bartering their birthright one jot or tittle, he thought there was very little in this charge that they had been slow.

Mr. A. J. BAKER, J.P., proposed "The Visitors," to which Mr. H. W. FORSTER, M.P., replied. Dr. RANDELL proposed "The Health of Mr. F. Stevens" (clerk to the Council), and that official responded in a fitting speech. Mr. A. GURNEY SMITH gave "The Hosts," and the replies of Mr. COLE and Mr. LENDON terminated the programme.

Some capital musical selections were rendered during the evening. It may be mentioned that the artistic arrangements of the electric lighting of the dinner tables had been carried out by Messrs. Buchanan and Curwen in the space of a few hours.

ON THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.

BY W. LANGDON, VICE-PRESIDENT.

Probably one of the most interesting questions associated with the application of electrical energy to railway work, is its eventual supersession of the steam locomotive. Electric locomotives of a capacity equal to that of the steam locomotive, doing similar work, and possessing certain marked advantages, are an accomplished fact, and to many it may seem that the days of the steam locomotive are numbered. We must not, however, forget that that which has been done has its *raison d'être*. Its employment has hitherto been generally confined to localities where the effects of steam and smoke would exercise a baneful influence. Because it has been so employed, and its employment has been attended with such marked success, it does not follow, however much it may appear desirable, than in overland lines of railway electricity will in future prove to be the element of power. Railways are commercial undertakings, in which vast sums of money have been embarked, all of which, investors expect, will produce a certain annual return. The supersession of the steam by the electric locomotive thus resolves itself, primarily, into one of profit and loss. If its adoption will enable railways to be worked more economically than is the case under steam, then it will, with its attendant advantages, sooner or later, be adopted—if not by the whole, certainly by the greater portion of the railways of this country; but, whatever the ulterior advantages may be, unattended by this result, its adoption will remain doubtful.

The first question to be asked is: Are we in a position to consider the subject? Are the data at our disposal such as to admit of a reasonable treatment of it? I think we are. The primary factors are well known. We know how many pounds of steam we can obtain from a given quantity of coal. The efficiencies of prime movers and electrical generators, the loss in transmission, transformation, and distribution are all determinable. Any advantages yet to come must be looked for in the steam generator and in the simplification and consequent ultimate increase of efficiency in the electrical apparatus. In each, no doubt, the future will see production cheapened. Labour may advance, but competition will grow, and in the price of the manufactured article we may reasonably look to the future to produce some advantage. Having then the material at hand, it is reasonable to conclude that the consideration of the subject can only be attended with good; for if it should be shown that advantage is to be anticipated from such a change, it will help us to grasp that which has to be attempted, and perhaps to evolve from the data at our disposal the course most desirable to follow.

The railways of the United Kingdom comprised on Dec. 31, 1899, the following mileage of line: double line or more, 11,977; single line, 9,723—total mileage, 21,700. The number of locomotives employed for working these railways was 20,461. The total number of vehicles of all descriptions was rendered as 752,930. The year's cost for locomotive power, including stationary engines, was £16,491,377. The number of miles

* Paper read before the Institution of Electrical Engineers, Nov. 29.

Digitized by Google

TABLE I.—MILEAGE OF LINE, COST OF LOCOMOTIVE POWER, TRAIN MILEAGE, ETC., FOR YEAR ENDING DEC. 31, 1899.

—	Length of line in miles open on Dec. 31, 1899.			Cost of locomotive power, including stationary engines.	Number of locomotives.	Number of miles travelled by trains.			Cost per train mile for locomotive power. $\frac{c}{g}$	Number of miles travelled by trains per hour during year of 365 days. $\frac{g}{8760}$	Number of trains per mile per hour (365 days to the year). $\frac{k}{b}$
	Double or more.	Single	Total.			By passenger trains.	By goods and minerals.	Total.			
(a)			(b)	(c)	(d)	(e)	(f)	(g)	(h)	(k)	(l)
				£					Pence.		
England and Wales	9,933	5,111	15,044	14 101 842	17,411	178 684 803	151,377,966	330,062 769	10 253	37, 678	2 505
Scotland	1,423	2,057	3,480	1,811 552	2,241	27 588,633	21 473 089	49,061,722	8 862	5. 601	1·609
Ireland	621	2,555	3,176	577 983	809	10,367,617	6,749 157	17 116 774	8 104	1, 954	0·615
Total—United Kingdom	11,977	9,723	21,700	16,401,377	20,461	216,641,053	179,600,212	396,241 265	9 988 Average	45, 233	2 084 Average
RAILWAY COMPANIES.											
				£					Pence.		
Great Northern	—	—	825	995,690	1 259	11,729 522	12,426,497	24 156,019	9·892	2.757	3 3
Great Western	—	—	2,602	1,884 032	1,933	23 085,687	22,561 470	45 647 157	9·905	5 210	2·0
London and North-Western	—	—	1,924	1,927,049	2,959	26 285 278	22 515,697	48.800,975	9 477	5 570	2 9
London and South-Western	—	—	900	709 110	728	12 598 390	4 689 644	17,288,034	9 844	1 973	2 2
Midland	—	—	1,431	2,016 816	2,507	18 979 594	28,387,090	47 366 684	10 218	5 407	3·7
North-Eastern	—	—	1,632	1,632 967	2 047	14 641 572	17.307,802	31,949 374	12 266	3 647	2·2
								Average	10 267		

travelled by trains was 396,241,265. Number of passengers, exclusive of season tickets, 1,106,691,991. The tonnage of minerals, 296,611,190; and of general merchandise, 117,011,835.

In dealing with a question of this nature it seems desirable to produce these figures; but they are, in fact, except to afford some idea of the magnitude of the subject, of very little use. The length of the passenger journeys is not stated, nor are the journeys taken by season-ticket holders included. To be of value the per passenger mileage, including, of course, the journeys made by season-ticket holders, should be given. The same objection applies to the mineral and goods tonnage statement. It records the tonnage declared as placed upon the railway, but whether it is carried one mile or one hundred miles is not shown. In fact, the returns as rendered aid the consideration of the subject very little, and I am sorry to say the information in the hands of the railway companies themselves carries us no further. Under these circumstances, the establishment of a common basis upon which to consider the relative cost presents much difficulty. The only manner in which it can be approached is by averaging the data obtainable, or by examining the work of a particular section of line. In Table I. I furnish extracts from the Board of Trade return for the year 1899, showing the mileage of line, cost of locomotive power, train mileage worked, etc., for England and Wales, Scotland and Ireland, together with certain deductions therefrom applicable to these results, as also similar data in reference to six of the most important English companies. In considering the mileage of line quoted, it should be mentioned that the figures do not disclose the *mileage of roads*. Over many sections of the several lines of railway there are more than two roads. Most main routes working out of London possess four and even six roads for a considerable distance; and the same applies to other busy portions of the chief railway systems. The table indicated shows that the cost of locomotive power for the United Kingdom, including stationary engines for pumping and other purposes, works out at 9·988d. per train mile; that the cost for England and Wales is 10·253d.; for Scotland, 8·862d.; and for Ireland, 8·104d.; and that this cost varies with the several companies quoted as follows: London and North-Western, 9·477d.; London and South-Western, 9·844d.; Great Northern, 9·892d.; Great Western, 9·905d.; Midland, 10·218d.; and North-Eastern, 12·266d.—their average cost being 10·267d. Column *l* indicates the number of trains per mile per hour, based upon the mileage of line of railway shown by the returns. Bearing in mind that there are, over many portions of the railways indicated, several lines or roads, the number of trains travelling per mile per hour is, perhaps, surprisingly small. Ireland claims but 0·615; Scotland, 1·609; England and Wales, 2·505. Of the railways individualised, the Great Western has an average of but 2; the London and South-Western and the North-Eastern each 2·2; London and North-Western, 2·9; Great Northern, 3·3; and the Midland, 3·7 (that is, the Midland, for instance, has on an average 3·7 trains passing over each *mile of line of railway* each hour, not that the mile of line is occupied by these 3·7 trains during the entire hour, but that that is the average number of trains worked over the mile of line of railway—quite irrespective of the number of lines of rails—within that period of time).

If trains were, in practice, so distributed, this might form a basis on which to found a comparison of cost for the entire railway system; but we know that this is not so—that trains are much more frequent on certain portions and less frequent on other portions of the lines of railway, and although it is a kind of basis affording some very interesting figures, it is not, as it stands, a practical one for the purpose in view. To effect this it is necessary to consider the work of an individual section of some line of railway; and with this view I have taken that portion of the Midland Company's main line between London (St. Pancras) and Bedford—omitting the suburban and local traffic applicable to the Metropolitan and Tottenham lines. The length of line of railway is 49·5 miles—practically 50 miles—and the number of lines of rails applicable to the traffic under consideration may be taken as four—it is not less. In order to ascertain the number and character of trains to be taken into consideration, I have obtained returns (Tables II. and III.) extracted from the block book, of those trains passing two points—Luton and Harpenden—each hour, during a day of 24 hours in the month of July, 1900, which I have summarised and classified so as to bring the subject within reasonable scope. These details are carried forward to Table IV., which forms the basis of calculation for comparison of cost for power to work the traffic indicated.

The classification adopted is necessarily somewhat arbitrary, but in its construction I have endeavoured to err on the right side—for instance, I have debited each train of its class as a loaded train, whereas some would certainly be light trains. Again I have, I believe, accorded to each their full merit of speed, although there is reason to assume that in many instances certain goods and minerals would not observe that allotted to them. From this table we get the tractive effort per train and the consequent mechanical and electrical power required to deal with *one hour's work*. The work may, and of course does, vary from one hour to another. Indeed, that is clearly shown by Tables II. and III.; for instance, the trains passing Harpenden vary per hour from 7 to 16, and Luton from 7 to 19, but the section of line chosen may be regarded as a full line, a line well occupied by trains both night and day, Sundays and weekdays. The returns show an average of 11·9 trains passing Luton and of 12·4 passing Harpenden per hour. In taking an average, however, I have apportioned no less than 14 trains to the hour. This number divided between the four lines of metals gives a result of 3·5 trains per mile per hour per line of metals. It may here, however, be as well to point out that, so long as the appropriated number of trains is fairly that in practice, the number applied is, for comparison purposes, immaterial, for the comparison I draw is based upon the train mileage cost.

Fig. 1 illustrates the section of line under consideration. The position of engine-sheds is shown by stars (*); of water-

Digitized by Google

TABLE II.—Luton. Statement of the Number of Trains recorded in the Block Book for the 24 hours ending midnight on Thursday, July 19, 1900.

Hours.	Express passenger.	Ordinary passenger.	Coaches.	Fish and milk.	Express goods. Class "A."	Express goods. Class "B."	Ordinary goods.	Minerals.	Light engines.	Total trains each hour.
12 to 1 a.m.	2	—	—	—	1	5	—	3	—	11
1 ,, 2 ,,	—	—	1	—	—	10	—	2	—	13
2 ,, 3 ,,	—	—	1	3	1	3	—	5	—	13
3 ,, 4 ,,	1	—	—	—	—	3	—	6	—	10
4 ,, 5 ,,	1	—	—	—	3	5	—	6	—	15
5 ,, 6 ,,	2	—	—	—	2	4	1	2	—	11
6 ,, 7 ,,	1	1	—	—	3	—	1	5	—	11
7 ,, 8 ,,	1	1	4	—	2	4	1	3	—	16
8 ,, 9 ,,	1	1	—	—	1	2	—	2	—	7
9 ,, 10 ,,	4	—	—	—	—	2	—	4	—	10
10 ,, 11 ,,	4	1	—	—	—	1	1	4	—	11
11 ,, 12 (noon)	3	—	—	—	1	1	1	3	—	9
12 ,, 1 p.m.	4	1	—	—	—	1	2	5	—	13
1 ,, 2 ,,	4	1	1	—	—	2	—	4	—	12
2 ,, 3 ,,	6	2	3	—	—	—	—	8	—	19
3 ,, 4 ,,	2	3	—	—	1	—	3	5	—	14
4 ,, 5 ,,	4	—	1	—	—	—	1	5	—	11
5 ,, 6 ,,	4	2	—	—	—	—	2	3	—	11
6 ,, 7 ,,	5	1	—	—	—	—	—	4	—	10
7 ,, 8 ,,	4	2	1	—	—	—	—	5	—	12
8 ,, 9 ,,	—	2	1	—	3	—	—	1	—	7
9 ,, 10 ,,	2	—	—	—	1	2	—	4	—	9
10 ,, 11 ,,	5	2	—	—	—	—	2	7	—	16
11 ,, 12 (midnight)	2	1	2	—	1	6	3	1	—	16

CLASSIFICATION.

Express passenger			62
Ordinary passenger		21	36
Coaches		15	
Fish and milk		3	
Express goods—Class "A."	20	71	74
Express goods—Class "B."	51		
Ordinary goods		18	115
Minerals		97	
Total number of trains during the 24 hours			287
Maximum number of trains in one hour			16
Minimum ,, ,, ,,			7

TABLE III.—Harpenden. Statement of the Number of Trains recorded in the Block Book for the 24 hours ending midnight on Thursday, July 19, 1900.

Hours.	Express passenger.	Ordinary passenger	Coaches.	Fish and milk.	Express goods. Class "A"	Express goods. Class "B"	Ordinary goods.	Minerals.	Light engines.	Total trains each hour.
12 to 1 a.m.	2	—	—	—	3	3	1	4	—	13
1 ,, 2 ,,	—	—	1	—	—	9	2	2	—	14
2 ,, 3 ,,	—	—	1	3	1	3	2	1	—	11
3 ,, 4 ,,	—	—	—	—	2	3	3	3	—	11
4 ,, 5 ,,	1	—	—	—	2	5	4	1	—	13
5 ,, 6 ,,	3	1	—	—	2	4	2	1	1	14
6 ,, 7 ,,	—	—	—	—	—	2	5	1	1	9
7 ,, 8 ,,	2	3	2	—	2	5	—	—	1	15
8 ,, 9 ,,	4	1	—	—	1	—	5	3	—	14
9 ,, 10 ,,	5	2	—	—	—	1	3	1	—	12
10 ,, 11 ,,	3	1	—	—	1	1	—	1	—	7
11 ,, 12 noon	5	—	—	—	—	2	2	2	—	11
12 ,, 1 p.m.	5	2	1	—	—	1	1	2	—	12
1 ,, 2 ,,	3	2	—	—	—	1	6	3	1	16
2 ,, 3 ,,	5	3	1	—	—	1	3	2	1	16
3 ,, 4 ,,	4	1	1	—	—	1	2	3	1	13
4 ,, 5 ,,	3	5	—	—	—	—	2	2	—	12
5 ,, 6 ,,	5	1	—	—	—	—	2	2	—	10
6 ,, 7 ,,	3	1	—	—	—	—	2	2	1	9
7 ,, 8 ,,	6	2	—	—	2	—	1	—	—	11
8 ,, 9 ,,	2	3	—	—	1	2	1	3	1	13
9 ,, 10 ,,	3	2	—	—	—	3	3	3	1	15
10 ,, 11 ,,	3	2	—	1	1	1	1	2	1	12
11 ,, 12 midnight	—	1	1	—	4	4	2	2	—	14

CLASSIFICATION.

Express passenger			67
Ordinary passenger		33	41
Coaches		8	
Fish and milk		4	
Express goods—Class "A"	22	74	78
Express goods—Class "B"	52		
Ordinary goods		55	111
Minerals		46	
Light engines		10	
Total number of trains during the 24 hours			297
Maximum number of trains in one hour			16
Minimum ,, ,, ,,			7

cranes by dots (·). The short or suburban traffic between St. Pancras and Hendon, and the Tottenham line, etc., is not included in my schedules, for the reason that, viewing the section of line as if actually subject to electrical working, there would be little doubt that this immediate London-suburban traffic would demand a generating station nearer home than that indicated in the scheme I have adopted as my basis for the comparison of costs for working a 50-mile section of line. The plant scheme is roughly outlined in Fig. 2. Midway in the 50 miles of railway is the central station, containing four 2,500-kw. three-phase, or other characteristic, 10,000-volt generators. At this pressure current is distributed to sub-stations, each serving 10 miles of railway, where the potential is converted to 600, from whence it is carried to the contact rail. Or the centre 10-mile section may be provided for by direct-current generators served from the same steam plant. The efficiencies of the various parts are assumed as follows:

	Loss, per cent.	Efficiency.
Motors	15	·85
Ohmic loss in rails	10	·90
Leakage	2½	·975
Rotary converters	10	·90
Static transformers	7	·93
High-tension transmission	10	·90

The total kilowatts required on the train wheels (Table IV.) is 2,905 per hour, and the number of trains is 14. Therefore $\left(\frac{2,905}{14}\right) = 207{\cdot}5$ will be the average kilowatts per train hour; and, assuming the efficiency of the motors at 85 per cent., $\left(\frac{207{\cdot}5}{{\cdot}85}\right) = 244$ kw. will be the average power required to be supplied to each train. If, now, we allow 10 per cent. loss in the rails which supply and return the current, a pressure of 540 only will be available at either end of a section of 10 miles. Therefore the amperes per train that will be required will be $\left(\frac{244 \times 1,000}{540}\right) = 452$. As there are 14 trains per hour in the total 50 miles section, there will be $\frac{14}{5} = 2{\cdot}8$, say three trains in one section of 10 miles to be supplied by one sub-station,

$$452 \times 3 = 1,356 \text{ amperes.}$$

Adding 2½ per cent. for leakage, we have 1,390 amperes as the current to be supplied by each sub-station at 600 volts. The efficiency of the converters and static transformers is taken at, respectively, 90 per cent. and 93 per cent., and the three-phase transmission at 90 per cent. $\therefore \frac{1,390 \times 600}{1,000 \times {\cdot}9 \times {\cdot}93 \times {\cdot}9} = 1,107$ kw. to be delivered to the trains for each section containing three trains. As there are 14 trains there will be four sections with three each, and one section with two trains. Now the four sections with three trains each would require $1,107 \times 4 = 4,428$ kw. To allow for the maximum loss let it be assumed that the centre 10-mile section, which, as previously indicated, might be supplied direct at 600 volts, is so dealt with, and that it is the section that has two trains only. The kilowatts required would equal

$$\frac{1,390 \times 600}{1,000} \times \frac{2}{3} = 556 \text{ kw.}$$

Therefore, the total kilowatts to be generated would be—

$$(4,428 + 556) = 4,984, \text{ say } 5,000,$$

and the combined efficiency $\left(\frac{2,905}{4,984}\right)$ would be 58·3 per cent.

This 5,000 kw. is the power required to be generated to work the 14 trains, travelling 479 miles during the hour, as shown in Table IV., and upon it all comparative calculations and deductions have to be based.

The demand may, of course, go beyond this, or it may be less, but so long as the generating power, and that of the corresponding parts, is there to meet it, that branch of the question may be disregarded. As I have previously stated, the comparison is made between the ascertained quantities travelling a stated mileage at a stated speed. If the mileage were greater, or the number of trains greater, the comparison would be equally applicable. It is in respect of the mileage result immaterial, so long as we apply it to a fairly representative condition. The speed and the train load indicated in Table IV. will, I believe, bearing in mind that the number of trains are regarded as all carrying the full load indicated, be found to conform to this. A generating plant capable of an output of 10,000 kw. is, of course, ample to provide for a calculated demand of just half that amount. I adopt the following estimate as applicable to the prime cost.

Digitized by Google

TABLE IV.—Basis of Calculation.—Showing Number of Trains, classified, passing certain points of a 50-mile Section of Line of Railway; Calculated Mechanical Horse-power and Electrical Power for working the same, together with apportioned Speed, Load, etc.

Class of train.	Number of trains per day of 24 hours passing.		Basis of calculation.							Total.	
	Luton.	Harpenden.	Apportioned number of trains per hour	Speed, miles per hour.	Train-miles per hour.	Load, including engine, tons.	Total tractive effort per train.*	Mechanical horse-power per train hour.	Equivalent in kilowatt hours.	Mechanical horse-power per hour.	Equivalent in kilowatts per hour.
1. Express passenger	62	67	3	50	150	275	3,575	477	356	1,431	1,068
2. Ordinary passenger and empty coaches	36	41	2	32	64	300	2,130	182	136	364	272
3. Express goods and perishables	74	78	4	35	140	400	3,160	295	220	1,180	880
4. Ordinary goods and minerals	115	111	5	25	125	500	2,750	183	137	915	685
Totals	287	297	14		479					3,890	2,905
Average per hour	11 9	12 4									

Tractive effort per ton $= 3 + \frac{V^2}{250}$ where V = speed in miles per hour. Horse-power $= \frac{\text{Tractive effort pounds} \times \text{miles per hour}}{375}$

* Tractive effort × load tons = total tractive effort per train.

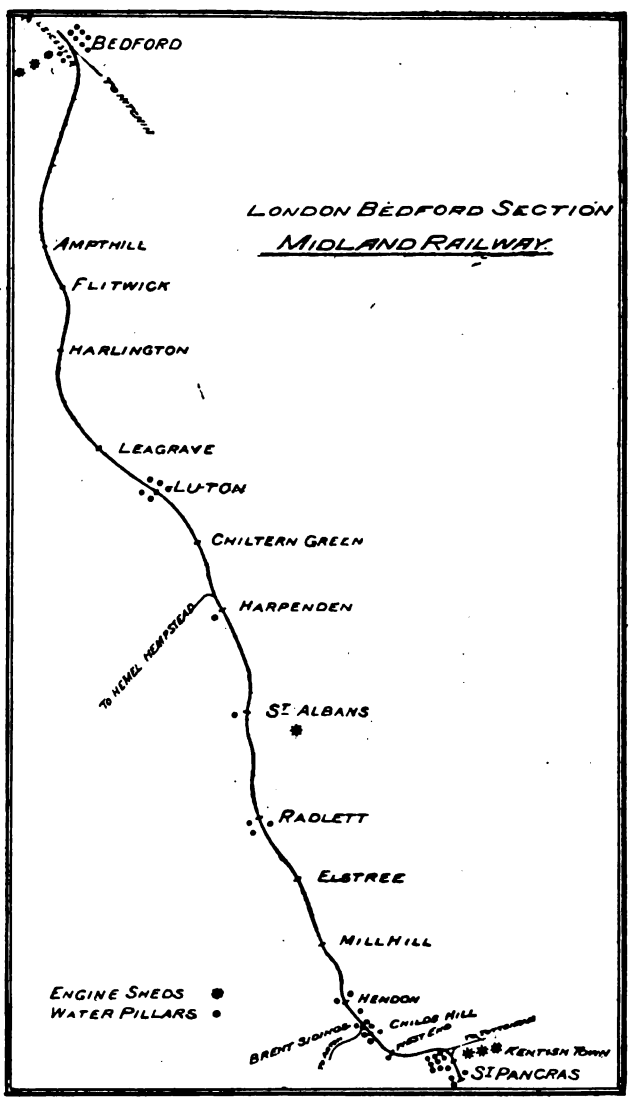


Fig. 1.

Generating Station.		
Buildings, foundations, chimney stacks, etc. ...	£50,000	
Equipment, including steam units, boilers, coal conveyers, steam mains, condensers, pumps, etc.	200,000	
		£250,000
Sub Stations.		
Buildings—five stations.....	10,000	
Equipment of ditto with transformers, converters, etc., delivering at 600 volts, and all necessary fittings.....	70,000	
		80,000
Cables, including laying.....	70,000	
Contact rail, 200 miles—*i.e.*, four roads of 50 miles each.....	70,000	
		140,000
Total capital outlay for generation and distribution of current.....		£470,000

The figures comprised within the two first items are practically those given by Mr. Parshall with reference to a somewhat similar plant, with the exception that the amounts have been increased to the extent of £15,000 for the generating station equipment, consequent upon the adoption of a higher voltage; and £10,000 for generating station buildings to meet any advance of prices; £10,000 has also been added for independent transformer buildings. The cost of cables,

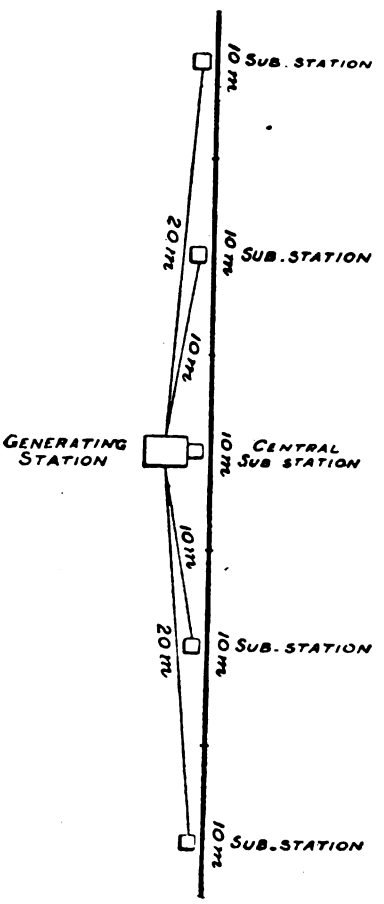


Fig. 2.

including laying in position, is based upon the current demand and mileage. The hourly demand has been shown to be 5,000 kw. The annual output for the section of line under consideration will therefore be this amount multiplied by the 24 hours per day, and 365 days to the year—viz., 43,800,000 kilowatt-hours. On this basis I estimate the annual cost for generation and distribution of current as shown in the annual column of the following table, from which, by dividing the sums there shown by the annual kilowatt output, I obtain the per kilowatt-hour charge. To the foregoing we have to add the cost for drivers and assistants in attendance upon the electric locomotives—performing practically the same duties as the driver and firemen in attendance upon the steam locomotive, together with that for repair and renewal of all machinery, including the locomotives.

(To be continued.)

Digitized by Google

LIGHT RAILWAYS.

Notices of intended application under the Light Railways Acts, 1896, have appeared in the *London Gazette* as follows: Bridlington and Fordingham Light Railway Company (extension of time, etc.), Rotherham, Tindsley, and Tickhill light railway (promotion by company), Tannock Valley Light Railway Company (extension of time, etc.), Mitcham light railway (promotion by the Croydon Rural District Council), Dartford light railways (promotion by the Urban and Rural District Councils), Halesowen light railway (promotion by the Rural District Council), Sandgate, Cheriton, and Folkestone light railway (promotion by company), Potteries light railways (extension), Isle of Thanet light railways (extension of time), Pwllheli, Nevin, and Porthdinlleyn light railways (promotion by North Wales and District Light Railway and Electric Power Syndicate), Worcester light railways (extension), Warrington and Northwich light railway (promotion by company), Barton-upon-Irwell (promotion by Rural District Council), Rhondda Valley light railway (extension and wideninga), Mid-Suffolk light railway (promotion by company), Lizard light railway (extension of time).

The Works Committee of the Beckenham Urban District Council are considering the proposed electric railway or tramway for the purpose of improving the communication between Beckenham, the Crystal Palace, and the town of Croydon.

Permission has been granted by the Chester-le-Street Highway Authority to the United Kingdom Tramways and Light Railway Syndicate to build an electric tramway connecting the Hettons by way of Houghton-le-Spring, Newbottle, Painshaw, Washington, Washington New-road, now in course of construction, with Gateshead and Tyneside.

The proposal to form a light electric railway connecting the village of Lyndhurst with Lyndhurst-road Station has so far progressed that application will be made in the ensuing session of Parliament for the necessary powers to carry out the project. The proposed railway would pass almost exclusively over forest land.

There appears to be some prospect of the Derby and Ashbourne light railway project being proceeded with, preliminary difficulties and differences concerning the mode of construction of the rails within the borough having been tentatively, at all events, settled.

The Commissioners have submitted to the Board of Trade for confirmation the Brackenhill light railway order.

The Basingstoke Town Council have decided to grant an interview to representatives of the promoters of the proposed light railway from Basingstoke to Kingsclere.

The Dartford district light railways order came before Sir Courtenay Boyle at the Board of Trade on Tuesday. The order was practically agreed to in 1897 by the Light Railway Commissioners subject to the promoters giving a satisfactory access to the Thames. In 1899 the promoters after a local enquiry satisfied the Commissioners on this point, and the order was subsequently sent to the Board of Trade for confirmation. In 1898 Messrs. Burroughs, Wellcome, and Co. bought some of the scheduled property, which they converted into a recreation ground for their workpeople—between 1,100 and 1,200 — at Dartford, but they had not been informed of the scheme, and only discovered subsequent to the local enquiry that the proposed railway would cut their newly laid-out recreation ground into two. It was urged that the Commissioners ought not to hang up a scheme for two years and then amend it without giving notice to all the parties then affected. Sir Courtenay Boyle said no time limit was imposed upon the Commissioners, and at his suggestion the parties are to meet in conference and try to arrange the matter. The promoters' engineer suggested the construction of a light iron viaduct to carry the railway over the recreation ground.—*The Times.*

The proposed North-Eastern Railway Bill contains the following paragraph: "Power is sought . . . to provide for the vesting of the undertakings of the Isle of Axholme and Goole and Marshland Light Railway Companies (hereinafter called 'the light railway companies') in the company upon such terms and conditions as have been or may be agreed upon, or as may be prescribed by the intended Act, and to provide for the dissolution of the light railway companies and for the exercise and fulfilment by the company of all the rights, powers, privileges, liabilities, and obligations of the light railway companies, and to confirm any agreement made between the company and the light railway companies or either of them in anticipation of or relating to any of the objects of the intended Act." The company will also apply for powers to acquire the powers granted for a light railway from Haxey, through Bawtry to Tickhill, thus connecting the Isle of Axholme and Goole lines with the South Yorkshire coalfields.

The Crewe Town Council are about to make application to the Commissioners for an order to carry out a scheme of light railways in the borough, which will be worked in connection with the electric light undertakings. The scheme involves eight railways. The proposed gauge is 3ft. 6in., and it is estimated that the power for the traction can be supplied from the present electric plant.

FORTHCOMING EVENTS.

FRIDAY, NOV. 30.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, inaugural meeting of twentieth session. Presidential address by Sir Lowthian Bell, Bart., F.R.S.

The Faradian Club.—At 8 p.m., at 8, Charing Cross-road. Lecture on "Swiss Polyphase Railways," by Prof. C. A. Carus-Wilson.

SATURDAY, DEC. 1.

Institution of Electrical Engineers.—At 2 p.m. and 3 p.m., students' visits to the generating station of the Waterloo and City Railway.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "The Overstraining of Iron," by Mr. Jas. Muir.

MONDAY, DEC. 3.

Institution of Electrical Engineers.—Annual dinner at Hotel Cecil, at 7 for 7.30 p.m.

Institution of Electrical Engineers (Newcastle-on-Tyne Section). At 8 p.m., ordinary meeting at Durham College of Science.

Liverpool Self-Propelled Traffic Association.—At 8 p.m., at Royal Institution, "Heavy Motor Traffic in France," by Mr. G. Forestier.

TUESDAY, DEC. 4.

Society of Arts.—At 8 p.m., Cantor lecture on "Electric Oscillations and Electric Waves" (lecture II.), by Prof. J. A. Fleming, F.R.S.

Institution of Civil Engineers.—At 8 p.m., paper on "Machinery for the Manufacture of Smokeless Powder," by Mr. Oscar Guttmann. Other papers to be read, time permitting, "The Signalling on the Waterloo and City Railway," and "Note on the Signalling of Outlying Siding Connections," by Mr. Alfred Weeks Szlumper; "Signalling on the Liverpool Overhead Railway," by Mr. Stephen Butler Cottrell.

WEDNESDAY, DEC. 5.

Institution of Electrical Engineers.—At 7.30 p.m., at 28, Victoria-street, students' meeting. Papers on "Bipolar Machines at the Paris Exhibition," by Mr. R. L. Pearson and "Direct-Current Multipolar Generators at the Paris Exhibition," by Mr. C. T. Stephenson.

Society of Arts.—At 8 p.m., paper on "Road Traction," by Prof. H. S. Hele-Shaw.

THURSDAY, DEC. 6.

Institution of Electrical Engineers.—At 8 p.m., probable extra meeting at Institution of Mechanical Engineers to discuss the paper on "The Supersession of the Steam by the Electric Locomotive," by Mr. W. E. Langdon.

Rontgen Society.—At 8 p.m., at 20, Hanover-square. Exhibition and description by Mr. J. Mackenzie Davison, M.B., of his stereoscopic fluoroscope and a new rotary mercury break.

Civil and Mechanical Engineers' Society.—At 8 p.m., at Hotel Victoria. Paper on "Valve Gears and Valve Diagrams," by Prof. R. H. Smith.

FRIDAY, DEC. 7.

Institution of Electrical Engineers.—At 4 p.m., students' visit to the Electrical Standards Laboratory of the Board of Trade, 8, Richmond-terrace, Whitehall (see front note).

Faradian Club.—At 8 p.m., at 8, Charing Cross-road. Lecture on the "Modern Steam Engine," by Mr. J. S. Raworth.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Dock Gates," by Mr. F. K. Peach.

SATURDAY, DEC. 8.

Institution of Electrical Engineers.—Students' visit to the Manchester-square Station of the Metropolitan Electric Supply Company.

Institution of Junior Engineers.—Visit, at 3 p.m., to the electric generating station of the London Electric Tramway Company, 88, High-road, Chiswick.

NEW COMMITTEES.

The following additional committees have been appointed:

NORWICH—*Tramways:* Messrs. R. G. Bagshaw, G. M. Chamberlin, C. Cunnell, G. Green, W. H. Hackblock, D. Havers, A. C. Havers, J. Moore, G. White, M.P., and E. Wild.

ROCHDALE.—*Tramways:* Councillor Duncan, chairman.

ST. PANCRAS—*Electricity and Public Lighting*: The Mayor; Aldermen W. Smith, M.D. (chairman), E. Cox-Sinclair, H. G. Regnart, and N. Robinson, L.C.C.; Councillors G. A. Hodgkinson (deputy chairman), W. Barnard, F. B. Cameron, E. M. Close, J. Dean, J. Gauntlett, Dr. W. F. Hazel, G. Hickling, T. H. W. Idris, J.P., L.C.C., J. Johnson, Dr. R. Paramore, G. B. Shaw, G. P. Thomson, J. Thornley, J.P., W. H. Walkley, and T. D. Woodhouse.

Digitized by Google

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

329. Describe and explain what you consider the best workshop method of determining the values of B and H, and for plotting B and H curves of wrought iron and steel.—A. F. W.

330. When feeding boilers with very soft feed water, in which there is a good deal of peat acid, what kind of feed pipes would you recommend (1) taking the outlay into consideration, (2) disregarding outlay altogether?—C. H. K.

ANSWERS.

Question No. 323.—In alternating-current supplies with networks of concentric cables, in switching on and off there is a danger of breakdown in the insulation between the outer conductor and the lead covering. What is the best way to prevent this defect?

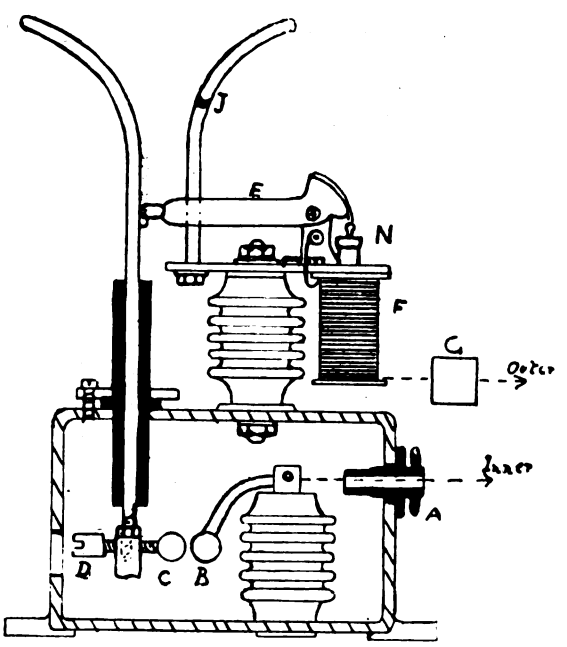
Best Answer to No. 323 *(awarded* 10*s.)*.—In order to deduce the precautions necessary to reduce to a minimum the risk of breakdown of the insulation between outer and lead on a concentric main, it is necessary, first of all, to investigate the probable cause of such breakdowns. The subject is a large one, however, and within the scope of the present answer it is only possible in some cases to state conclusions without fully tracing out the reasoning leading thereto.

Consider the case of a system of concentric feeders supplying transformers at a considerable distance from the generating station, and let us assume that through some cause or other the outer of one of the feeders is disconnected at the station end, whilst its inner remains connected to the inner 'bus bar. The cables may be considered in a sense as condensers, the dielectrics of which are the insulations between outer and lead. Let the capacity between the disconnected outer and the lead sheathing be called C_1, and the sum of all the capacities of the connected cables between outer and lead be called C_2. Now the disconnected outer prevents the current returning to the outer 'bus bar in the usual manner; nevertheless, a current will flow, its course being from inner 'bus bar, through inner conductor and primary of transformer to outer conductor, and through C_1 to lead (or earth), from thence to the lead of all the other cables, returning to the station outer bar *vid* C_2, and the other outer conductors which are connected to the bar at the time. In this case C_1 and C_2 are in series, but if the number of feeders is large, C_2 will be large enough to justify us in considering all these outer conductors as directly earthed, so that C_1 is the only capacity to be dealt with, and the insulation around the disconnected outer will have to stand the full voltage of the capacity current. If this voltage were never greater than the station voltage, the outer insulation would probably be able to stand the stress. We cannot, however, rely on such being the case. The transformer may for our purposes be considered as merely part of the circuit, possessing resistance and a variable amount of self-induction, and it is a well-known fact that when a capacity and inductance exist in series a resonance occurs between them which under certain circumstances has the effect of raising the voltage to two or three times its normal value. This, in the case in question, would mean an inevitable breakdown.

Each value of self-induction in the transformer produces a maximum rise in voltage in conjunction with a certain definite capacity, and the capacity varies with the length of cable. Above and below this certain length of cable the pressure rise becomes less and less. If the secondary of the transformer has a non-inductive load, the self-induction of the primary will be comparatively small, and in this case the length of cable which would produce a maximum rise will be rather a short one, but the rise itself will not be great. On the other hand, should the load be highly inductive, the most dangerous length will be considerably greater, and voltage rise also much greater. With the secondary on open circuit, the values to produce the maximum effect lie in between those of the two cases just quoted, and will be dependent on the design of the transformer. In either case breakdowns might occur, and to obviate them the following rules must be adhered to: close the outer switch first; open the outer switch last; avoid all fuses in the outer circuit, or if fuses are inserted make them heavy enough to ensure the inner fuse blowing first; earth the outer conductor at one point. Modifications of the above cases occur, but which space will not permit me to deal with. The same rules, however, may be effectively applied in these cases also. If the cables are very long and of high capacity, and the voltage extra high, say 5,000 and above, additional precautions are found advisable, for dangerous surgings result if the cable is switched in in the usual manner, accompanied by a rise in pressure.

To avoid a breakdown: (*a*) gradually load the feeder up instead of suddenly switching in; (*b*) make use of an apparatus for automatically preventing an undue rise of pressure in the mains.

(*a*) This end is accomplished at Willesden by first connecting the cable to be made alive to the high-tension 'bus bar in series with the primary of a small transformer, the secondary being on open circuit. The self-induction of the primary is now so great that practically no current can flow, a water resistance is now inserted in the secondary circuit, and the plates are gradually brought closer and closer together until finally the winding is short-circuited. When this occurs the self-induction in the primary is so small that it also may safely be short-circuited, and the transformer cut out, leaving the feeder directly connected to the 'bus bar. By this means any sudden rush of current in the cable is avoided.

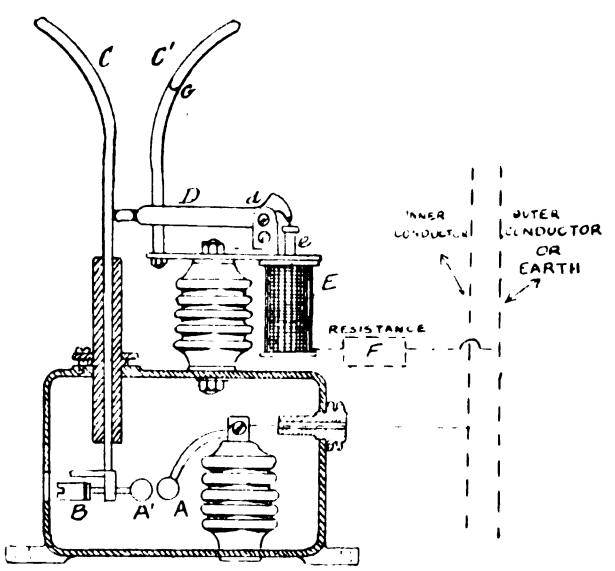


(*b*) The figure is a sketch of a "Partridge" mains discharger, and is in use, I believe, at Willesden and Deptford. A connection from the inner conductor is brought to the insulated ball, B. C, a similar ball (whose distance from B may be regulated by the screw, D), is in connection with the outer conductor through the pivoted arm, E, the solenoid, F, and the resistance, G; H is an iron plunge connected by means of a chain with the arm, E, in such a manner that when H is drawn down E rises, breaking the circuit; J is a stop, which limits the travel of the arm,

Digitized by Google

E. Now, the distance between the balls, B and C, is so adjusted that when for any reason the voltage of the main rises 25 per cent. above the normal, a spark passes across the air-gap which separates them, and the discharge which follows, having to traverse the windings of F before reaching the outer, causes it strongly to attract H, which in turn moves E, thus producing a second break in the circuit. The arc thus formed rises with E, and when E reaches J continues upwards, and finally dies away at the tips of the curved arms. Immediately the arc ceases E falls by gravity into its original position, and remains there until a further rise in pressure occurs. This arrangement has been found most effective in preventing breakdowns due to surges set up in the feeder, from any cause, which might otherwise have caused much trouble.—W. G. M.

Answer to No. 323 (*awarded* 5*s.*).—On first glancing at the question speaking of alternating-current networks, one is inclined to suppose, by networks, that low-tension cables are the subject of the question; if so, it is a very unusual occurrence for a low-tension cable to break down between outer and earth, as the pressure would not be above 250 volts, and the inductive effect at the voltage would not be sufficient to break down a paper-insulated lead-covered cable. If the cables are subjected to a thorough test, say at 1,000 volts, for one hour when laid, there need be no fear under ordinary circumstances of them breaking down when switching on or off the load. If the conductivity of the lead covering is not efficiently maintained at sub-stations, joint-boxes, etc., and the whole thoroughly earthed, the faults may be due to the proximity of electric traction using the earth as a return; this might attack the lead covering, and by electrolysis get through the lead, causing a weak spot, so that when current was switched on or off the mains the cable would break down at these places. The question is more applicable to high-tension networks feeding transformer sub stations or house-to-house transformers, where the liability of break-down between the outer and earth has been overcome by the universal practice of earthing the outer. We still have the difficulty to overcome to prevent the inner getting to earth. The protection of electrical circuits from the effects of abnormal high pressures has been practised since the introduction of overhead wiring for telephones, electric light, etc., by means of such devices as spark gaps between two metallic horns, so constructed that the convection currents caused by the spark cause the spark to rise to where the gap is so wide that the spark is exhausted. A similar



effect caused by the effect of lightning on aerial wires is the effect caused by inductance and capacity of high-tension cables or any apparatus connected to them when any part of the circuit is connected to or disconnected from the rest of the circuit. To overcome this danger, Mr. Partridge, the chief engineer to the London Electric Supply Corporation, has brought out a very ingenious apparatus, which is manufactured by Messrs. Elliott Bros. A A is an adjustable spark-gap; the screw at B can be adjusted for any pressure. After sparking between the two balls the path of the current is up one of the metallic horns, C; C' is the other horn, the width between which increases with the height. The metallic lever, D, normally short-circuits the two horns, and it is pivoted at *d*, and on its end it carries a small iron core, *e*, which is supported at the mouth of the solenoid, E. The path of the current is through the lever, D, through solenoid, E, in series with which is a non-inductive resistance, F, thence to earth or the outer conductor. When a current flows it energises the solenoid, E, attracting the iron core, *e*, which lifts the lever, D, until it strikes the horn C' at the point, G, at which point the spark is transferred to the two horns, where the gap is wide enough to allow the convection currents to lift the flash until it is extinguished by the widening parts of the horns. This apparatus has given great satisfaction, and will efficiently discharge the cable if by any means the pressure should rise to 50 per cent. above the normal or any other percentage which may be required.—W. A. J.

Question No. 324.—Compare the cost of lighting by direct and alternating current arc lamps respectively.

Answer to No. 324 (*awarded* 7*s.* 6*d.*).—The question is asked in very general terms, and the object of the enquiry would have been best attained under the consideration of the different types for a given problem. We can, however, obtain much information by dealing with the subject generally. In the first case, let us take the lamps themselves. It is generally acknowledged, and, in fact, has been proved by experiment, that the continuous-current lamp is more economical and efficient than the alternating-current lamp. To investigate the reason of this, it will be necessary to briefly review the nature of the arc. It has been shown that in the case of the continuous-current lamp the light emitted depends on the area and temperature of the crater which is formed on the positive carbon. The temperature at the arc, which is the temperature of the volatilisation of carbon, and which is always constant, necessitates a potential difference of 39 volts; the area of the crater is proportional to the current. It will be seen that with a continuous-current lamp the voltage and current are steady; thus the arc soon attains its normal condition. What have we in the case of the alternating-current lamp, however? That the voltage is continually changing between zero and a positive or negative maximum, and alternating in direction. Applying this, it will be seen that for the greater portion of every period we have not the voltage required to strike the arc or to volatilise the carbon. Thus for a corresponding period there will be no light given from the arc. The alternations are so rapid, however, that this is not visible to the naked eye. Further, we have a constantly varying temperature, therefore a lower mean temperature. As each carbon is alternately positive and negative, a crater cannot be formed on either, as in the case of the direct-current lamp; and as the crater is the hottest portion of the arc, it will follow there will be a further tendency for the mean temperature of the arc to be lower. Another point of importance is that as 85 per cent. of the light is emitted from the positive carbon, the light in the alternating-current lamp will be thrown alternately up and down, a greater portion of the up light being lost, whereas in the continuous-current lamp the light can be always thrown down by making the top carbon the positive, or the reverse for inverted lamps. The loss in the mechanical part of the alternating-current lamp is greater than in that of the continuous-current lamp, owing to induction.

From this brief *résumé* it will be seen there are a number of reasons why the alternating-current lamp should not be so efficient as the continuous-current lamp. In the application of the lamps themselves, however, there are cases where the alternating-current system would be cheaper than the continuous-current system. Take, for instance, where a consumer is fed off the town mains with 100 or 200 volts. If he requires one lamp only, by the use of a transforming choking coil with the alternating current he can take an economical supply of either 100 or 200 volts. Care must be taken in this case, however, that he has a wattmeter installed and not a current meter, as used by most alternating stations. It is also possible to run three

Digitized by Google

lamps in series off a 100-volt supply, whereas two lamps only could be taken off a 100-volt continuous-current supply. It is questionable, however, if even in this case the alternating-current lamp would be the most economical. In the case of public lighting where the supply is on the alternating-current system, though separate mains for the continuous-current arc lighting has its advantages, under ordinary conditions, alternating current rectified would probably be the most economical. Comparative efficiencies of various types have been given by Elihu Thomson. The following are taken from the *Electrical Engineer*, Sept. 22, 1899:

POWER PER CANDLE POWER WHEN LIGHT EMITTED DOWNWARDS ONLY IS CONSIDERED.

Type of lamp.	Watts per candle-power.
Naked arc	·5
Enclosed arc	1·5
Alternating-current arc with reflector	·8
Alternating-current arc without reflector	1·12
Enclosed alternating	2·0

This table is instructive, inasmuch as it shows comparative costs for various types of lamps if the conditions for all are equally favourable. Of course, the carbon and labour items must be considered when comparing enclosed lamps with open types. In conclusion, the working of alternating-current lamps cannot be said to be as satisfactory as continuous-current lamps. Screws are found to work loose, and this may become a source of annoyance. The extra attention they require cannot be ignored when comparing the comparative costs with continuous-current lamps.—E. T. W.

Answer to No. 324 (*awarded* 7*s.* 6*d.*).—When we consider the cost of lighting by direct or alternating arc lamps, we must take into consideration (1) the capital outlay, (2) cost of supply. With direct-current arc lamps no special machinery need be installed, as the lamps may be connected nine or ten in series across the 460-volt mains. A small additional cost, amounting to about £30, for cable to connect the lamps, is about the only item specially required. The table below shows the cost of direct arcs:

Capital Outlay.

10 lamps, including spare	£80	0	0
10 lamp columns at £10. 10s.	105	0	0
500 yards cable, at 1s. 3d. per yard	31	5	0
10 isolating switches, at £2. 9s. 6d.	24	15	0
10 service boxes at £1	10	0	0
Cable laying, erecting columns	120	0	0
Sundries	24	0	0
Cost of 10 lamps	£395	0	0

Cost of one lamp, £39. 10s.

Cost of Supply.

Interest and sinking fund charges	£24	0	0
Labour, trimming, attendance, etc.	60	0	0
Energy, 10 by 920 units (at 2d. per unit)	76	13	8
Carbons	12	0	0
	£172	13	8

Annual cost per lamp, £17. 5s.

When alternating current is used, the lighting must be either supplied by means of a rectifier or else by transformer. If a rectifier is used, £373 must be added to the above capital outlay, and if transformers in the lamp columns £4 per transformer must be added, and all these items make the generating expenses more. The cost of supplying arc lamps by rectified currents was given in a paper read before the Electrical Engineers as £19, for transformers for each lamp £18. Against this, Edinburgh supplied lamps at £16 per annum. The table of charges in connection with the rectified system as running at present in one of our central stations is given below:

Capital Outlay.

Rectifiers complete (one spare)	£373	3	6
25 arc lamps (four spare)	262	10	0
25 high-tension switches, £2. 9s. 6d.	61	17	6
25 lamp columns	262	10	0
Trimming ladder	13	10	0
Arc lighting cable, at 1s. 3d. per yard	231	0	0
Erection, laying cable, etc.	288	15	0
25 service boxes at £1	25	0	0
Sundries	52	5	0
Total for 25 lamps	£1,570	11	0

Cost of Supply.

Interest and sinking fund at 6 per cent.	£94	4	7
Labour	156	0	0
Energy, 25 by 920 units at 2d. per unit	191	0	0
Carbons	30	12	6
	£471	17	1

Cost per lamp (approximate), £19.

It is claimed that with rectifiers that these lamps require no more energy than direct-current lamps and that the candle-power is higher. The cost of arc-lighting by the transformer method is given below:

Capital Outlay.

25 service boxes	£25	0	0
25 arc lamps (four spare)	262	10	0
25 columns	262	10	0
25 transformers	200	0	0
25 switches	61	17	0
1 ladder	13	10	0
Service cable, £1 per post	25	0	0
Labour	48	0	0
Total cost for 25 lamps	£898	7	0

Cost of Supply.

Interest, etc., 6 per cent.	£54	0	0
Labour, etc.	156	0	0
Generating 570 watts	217	10	0
Carbons	30	0	0
Cost of 25 arcs	£457	0	0

Cost per lamp (approximate), £18.

Thus we see from the above figures that taking each system as satisfactory the direct-current arc lamps are supplied much cheaper than alternating-current arc lamps.—F. M. M.

Answer to No. 324 (*awarded* 5*s.*).—The vital question in comparing direct and alternating current arc lamp systems is the relative amount of power consumed for a given amount of light. Much will, however, depend upon the circumstances and local conditions, for in cases where a large number of circuits have to be run for a great distance in the same street, a saving in the investment could probably be made by adopting an alternating-current system with sub-stations at the points of distribution. But in the actual comparison the different types of lamps may be classified in the following manner:

	Watts at arc.	Candle-power.
Direct-current open arc	450	2,000
Direct-current enclosed arc	450	1,500
Alternate-current open arc	450	1,150
Alternate-current enclosed arc	400	950
Direct-current open arc	300	1,200
Direct-current enclosed arc	300	900

Then, so as to arrive at an equitable figure for comparing the direct open and enclosed arcs, we may assume that the ratio of watts per mean spherical candle-power in the open arc to those in the enclosed arc is 75 per cent., as "obtained by Elihu Thomson and others." The excess of watts per mean spherical candle-power for alternating-current arcs over direct-current is approximately 33·3 per cent. The accompanying table of relative costs is on the assumption that in every case the lighting part of the plant is running at very nearly full load.—K.

TABLE OF RELATIVE COST FOR 3,800 HOURS.

Systems.	Total cost per lamp.	I H.P. per lamp	Total operating expenses.
	£ s. d.		£ s. d.
Alternating-current enclosed arc, 400 watts	28 14 6	708	10 8 6
Direct-current driven by alternate-current motor, enclosed 300-watt lamps	27 0 0	630	9 9 0
Direct-current driven by belts, 300 watts, enclosed	24 5 0	552	8 10 6
Direct-current direct-driven, 450 watts, open	29 2 0	810	12 16 0
Direct-current driven by alternate-current motors, 450 watts, enclosed	20 15 0	948	11 0 0
Rectifier system, 450 watts, enclosed	31 14 0	816	10 15 0
Incandescent lamps, three 50-c.p. lamps, 450 watts	25 0 0	766	12 0 0

Sheffield.—Electric traction was inaugurated on the Brightside route of the Sheffield city tramways on the 26th inst.

Digitized by Google

PHYSICAL SOCIETY.

At the ordinary meeting on Nov. 23, Prof. Everett, F.R.S., vice-president, in the chair, a paper on "**A Self-Adjusting Wheatstone's Bridge**," by **E. H. Griffiths** and **W. C. D. Whetham**, was read by Mr. Whetham. The object of this paper is to describe a cheap and easy method of getting a self-adjusting bridge to show on a scale the actual resistance of any wire. Contact with the bridge wire is made by means of a light horizontal bar, which is suspended by a phosphor-bronze strip from the coil of the d'Arsonval galvanometer used with the instrument. A second bar, parallel to and above the first, is rigidly connected with the coil. A wooden beam, worked by clockwork, moves up and down between the bars and clamps them alternately. When the beam is down, contact is made with the bridge wire. If this contact is not at the zero point a current will flow through the coil, and if the cell is connected up the proper way it will turn the coil so as to bring the upper bar nearer to the null point. This puts a twist into the phosphor-bronze strip, and when the beam rises and clamps the upper bar the torsion comes into play and brings the lower bar under the upper one. The beam then descends and makes contact at this point, and if any current flows through the galvanometer there is further movement until the null point is reached. Any alteration in the resistance of the wire under experiment causes a movement of the zero point on the bridge wire, and this is followed by the lower arm. The position of the lower arm can be directly indicated by means of a scale.

Prof. S. P. Thompson asked how the scale was calibrated.

Mr. Whetham said the scale was arbitrary, but it could be calibrated by the known resistance of the bridge wire per unit length. Extension of the range could be obtained by shunting the bridge wire with various resistances

Mr. Glazebrook asked how sensitive the bridge was.

Mr. Whetham said that working with a dry cell it could easily indicate 1deg. on a platinum thermometer.

Mr. Blakesley pointed out that if the cell was connected up the wrong way, the zero point would be an unstable one.

A paper on "**The Liquefaction of Hydrogen**" was read by **Dr. M. W. Travers**. These experiments were undertaken in order to provide liquid hydrogen in sufficient quantity for the separation of neon from the helium, with which it is usually mixed. The separation is effected by cooling the gases to the temperature of hydrogen boiling at atmospheric pressure. The principles and conclusions do not differ from those of Dewar, but as the production of liquid hydrogen is neither difficult nor costly an account of the experiments is given. In 1884 Wroblewski showed that strongly coiled and compressed hydrogen on being allowed to expand formed mist or spray in the tube, and later Olozweski repeated these experiments on a larger scale and determined the temperature of the liquid. Other methods of liquefying hydrogen have been suggested by Lord Rayleigh and Kammerlingh Onnes. In the case of many gases a fall of temperature takes place on free expansion, but under ordinary circumstances the temperature rises in the case of hydrogen and helium The principle of free expansion was first applied by Hampson and Linde to the liquefaction of air. Within the last two years Dewar has shown that at a temperature close to – 200deg. C. hydrogen behaves as an imperfect gas, and becomes cooled when allowed to expand. This principle has been applied by Dewar to the liquefaction of hydrogen in quantity. In the author's experiments, hydrogen under a pressure of 200 atmospheres passes through a coil which is cooled to –80deg. C. by a mixture of solid carbonic acid and alcohol. It then enters another coil contained in a chamber which is continually replenished with liquid air. The lower portion of this coil passes into another chamber which is closed, and communicates through a pipe with an exhaust pump. Liquid air flows continuously from the first chamber into the second through a pin valve controlled by a lever. The liquid air boiling under a pressure of 100mm. of mercury lowers the temperature to – 200deg. C. The gas then passes into a regenerator coil, which is enclosed in a vacuum vessel, and expanding at a valve passes upwards through the interstices of the coil and the annular space surrounding the chambers through which the gas first passes to an outlet whence it can return to the main supply pipe. The liquid which separates from the gas is ultimately collected in a vacuum vessel. The apparatus, with the exception of the compressor, motor, and Hampson's air liquefier, is comparatively inexpensive. About £50 is required for the additional apparatus, and each time liquid hydrogen is made involves a further expenditure of about a sovereign.

Dr. Hampson said he would like to offer a correction. Dr. Travers had said that he (Dr. Hampson) was the first to liquefy air by the application of the counter current process to the Joule-Thomson effect. Although he was the first to make the proposal, he was not the first to apply it. He made the proposal to Prof. Dewar's assistant in 1894, and air was liquefied by Prof. Dewar by this method. Dr. Travers had referred at length to a valve which he (Dr. Hampson) had devised, but as it was straightforward common-sense, he did not wish to accept any credit for the use it had been to the author in his experiments. He would like to call attention to the remarkable features of the work in two respects—the economy of means and the magnitude of results. By means of liquid hydrogen Prof. Ramsay and Dr. Travers had succeeded in obtaining the physical and other properties of some of the rarer gases.

Prof. S. P. Thompson said the author had asserted that the Joule-Thomson effect for hydrogen changes in sign at some temperature, and expressed his interest in the fact that it was possible to get a cooling effect by allowing hydrogen to expand.

Mr. Boys asked if it was necessary or desirable to allow the hydrogen to expand to atmospheric pressure.

Dr. Travers said the mechanical advantages of this were great.

Dr. Lehfeldt asked if there had been any attempt to determine the temperature of the liquid, and, secondly, if the apparatus could be employed to determine the magnitude of the Joule-Thomson effect.

Dr. Herker asked if the temperature at which the Joule-Thomson effect changes sign was known.

Dr. Donnan said that the effect changed sign at the temperature at which "P V" was a minimum.

Dr. Travers, in reply to Dr. Lehfeldt, said he had not determined the temperature of the liquid, and the apparatus was not suitable for measuring the Joule-Thomson effect. He should say that the change of sign occurred about –150deg. C. It was Daniell Berthelot who first pointed out that the change of sign corresponded with the minimum value of "P V," but the experiments of Amagat on the relation between pressure and volume were not sufficiently accurate to fix the temperature.

A paper on "**The Anomalous Dispersion of Carbon**," by **Prof. R. W. Wood**, was taken as read. Experiments were made with smoke films and with films deposited on plate glass in a vacuum by an incandescent lamp. The dispersion was first measured with a Michelson interferometer, illuminated with monochromatic light of various colours obtained by prismatic analysis. The fringes were photographed and measured, readings being obtained between wave lengths ·000040cm. and ·000066cm. The results show a steady increase of refractive index from blue to red. The refractive index for sodium light was measured by estimating the thickness of the film and the fringe displacement, and was found to be 2·2. A prismatic deposit of smoke was then made by allowing a piece of plate glass to move uniformly backwards and forwards over the top of a small flame. The deviation produced by this prism was measured by means of a direct vision spectroscope, with the prisms removed. Experiments were performed with red and blue light. The mean deviation of red and blue was taken for sodium light, and this result was in good agreement with the deviation obtained by the interferometer method.

A paper on "**The Refraction of Sound by Wind**," by **Dr. E. H. Barton**, was taken as read. Assuming that the wind is everywhere horizontal, and does not vary in any one horizontal plane, but is different at different levels, then the following results are obtained for rays in the same vertical plane as the wind: (1) the direction of propagation is not usually at right angles to the wave-front, where there is a wind, consequently the cosecant law for the wave-front needs supplementing by another expression giving the direction of the ray; (2) total reflection cannot occur if the wave-front is initially horizontal; (3) in a region where the horizontal wind increases uniformly as we ascend, the rays instead of forming a catenary describe a more complicated curve, which, however, reduces to a parabola in the special case of rays whose wave-fronts are horizontal. In the paper the relation between direction of propagation and wave-front is first worked out, and then the refraction of waves and rays on crossing into a new wind zone is considered. This principle is then applied to the diffraction through any number of parallel wind zones, and it is shown that the final inclinations of wave-fronts and rays are independent of the characteristic constants of the intermediate zones. It is shown that since a cosecant cannot have a value between +1 and –1, total reflection becomes possible. If, however, the wave-front is initially horizontal there is no refraction of the wave-front and no total reflection, but the ray deviates without limit from the vertical and tends to correspond with the wave-front. When reflection occurs it follows the ordinary optical law.

The society then adjourned until Dec. 14, when the meeting will be held at the Royal College of Science, South Kensington.

LEGAL INTELLIGENCE.

THE BRITISH ELECTRIC TRACTION COMPANY, LIMITED, AND THE COMMISSIONERS OF INLAND REVENUE.

Judgment was given in this case on Wednesday in the Queen's Bench Division. The questions involved the rights to use certain tramway lines, and that rent should be paid for same. There was an agreement to the effect that £900 a year was to be paid for the repairs to the tramway line, to be undertaken by the Corporation; a further agreement to pay another sum as indefinite rent; and, still further, one to take all the electrical energy from the Corporation working the tramways, and to pay for it at least a minimum of £4,000 a year. It was argued that the £900 a year for repairs was rent, and chargeable as rent; that the £4,000 a year was a bond or covenant, also chargeable. The questions submitted by the Commissioners of Inland Revenue for the Court were whether the instrument was chargeable with the several sums of £20. 15s., 10s., and £105, and, if not, with what duty the instrument was chargeable. Section 77 (2) of the Stamp Act, 1891, enacts as follows: "No lease made for any consideration or considerations in respect whereof it is chargeable

Digitized by Google

with *ad valorem* duty, and in further consideration either of a covenant by the lessee to make, or of his having previously made, any substantial improvement of or addition to the property demised to him, or of any covenant relating to the matter of the lease, is to be charged with any duty in respect of such further consideration."

Mr. Justice Phillimore held that the £900 was rent, and that the £4,000 a year was a part of the consideration for the lease, and as such chargeable *ad. val.* accordingly.

Mr. Justice Kennedy dissented, and held that neither sum was rent, and would therefore be relieved from duty under Section 77, Sub-Section 2—that is to say, that when a lease is made in respect of a consideration it was chargeable, and shall not be chargeable in respect of subsidiary subjects.

Mr. Justice Phillimore withdrew his judgment; therefore the judgment of Mr. Justice Kennedy prevailed, and the duty chargeable on the instrument was accordingly reduced to £16. 5s., together with the 10s. in respect of Clause 5, the liability for which was not disputed.

FIXING UP A TELEPHONE.

Mr. H. E. Childs, Liverpool road, Islington, on Nov. 22 obtained judgment against Messrs. Charles Atkins and Nisbet, 1, Waterlane, for £3. 3s., for fixing up a telephone at their premises. The defendants paid £2. 10s. into court, and said they thought that was more than the plaintiff was entitled to. At the first hearing of the case it was contended that an incompetent workman was sent in the first place, and that the work might have been done by an ordinary bellhanger. The case was now undefended.

WOLVERHAMPTON CORPORATION v. BRITISH ELECTRIC TRACTION COMPANY, LIMITED.

On Thursday last **Mr. Justice Joyce** delivered judgment in the above case, which was reported in our issue of Nov. 23. He found for the Corporation of Wolverhampton on all points at issue, and gave judgment accordingly, with costs The defendants have not yet decided whether they will appeal against the judgment.

COMPANIES' MEETINGS AND REPORTS.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

In the first annual report, for the period from July 10, 1899, to July 31, 1900, the directors state that in addition to the orders and contracts taken over from the vendors, amounting to £279,000, orders have been received and contracts have been entered into since the incorporation of the Company amounting to £550,000, thus bearing out the expectation expressed in the prospectus as to the development of the business. The net profit for the period under review, exclusive of the amount guaranteed by the vendors, is £10,777. 7s. 7d., after providing for expenses of management, directors' fees, and all other charges, which is considered satisfactory, considering that the works at Trafford Park are still in course of construction. Out of this profit, supplemented by the guarantee, the directors distributed an interim dividend on the 6 per cent. preference shares in May last, amounting to £7,551. 2s., calculated on the amounts paid up to Jan. 31, and now recommend the payment of a final dividend for the six months ending July 31, ammounting to £15,000, making 6 per cent. thereon for the whole period. The directors are pleased to report that the works at Trafford Park, Manchester, are making good progress, the agreement for the purchase of the land having been concluded, the plans for the entire works having been prepared by Mr. Thomas Rodd, of Pittsburg, U.S.A., from information and drawings supplied by the American Westinghouse Electric and Manufacturing Company under their agreement, and the principal contracts for the construction work having been placed. The requisite connections between the works and the principal railways have also been completed. In view of the large staff which will necessarily be required in connection with the works, a number of young English engineers have been sent to serve an apprenticeship in the works of the American company at Pittsburg. By this method of forming the staff, the directors believe that the principles of manufacture which have been so successfully worked out in the United States will be reproduced in the works at Manchester. Arrangements are being made to provide suitable dwellings for the operatives to be employed in the works, in which the men and their families will be well housed at reasonable rates with great advantage to the Company. Technical and commercial managers have also been appointed, and are making themselves familiar with the approved methods adopted at the works at Pittsburg, which, as is well known, are equipped with the most modern plant and appliances, and where about 7,000 men are employed. The directors intend to establish branch offices in the more important manufacturing centres, and they have recently opened an office in Manchester, at Haworth-buildings, 5, Cross-street. In July this Company took part in the Electric Traction Exhibition at the Agricultural Hall, Islington, and at the close of the exhibition the car and track shown by the Company were purchased by the London County Council for their experimental work at Camberwell. Pursuant to the provisions of the special resolution passed and confirmed in August, 1899, empowering the directors to appoint any qualified person an additional director the Board have to report that they have appointed Mr. Lukach and Mr. Kobbé to be directors of the Company. The appointments do not require confirmation by this meeting. Under the articles of association no directors retire from office at this meeting. The Board appointed Messrs. Deloitte, Dever, Griffiths, and Co. the first auditors of the Company, and they will be proposed for re-election.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Kendal.—The Corporation invite tenders for the supply and erection of various plant. Tenders by Dec. 1. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons and oils for one year. Tenders by Dec. 17. Details in our advertisement columns.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads. Tenders by Dec. 13. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for supply of 12 workmen's tramcar bodies. Tenders by Dec. 1. Details in our advertisement columns.

Partick.—The Commissioners invite tenders for electricity meters, demand indicators, and fuses. Tenders by Dec. 4. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply and erection of storage batteries. Tenders by Dec. 22. Details in our advertisement columns.

Birkenhead.—The Corporation invite tenders for switchboard and instruments for Craven-street generating station. Tenders by Dec. 4. Details in our advertising columns.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and erection of electricity mains. Tenders by Dec. 17. Details in our advertisement columns.

Bermondsey.—The Vestry invite tenders for arc lamp columns, arc and incandescent lamps, automatic switches, and fittings. Tenders by Dec. 3. Details in our advertisement columns.

Mendon.—The Urban District Council invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by Dec. 31. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for three high-speed triple-expansion steam dynamos, one balancer, and one motor-generator. Tenders by Dec. 24. Details in our advertisement columns.

Harrogate.—The Corporation invite tenders for two high-pressure 30ft. by 8ft. 6in. Lancashire boilers, with fittings complete, and economiser. Tenders by Dec 25. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for induced-draught plant, steam and electric feed and general service pumps, and water-softening plant. Tenders by Dec. 20. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the overhead electrical equipment of tramways in the borough of Portsmouth, and extending to Cosham, Hants. Tenders by Dec. 7. Details in our advertisement columns.

Blackburn.—The Highways Committee invite tenders for the electric wiring of the underground conveniences in Church-street, Blackburn. Plans, etc., may be seen at the Borough Engineer's Office. Tenders by Dec. 6.

Leigh.—The Electricity and Tramways Committee invite tenders from manufacturers for the supply of 1,000 220-volt incandescent lamps during a period of 12 months. Tenders by Dec. 17. Details in our advertisement columns.

Ilford.—The School Board invite tenders for wiring and all ordinary fittings for about 200 lamps at 16 c.p., the Higher-Grade School, Melbourne-road, Ilford, Essex. Tenders by Dec. 17. Details in our advertisement columns.

Rathmines.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 10, 1901. Details in our advertisement columns.

Glasgow.—The Caledonian Railway Company invite tenders for telegraph and electrical appliances. Specifications, etc., may be obtained from Mr. J. Lorimer, stores superintendent, Charles-street, St. Rollox, Glasgow. Tenders by Dec. 17.

Sunderland.—The Corporation invite tenders for the whole of the work necessary in erection of buildings for new electric light station, Hylton-road. Particulars, etc., may be obtained at the

Digitized by Google

Borough Electrical and Tramway's Engineer's Office, Dunning-street. Tenders by Dec. 10.

Bexhill.—The Council invite tenders for the supply, delivery, and erection of a water-tube boiler and pipework and one 150-kw. steam dynamo at their electricity supply station. Tenders by Dec. 10. Details in our advertisement columns.

Southwark.—The Electric Light Committee invite tenders for the supply and erection of certain back E.M.F. cells at the Corporation electric light station, Penrose-street, Walworth-road. Tenders by Dec. 3. Details in our advertisement columns.

St. Pancras.—The Guardians of the Poor invite tenders for the installation of the Cook's-terrace Infirmary, Pancras-road, N.W., with electric light, according to drawings and specification. Tenders by Dec. 20. Details in our advertisement columns.

Oldham.—The Tramways Committee invite tenders for the erection of a tramway car depot at Wallshaw, within the borough. Specifications, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by Dec. 5.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and delivery of the following motors and starting switches: one 10-h.p. motor, four 3-h.p. motors, three 2-h.p. motors, and three 1-h.p. motors. Tenders by Dec. 17. Details in our advertisement columns.

Tooting.—The Metropolitan Asylums Board invite tenders for the execution of certain wiring and other works in connection with the proposed electric light installation at the asylum now in course of erection at Tooting Bec. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Brighton.—The Council invite tenders for the supply and delivery of the following: points, crossings, etc., soleplates, manhole covers with frames, gully grates with frames, tie-bars, fish-bolts, and other bolts for fastenings, etc. Tenders by Dec. 6. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for the permanent-way construction and underground feeders in connection with the equipment for electric traction of the tramways in the borough of Portsmouth, and extending to Cosham, Hants. Tenders by Dec. 7. Details in our advertisement columns.

Wolverhampton.—The Tramways Committee invite tenders for steel stanchions, wrought-iron roof trusses, rolled-steel joists, etc., and other works required at the tramway car depôt. Plans, etc., may be seen on application to Mr. J. W. Bradley, borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Dec. 3.

Oldham.—The Tramways Committee invite tenders for the supply and erection of the iron and steel work required in the completion of a car depot at Wallshaw, within the borough. Specification, etc., may be obtained from Mr. S. A. Pickering, A.M.I.C.E., borough surveyor, Town Hall, Oldham. Tenders by Dec. 5.

Bristol.—Tenders are invited for the installation of the electric light at the Bristol General Hospital, Bristol. Specification, etc., may be obtained from the secretary, Mr. W. Thwaites, Bristol General Hospital, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders by 11 a.m. on Dec. 3.

Ayr.—The Tramways Committee invite tenders for Section 2, overhead work: Part 1, poles, centre and side brackets, section boxes, etc.; Part 2, complete overhead electrical equipment; Section 3—underground work: supply of feeders, distributors, telephone cables, conduits, trenching, etc. Tenders by Dec. 7. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply of materials and erection and completion of proposed alterations and additions to the buildings in connection with the meter-testing and stores departments at the electricity works, Bolton-road, Bradford. Specifications, etc., may be obtained from Mr. R. A. Chattock, M.I.E.E., city electrical engineer, Town Hall, Bradford. Tenders by Dec. 6.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

RESULTS OF TENDERS.

London.—The London School Board has been recommended to accept the tender of Mr. J. C. Christie, at £445, for wiring, etc., for electric lighting at St. John's-road School.

Sunderland.—The Town Council have accepted the contract of Messrs. Dick, Kerr, and Co., Limited, for 24 motorcars of the top-seat type, together with track cleaner and traverser, at £675 per car. All of these cars will be equipped with standard air brakes.

London County Council.—The Council have accepted the tender of the Gilbert Arc Lamp Company, at £2,515, with certain modifications of the specification, which are mentioned in another column, for the lighting of Victoria-embankment and Westminster Bridge.

Greenwich.—The Guardians have accepted the tender of Messrs. Cooksley, of Lightcliffe, Yorkshire, at £4,338, for the electric lighting of the new workhouse at Grove Park. The highest tender was £9,907.

Aberdeen.—The Town Council have accepted the tender of J. Leith, jun., 3, Cattofield-place, Aberdeen, at £9,904. 15s., for the supply of materials and the construction of works in connection with the laying down of the permanent way of new electric tramways.

Ayr.—The Town Council have accepted the tender of Messrs. Siemens, at £2,505, for a 200-kw. complete set for a voltage of 500 to 550, the delivery to be not later than 9½ months from date. It is conditioned that Messrs. Siemens in February, 1901, take out and dismantle at their own expense the present No. 3 plant, substituting for it the above 200-kw. set, at the difference of cost, they allowing £2,070, less 5 per cent. per annum for the use of No. 3 set.

Devonport.—The following tenders have been recommended for acceptance:

A. N. Coles, Plymouth, buildings (exclusive of chimney and flues)	£5,433
S. Z. de Ferranti, Limited, Hollinwood, two vertical engines	3,200
Electric Construction Company, Wolverhampton, two 300-kw. generators, balancer, battery, booster, and motor	3,659
Electric Construction Company, switchboard, lighting and traction (subject to certain deductions)	2,922
Ashmore, Benson, Pease, and Co., Stockton-on-Tees, storage battery	2,600
Higginbottom and Mannock, Manchester, 10-ton travelling crane	326
Babcock and Wilcox, two boilers (with mountings complete)	1,950
Bennis and Co., stokers and automatic steam damper	535
Green and Son, economiser	440
Glenfield and Kennedy, tanks and meter	274
Mather and Platt, oil filter	70
Carruthers and Co., valve chest	60

London, E.—The Whitechapel District Board of Works have received the following tenders for the erection of a chimney shaft and the construction of economiser chambers, flues, and cableways at the new electrical supply station yard, Osborn-street, Whitechapel, E.

Chimney shaft only.

R. Anderson and Co., 101, Leadenhall-street, E.C.	£8,475
Gibb and Co., 1A, Birchfield-street, West India Dock-road, Limehouse, E.	8,834
Watts, Johnson, and Co., 785, Commercial-road, Limehouse, E.	9,775
F. Minter, Ferry Works, Page-street, Westminster, S.W.	7,916
W. Neil and Co., 165, Turner's-road, Burdett road, Bow, E	9,322
B. E. Nightingale, Albert Works, Albert-embankment, Lambeth, S.E.	7,763
T. Smart, Trent Bridge, Nottingham	8,021
Harris and Wardrop, 10, Wallwood-street, Limehouse, E.	9,686
Myles and Warner, 20, Sett-street, Stalybridge	7,157
Wilson Bros., 31, Berens-road, Kensal Rise, N.W.	6,189

Flues, cableways, &c.

R. Anderson and Co.	6,475
Gibb and Co.	5,516
Watts, Johnson, and Co.	4,911
F. Minter	5,112
W. Neil and Co.	5,619
B. E. Nightingale	4,860
T. Smart	5,143
Harris and Wardrop	5,523
Myles and Warner	5,851
Wilson Bros.	4,999

BUSINESS NOTES.

TRACTION.

Ilford.—It is rumoured that the G.E.R. Company contemplate running an underground railway to Ilford or beyond.

Personal.—Mr. A. R. Bramley, for the past six years manager and secretary of the Bradford and Shelf Tramway Company, has been appointed manager of the Birkenhead electric tramways.

Accident - A collision between a tramcar and a dray laden with wool occurred in Gibbet-street, Halifax on Saturday noon owing to the fog, but was, happily, unattended with injury to any person.

Surbiton.—The proposals of the London United Tramways Company and the Kingston Corporation to construct tramways in the Council's area has now been agreed to by the Rural District Council.

Walsall.—A special meeting of the Urban District Council is to be held, at which representatives of the electric tramways company are to be present to give the Council full particulars of their scheme.

Gosport.—The Gosport and Alverstoke Urban District Council on Tuesday definitely decided to give the promoters of the Gosport Tramway Company notice of the Council's intention to purchase the tramways.

Digitized by Google

Folkestone.—The owners and ratepayers, by their poll on Tuesday, reversed the decision to authorise the Corporation to proceed for a Bill to incur an expenditure of £100,000 upon municipal tramways.

Gateshead.—Rapid progress is being made with the laying of the tramlines at Gateshead. A start has just been made with the work in Half Moon-lane, and it is stated that for a time traffic will have to be diverted.

China War.—The Chinese have destroyed railway and telegraph lines in Manchuria, or a distance of 300 versts. The total damage is estimated at 10 million roubles. The repairs of the line will probably cost 150,000 roubles.

Kingston.—The long-expected meeting of ratepayers, which was held last week, had a curious result. First, the Corporation Bill was rejected, then it was decided to oppose the London United Tramways Bill, and, thirdly, a poll was demanded on the first resolution.

Italy.—The Government are preparing a scheme for the introduction of an electric railway able to do the journey from Rome to Naples in three hours instead of five, as at present. The system adopted will probably be overhead traction, and the motive force will be supplied from the rivers in the district.

Cleator Moor.—The Urban District Council have been notified that application is intended to be made to Parliament in the ensuing session for an Act to authorise the laying down of electric tramways and tramroads in West Cumberland including some streets and roads within the district of the Council.

Dundee.—A deputation from the Aberdeen Corporation visited Dundee on Monday to inspect the electric tramway system, carshed, and the workshops at the electric station. The visitors appeared to be specially interested in the lifeguards on the cars, and also in the fitting up and general arrangement of the workshops.

Birmingham.—The work of reorganising the Bristol-road service is proceeding satisfactorily. The poles which are to carry the overhead wires are nearly all in position. A contract for 20 new cars has been placed, and it is hoped that the whole work will be completed by March next. The proposed Bill provides for three extensions.

Leamington.—The British Electric Traction Company have concluded an agreement with the shareholders of the Leamington and Warwick Tramways and Omnibus Company, Limited, for the purchase of their undertaking, and they have obtained the consent of the Corporations of Leamington and Warwick to the installation of an overhead system of electric traction.

Lake District.—It is now stated that, contrary to former announcements, the British Electric Traction Company will not again introduce their scheme for a light railway between Windermere and Ambleside this year. Another application will be made to the Light Railway Commissioners when a scheme more satisfactory to those concerned has been drawn up.

Surrey.—The Corporation of Kingston-upon-Thames have on more than one occasion pressed for an expression of the views of the County Council with respect to the Corporation's intended tramway scheme, and the Parliamentary Committee have directed a reply to be sent intimating that until they are in possession of the details of the various schemes affecting the district, they are unable to make any recommendation to the Council on the subject.

Blackpool.—A start has been made with the extension of the Blackpool trams round Marton, and the work is expected to be finished by Whitsuntide. The proposed amalgamation with St. Annes having been abandoned, the proposal to construct a tramway there has been withdrawn from the Bill about to be proceeded with by the Corporation, though powers are being sought to lay tramways in several other parts of Blackpool, and to double the Lytham-road tramways.

Maryport.—The General Purposes Committee have been authorised in connection with the proposed formation of a company to construct a tramway extending from Cleator Moor, through Whitehaven, Workington, to Maryport, Allonby, and Silloth, to take the necessary steps to safeguard the interests of the Council, to obtain legal advice if required, to confer with the neighbouring local authorities interested, and, if deemed necessary, to agree with any joint action with the other authorities.

Paris.—The Paris Metropolitan Railway Company, having commenced the construction of a second section of its conceded lines, is about to raise its share capital from 25 million francs to 50 millions by the issue of 100,000 new shares of 250fr., reserved for holders of the 100,000 shares now in circulation. As before, the tunnelling and permanent way will be executed by the city of Paris, the company building the stations, providing the rolling-stock, working the lines, and sharing the receipts in equal parts with the municipality.—*Economist.*

Leeds.—As preliminary steps towards equipping the Burley and Cardigan-road tramway route with electric traction, arrangements have been made for breaking up the ground and laying down feeder wires from the Calls to Headingley by way of Swinegate, City-square, Quebec-street, St. Paul's-street, Park-lane, Burley-road, and Cardigan-road. Victoria-road will be similarly treated. The work of erecting poles for carrying the overhead electric wires between North-street and Meanwood-road and Woodhouse-street commenced on Wednesday last week.

Sixty Pounds a Foot.—An enquiry was opened at the Surveyors' Institution last week to fix the amount of compensation to be paid by the City and South London Railway Company to the wardens of the church of St. Mary Woolnoth. The crypt and land in the vicinity of the church, which was taken on the present valuation, was worth £260,700, and with the cost of reinterring the bodies buried in the crypt and sundry other items and expenses, the claim amounted to £291,606. After hearing expert evidence on behalf of the churchwardens, the case was adjourned.

London United Tramways.—The machinery at the central power station of the London United Tramways Company at Chiswick has been started. No. 1 engine, of 1,000 h.p., was started last week. During the present week a second engine of similar capacity will be started, and the third engine will be ready in about a fortnight, which completes the installation for the operation of the 16 miles of tramway route from Shepherd's Bush to Acton, from Shepherd's Bush to Chiswick, *vid* Goldhawk-road, and from Hammersmith-broadway to Kew, Brentford, and Hounslow.

Hendon.—A Bill is to be introduced into Parliament asking for powers to extend the underground electric railway from Hampstead to a point not far from the Guards' Convalescent Home at Golder's Green. There the line will emerge from the ground and convey the passenger by means of a number of cars carrying their own motors to Central Hendon and along Regent's Park-road to Finchley. The Middlesex County Council, it will be remembered, have already secured powers from the Light Railway Commissioners to lay certain lines in the districts of Hendon and Finchley.

Bournemouth.—Sir George Merrick, owner of the East Cliff frontage at Bournemouth, has offered the Corporation a long lease of the overcliff between Bournemouth and Boscombe at a small ground rent. He retains, according to the *Daily Chronicle*, his rights in the cliff front and the foreshore, but the offer, if accepted, will allow the town the privilege of a magnificent top cliff drive of considerably over a mile in length. Sir George does not announce the abandonment of the undercliff drive scheme, and hints in his letter at an electric tramway in the future and some building developments near Boscombe and Bournemouth piers.

Rochdale.—At the last meeting of the Tramways Committee a proposition was agreed to expressing the willingness of the committee to enter into negotiations with the Middleton Light Railways Company in regard to the Corporation extending their lines to the centre of Castleton. Prior to the incorporation of the district in the borough the company obtained powers under which they can construct tramways from Middleton to Sudden. Mr. S. S. Platt, the borough surveyor, was appointed permanent-way engineer; and it was decided to ask Mr. T. A. Lacey, of London, to meet the committee with a view to his appointment as electrical engineer in connection with the tramway scheme.

Paisley.—At a recent meeting of the Town Council, it was moved that the minute recommending the Council to apply for a provisional order for the construction of a tramway line in the east end of the town be not approved of. It was said that this was simply an effort to get in the thin edge of the municipalisation wedge, and it was not fair to the ratepayers, who had by a large majority voted against the Corporation working the tramways. On the other hand, it was agreed that it was essential that Paisley should be put in the position of having a tramway connection with Glasgow, and they asked powers for that purpose, and finally the approval of the minutes was carried by a large majority.

Tunbridge Wells.—The borough electrical engineer has prepared a report on the advisability of the establishment of an electric tram service in the town. Mr. Boot makes recommendations as to the route, and estimates the cost of construction at £33,000. From returns taken from all over the kingdom, about 6d. per car mile, and in most cases less, covered the total working expenses. However, in Tunbridge Wells he took 8d. per mile, on account of the hills. The number of car miles estimated to be run in 313 days, working 10 hours per day, with four cars on the route, was 75,120. The cost per annum equalled £2,504; interest and sinking fund on the capital expenditure at 6 per cent. equalled £1 980—making a total of £4,484 per annum. Referring to other returns in the kingdom, and allowing a very modest return indeed compared with them, each car should earn £10 per day, or producing a total revenue of £12,250 per annum, and leaving a profit, after paying 6 per cent. on the capital, of £8,036.

New Issue.—The Brisbane Electric Tramways Investment Company, Limited, are making an issue of £400,000 4½ per cent. first debenture stock at par (part of a total authorised issue of £500,000). The concession for the Brisbane tramways is now, and will continue to be, vested in the Brisbane Tramways Company, Limited, all the shares of which company—viz., 150,000 fully paid shares of £5 each (except 107 of such shares held by its directors and first subscribers)—will belong to this company, and will be transferred to the trustees, and constitute the security for the first debenture stock of this company. The Brisbane Tramways Company, Limited, will be free of all mortgages and debentures whatever. The shares thus held—viz., 149,893 shares of £5 each—will carry dividends in respect of profits from June 30, 1900. The proceeds of the present issue will be applied in paying off the existing debentures and other debts and liabilities of the Brisbane Tramways Company, Limited, and in the construction and equipment of the extensions now proposed to be carried out. The present length of the Brisbane Tramways Company's lines is upwards of 33 miles of single lines of tramways, and the extensions now contemplated will represent upwards of 12½ miles of additional single lines of tramways. The revenue account of the Brisbane Tramways Company, Limited, for the six months ended

Digitized by Google

June 30, 1900, showed net profits at a rate which, after payment of all outgoings, should give a net profit to this company of upwards of £36,000 per annum.

Manchester.—Mr. C. H. Wordingham has prepared a report to the Electricity Committee, in which he deals with some of the statements in the report of the general manager of the Tramways Committee, which was recently presented to the Tramways Committee, with regard to the supply of electrical energy for the working of the tramways. As regards the generating station in Stuart-street, Bradford, Mr. Wordingham says (according to the *Manchester Guardian*) that, although the Electricity Committee arranged for the purchase of the land in December, 1897, the purchase was not completed until October, 1898. There was then a further delay of six months on account of the Tramways Committee having under consideration the question whether it would not be better themselves to provide the electrical energy for driving the trams. He also states that details and plans were asked for from them, with an account of the dates when electrical energy would be required, and a definite order; but these have not been forthcoming. He replies to the statement that the Tramways Committee are pushing forward rapidly with the preparations for the taking over of the line by instalments, and also that the permanent way is being rapidly reconstructed, and says that, as a matter of fact, the tramways department themselves are hopelessly behindhand with this work. He describes the arrangements for the supply of energy to the different parts of the city, and says that his report of Oct. 23 clearly shows that the Electricity Committee will be prepared to furnish the energy for the first three tramway routes long before these routes are ready to take the supply. He deals with other work done by his department, and in conclusion says: "I have to say that I consider that the report of the general manager is so drawn as to leave the impression that the Tramways Committee will be quite ready with their lines so as to take current on the date named in their communication to the Electricity Committee of July 22, 1899, and that they will be prevented from opening the lines on the dates named in that communication on account of the Electricity Committee not being in a position to supply them with the necessary electrical energy. In point of fact, the Tramways Committee are already five months' late with the first section, and have not begun the work of reconstruction of any one of the three remaining sections, while the Electricity Committee will be ready to supply the electrical energy to the first section some time before the Tramways Committee can be ready. What has happened in regard to the first section of lines may be expected to happen with the remainder, and it is by no means evident at the present time that the Electricity Committee will be greatly behind the Tramways Committee. Both committees are engaged on very large and difficult schemes, and it will not be surprising if both find themselves in the position of having underestimated the time required to carry them out."

LIGHTING AND GENERAL.

Grimsby.—The telephone question has been adjourned till next week.

Ayr.—Mr. Hammond's resignation as consulting engineer has been accepted.

Ashton.—The Guardians have resolved to instal the electric light at the union offices.

Frome.—The Urban District Council have decided to apply for an electric lighting provisional order.

Newark.—The Sanitary Authority have decided to proceed with a scheme for providing the electric light.

Dunstable.—The Town Council have agreed to apply for a provisional order to supply electric light in the town and district.

The New Cable.—It appears that owing to the unfavourable weather usually prevailing at this time of the year, the new Anglo German telegraph cable cannot be laid before the spring.

Cheshunt.—The Council intend to apply for an electric lighting provisional order, and have appointed an Electric Emergency Committee, comprising Messrs. Cull, Greenleaf, Robinson, and Shackle.

Battersea.—Application is to be made to the London County Council for the advance of £20,000 further on account of the general electric lighting scheme, sanction for which has been obtained.

Eastbourne.—We learn that Mr. A. J. Bessant, of Grove-road, Eastbourne, has been commissioned to effect installations of the electric light in St. Anne's Church, Eastbourne, and the County Hall, Lewes.

London Gazette.—The last day for receiving proofs in the estate of G. H. Bentley, 63, Cross-lane, Earlestown, Lancashire, is Dec. 11. Mr. G. F. Clarke, 71, Cross-lane, Earlestown, Lancashire, is trustee.

Dublin.—Mr. P. C. Cowan has held an enquiry in the city hall into the application of the County Borough Council for sanction to a supplemental loan of £10,400 for electric lighting.

City and South London Railway Co.—This Company has recently issued 10,000 shares, of the nominal value of £10 each, at the price of £5. 10s. per share. The shares were offered to the share and debenture holders only.

Inverness.—A modified proposal which has now been made *re* the proposal for transfer of the Corporation's provisional order to the North of Scotland Electric Light and Power Company is before a committee of the Town Council.

Islington.—The Electric Lighting Committee are making enquiries regarding the discharge of coal breeze and dust from the electric lighting shafts to the great annoyance and serious loss of the inhabitants of Eden-grove.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to General Electric (1900), Limited, 5 per cent. cumulative preference shares of £1 each, and £150,000 4 per cent. first mortgage debenture stock.

Eastern Extension Telegraph Co.—At an extraordinary meeting of the Eastern Extension, Australasia, and China Telegraph Company last week, at Winchester House, Sir J. Wolfe Barry presiding, the special resolution passed on Nov. 7, referring to remuneration of directors, was confirmed.

Ashton-under-Lyne.—Mr. N. Appelbee, the engineer of the Cardiff Corporation electric lighting works, has been appointed as electrical engineer of the Corporation. There were 47 applicants for the post. The Corporation do their own lighting and supply the current for the tramways on the combined system.

Edinburgh.—At the meeting of the Electric Lighting Committee on Wednesday it was resolved to recommend that application should be made for consent to borrow a further sum of £76 000 for the execution of capital works. This sum will make a total of £700 000 for which borrowing powers have been authorised by the Secretary of Scotland in connection with the electric lighting undertaking.

Appointments Vacant.—The Doncaster Corporation have vacancies for two pupils at their electricity works for a period of three years.—The Electric Light Committee of Battersea invite applications for the appointment of engineer, at a salary of £350 per annum, with residence at the central station when the works are completed. Particulars of these vacancies appear in our advertisement columns.

Wind Power.—An electric lighting installation has recently been laid down at Boyle Hall, West Ardsley, in which wind is the only motive power employed for generating the currents. There are 50 sails, set radially in a circular frame about 30ft. in diameter. A large pulley fixed on a horizontal shaft in an adjacent building drives the dynamo. The duty of this machine is to charge the storage cells, which are sufficiently large to run the 109 lights for about eight days in winter should there be no wind for that length of time, and more than a fortnight in summer.

Willesden.—At a meeting of the District Council on Tuesday, it was reported that the engineer had received the bills of quantities in connection with the main and sub-electricity stations. The Council decided to apply to the Local Government Board for sanction to a loan of £52,550, for use as follows: buildings, walls, sites, works, chimney shafts (main station), £36,104; tenants' compensation, £121; cost of road, £325; coal sidings, £2,500; offices and sub station, £13,500. It was pointed out that the surveyor's estimate was within £1,500 of the total amount.

Manchester.—The local papers are publishing conflicting reports as to the appointment of a tramway expert to supervise conversion of their tramways for electric driving. Thus, on the 28th inst., in the *Manchester Guardian* it was reported that Mr. H. F. Parshall, the well known expert, had been appointed, and in yesterday's issue of the same paper it is stated that the committee still have the matter under consideration. It is a great pity that the committees in Manchester do not keep these informal notices of their meetings out of the Press. As a rule the proceedings of all committees should be kept private, and their recommendations to the Council alone made public.

Charing Cross and City Station.—We are informed by Messrs. H. M. Salmony and Co., Limited, of 118 and 120, Charing Cross-road, London, W.C., British representatives of E.A.G., late W. Lahmeyer and Co., of Frankfort-on-Main, that a contract for generators and motor dynamos for the Charing Cross and City station has been given to Messrs. Lahmeyer. The switchboard will be provided with Messrs. Lahmeyer's patent switching gears, which are arranged in such a manner that no high-tension current is on the main board itself. By this arrangement, the greatest safety to human life is ensured. Even the instruments recording the high-tension current are connected in such a way that they can be handled with perfect safety, as no high tension current reaches them.

Kensington.—At the last meeting of the Guardians a report came up from the Special Electric Lighting Committee. They were unanimously of opinion that it was desirable to light the workhouse infirmary, and office buildings in Marloes-road by electricity, and the only question was whether the electricity should be obtained from a public company or be generated by the Guardians' own plant on their own premises. After consideration of the relative merits and costs of both systems, and lengthy consultation with Prof Robinson and ascertaining that the future cost of obtaining the supply from a company would be about £1 040 a year, as against a future cost of £650 a year—after 20 years—if the Guardians generated their own supply, the committee have come to the conclusion that it would be more satisfactory, and in the long run more economical, for the Guardians to undertake the work of generating. This report was adopted, and the Board decided to instruct Prof. Robinson to prepare and submit a complete plan and specification for the buildings, machinery, and plant required, at an estimated cost of £12,500. It was mentioned that the cost of the gas at present was £1,400 a year for lighting, and that the electric light for the first 20 years was estimated to cost £1,470 a year. The great saving, however, would be found after 20 years, as shown above.

Digitized by Google

Shildon.—The draft agreement with the Northern Counties Electric Supply Company for the lighting of the Shildons has been sealed.

Dover.—Amongst the applications for private Bills will be found one of the Corporation, seeking powers to purchase the undertaking of the electricity supply company.

Dredgers.—We learn that there are about 90 dredgers for mining operations being built for various parts of New Zealand, and that the demand there is so active that the supply is unable to cope with it. Electricity is to be the motive power.

Leeds.—The Highways Committee have granted an application of the Corporation Electric Lighting Committee to open out 14 streets at Beeston, Hunslet, and New Leeds for extensions and also to construct transformer chambers in Roundhay-road and Vicar-lane.

Aberdare.—The District Council have agreed to dissent from the scheme of the Aberdare Electric Lighting Company, Limited, for the electric lighting of the town, and a proposal will come before the next meeting to the effect that the Council themselves promote an electric lighting scheme.

Lyndhurst.—Application is being made by the Lyndhurst Electric Lighting and Traction Company, Limited, for a provisional order. It is proposed to lay cables in the High-street, Gosport-lane, Romsey-road, Welland's-road, Empress-road, Queen's-parade, and Pemberton-road.

City.—At last night's meeting of the Court of Common Council the Streets Committee reported on the practicability of generating electricity from steam raised by burning the City's refuse. The committee recommended that, as the lease of Letts's Wharf has so short a time to run, it will be inexpedient to sink further capital at the wharf.

Aston.—In the recent loan applied for we note that £11,800 of the sum required was for the hospital and its equipment, and providing for laundry plant and electric energy and lighting for both the small-pox and fever hospitals. This sum includes the following sums: laying down of electric plant, £1,800; and for a telephone, £530.

Radstock.—The Urban District Council have resolved to engage an engineer at a fee not exceeding 25 guineas—provided the Midsomer Norton Council would pay half the expense—to report upon the advisability of (*a*) lighting Radstock by electricity, (*b*) lighting Midsomer Norton by electricity, (*c*) lighting both the said urban districts by a joint electric scheme.

Llandudno — The Public Works Loan Commissioners have declined to give their consent to the unexpended balance (£1,045) of the loan for refuse destructor being applied towards the excess expenditure on the electric light loan, but the Local Government Board are prepared to sanction a loan of that amount for purposes of electric lighting, and the requisite application will now be made.

Glazing.—We learn that Messrs. Helliwell and Co., Limited, Patent Glazing and Roofing Works, Brighouse, are engaged upon the execution of various contracts for new tramway schemes, which include glazing car sheds, etc., at the London United depôts, Acton and Chiswick; East Ham borough electric works; Bristol depôts at Bedminster and Brislington; Sunderland, Aberdeen, Glasgow, etc.

Bermondsey.—The Council have granted an application from the London Electric Supply Corporation asking that the customary month's notice might be waived in reference to supplying electricity to premises in Southwark Park-road, as the tradesmen concerned might be placed at great disadvantage by waiting. The Council have added a rider to the effect that in future the full period of notice would be demanded.

Luton.—The Town Council have obtained a loan of £26,000 from private parties, at £3. 5s. per cent., for a term of 25 years, the capital to be repaid at the end of such term, the town clerk making provision for such repayment by way of a sinking fund, the interest to be paid half-yearly. The annual repayment of the fund amounts to £1,130. 8s. 8d. The question of arc lamps, meters, etc., will be considered shortly.

Christmas Number.—We have received the Christmas number of the *Illustrated English Magazine*, which consists of a double number of the usual type of this excellent publication. The stories are freezingly appropriate of Yuletide, ghosts and Arctic yarns vying with each other to produce that pleasant effect so well known by the reader of gruesome tales who is himself safely installed in a comfortable chair by the side of a roaring fire.

Chiswick.—At the last meeting of the District Council the surveyor reported that the poles on the Homefields recreation ground and Turnham Green Common had not been removed. The clerk was directed to write to the National Telephone Company, Limited, calling their attention to the matter, and asking for an explanation of the reason for the non-compliance with the notices served upon the company requiring the removal of the poles.

Cricket Club Dinner.—The first annual dinner and concert of the Brighton Corporation Electricity Works Cricket Club was held last week at the Cricketers' Hotel, Black Lion street, when a company numbering about 40 members and friends sat down. Mr. J. Christie, resident engineer of the electricity works, presided, and the vice chair was occupied by Mr. G. Goodall. After dinner an attractive musical programme, interspersed with toasts, was carried out.

Melrose.—The draft agreement between the Burgh Commissioners and Messrs. Crompton and Co. provides that the company lay the electric light as far as The Avenal, round by Ormiston-terrace, Buccleuch-street, and as far as the railway bridge. They will also extend the connection through Darnick on condition that the Waverley Hydropathic become consumers, and they will include Dingleton on condition that the asylum be secured as a customer.

Lancaster.—Colonel Slacke, R.E., held an unopposed enquiry on the 27th inst into an application by the Corporation for sanction to the borrowing of £14,700 for the provision of refuse destructors. It is proposed to use the steam generated for the boilers at the electricity works, which immediately adjoin the suggested site, and the engineer calculated that the amount of refuse which would be burnt would produce 4,500lb. of steam per hour, equivalent to 225 h.p.

Brighouse.—The Corporation propose to establish new electricity works, combined with a refuse destructor. Some years ago the Corporation bought out a private electrical venture and obtained a provisional order authorising them to make and supply electricity. These works have proved inadequate to meet the demand, and a scheme prepared by Messrs. Lacey, Clirehugh, and Sillar for the construction of new works, combined with a refuse destructor, at an estimated cost of over £20,000, has been adopted.

Wood Paving Blocks.—At the new public works depôt in Harrowby-street Docks, Cardiff, which is being erected for the Cardiff Corporation and is nearing completion, an extremely compact little plant has been installed for cutting blocks for wood pavement for the public streets. From 7,000 to 8 000 blocks can be cut in a day, or about 32 per minute, by a Temperley patent block-cutting saw supplied by Messrs. Ransom and Co., Chelsea. This is worked by one of Ruston and Proctor's 14 h.p. undertype engine and boiler combined. There is also a "thicknessing" machine, whereby uniformity of thickness in the planks is ensured.

Midland Electric Power Distribution, Limited.—Amongst the proposed Bills there is an application by the Midland Electric Corporation for Power Distribution, Limited, of Liverpool, for a provisional order under the Electric Lighting Acts for the extension of the area of supply, which will include additional districts and parishes in the counties of Stafford and Worcester. The districts of the Urban Districts Councils of Perry Barr and Tettenhall will be included. Among other streets and places the undertakers propose to lay electric lines within a specified time along Tettenhall Wood road, from Werge-road to School lane, Tettenhall Wood; and along Compton-holloway, from Tettenhall Wood-road to the bottom of Finchfield-hill.

Berkhampstead.—The report on electric lighting, adopted by the Urban District Council last week, concludes as follows: "After fully considering all the local circumstances, the committee were of opinion that in the interests of the district it would be well for the Council to obtain a provisional order at the earliest opportunity. As, however, the necessary notices could not be given in time for the next session of Parliament, and as the term of office of the whole of the present Council expires in April next, the committee suggested that the matter be referred to the new Council at its first meeting, so as to enable the proper notices being given for the ensuing session should that Council determine to carry out their recommendation."

Brighton.—A sub committee of the Telephone Committee has been appointed to report on a suitable site for telephone offices. At the meeting of the Town Council on Thursday last week a report was adopted from the Lighting Committee recommending that 107 arc lamps be erected along the tram routes, and wherever possible the standards for the tram wires be used to carry the lamps. The increased cost per year will be £1,431. The cost of the lamps was given as £6,400. The committee also recommended that all consumers agreeing to pay £1 extra a year may have their demand indicators cut out out all day on Sundays and on weekdays except during the ordinary hours of lighting—viz., from dusk till 10 p.m. During the debate which ensued reference was made to the charges for the Pavilion light, which worked out practically at 7d. per unit, and it was urged that the price could be reduced if the committee would only use the electricity for illuminating the grounds for the promenade concerts.

New Companies.—The following new companies have been registered: Ross Electric Light and Power Company, Limited; capital £8,000, in £1 shares.—French Electric Lighting Boards, Limited; capital £4,000, in £1 shares.—Perfect Light Company, Limited; capital £25,000, in £1 shares (object being to adopt an agreement with the Scott Snell Phillips Syndicate, Limited, and M. Lachman, etc.).—Greenall's "Positive" Meter Syndicate, Limited; capital £20,000, in £1 shares (object being to adopt an agreement with J. Greenall, etc.).—Imperial Electrical Supplies Company, Limited; capital £50,000, in £1 shares (object being to adopt an agreement made by this company with G. Bargate, G. S. Hertslet, H. W. Knott, E. P. Harvey, and J. L. Bell, etc.).—Horsehay Company, Limited; capital £100,000, in £10 shares (object being to adopt an agreement made by this company with H. C. and A. Simpson for the acquisition of the business of engineers, etc., as now and hitherto carried on at Horsehay Works, Horsehay, Salop, etc.).

Durham Power Scheme.—A company is being formed by local men in South Durham, West Durham, and Cleveland for the formation of an electrical supply company, and the promotion of a Bill in Parliament in their behalf to enable them to take up this task. It is reported that the following names are amongst the promoters: Messrs. Hugh Bell, A. J. Dorman, H. Pike Pease, M.P., J. Torback, J. Walton, M.P., E. R. Whitwell, W. Hustler Hopkins, E. Lloyd Pease, Sir Thos. Wrightson, M.P., and the representatives of Pease and Partners, Limited, Consett Iron

Digitized by Google

Company, H. Stobart and Co., W. Whitwell and Co., Skinningrove Iron Company, and many others. The area to be taken in under the scheme is very extensive, but will be easily covered when it is pointed out that from four central stations the power will be distributed, each station capable of transmitting the electrical energy 20 miles. The Bill which is being promoted in Parliament is similar in essence to one put through by South Wales last session, and the Board of Trade in that case settled protective clauses which were inserted in the Bill. Messrs. Lucas, Hutchinson, and Meek, of Darlington, and Messrs. Jackson and Jackson, of Middlesbrough, are the solicitors.

London County Council.—At Tuesday's meeting the Highways Committee reported that the arc lamps for the installation of electric lighting on Westminster Bridge and the Victoria-embankment would shortly be required, and tenders for the supply of these were invited by public advertisement. The tenders received, and which were referred to them by the Council on Nov. 13, were as follows: Gilbert Arc Lamp Company, £2,209. 18s. 6d., or, with certain modifications of the specification, £2,515; New Century Arc Light Company, £2,330; Crompton and Co., £2,598; Oliver and Co. (alternative), £2,910. 11s. 6d. or £2,676. 2s.; Verity's, Limited, £2,959. 12s.; General Electric Company, £3,320. The Gilbert Arc Lamp Company submitted, in addition to its tender strictly in accordance with the specification, two modified proposals—namely, for the use of (*a*) split globes at a cost of 30s. each extra for the parapet lamps; and (*b*) specially long carbons at an extra cost of 50s. each for the kerb lamps. The engineer states as regards proposal (*a*) that split globes were not specified, as they are not in general use, but that the adoption of them would facilitate the trimming and cleaning of the lamps, and that the extra cost would be about £105. As regards the proposal (*b*) the engineer states that probably a considerable saving would be effected in the cost of trimming, although some loss might arise from breakage through the use of such long carbons, and that the extra cost if the proposal were adopted would be about £200. The engineer was of opinion that the advantages to be gained by the adoption of both proposals would justify the increased expenditure, and the committee recommended the acceptance of the Gilbert Arc Lamp Company with the modification as suggested. The report was agreed to.

Colonial.—We are indebted to the *New South Wales Railway Budget* for the following interesting information: With a view to increasing the electric power at North Sydney, and for the purpose of providing a reserve for use in times of emergency or extra strain, an extensive battery is being constructed at the power-house, Ridge-street, North Sydney. The battery, when completed, will be one of the largest in the colony, and will contain no fewer than 260 cells. The accumulated power thus provided will form a useful auxiliary to that supplied direct from Ultimo, and will enable the management to cope with the ever-increasing demands of the district by allowing additional trams to run over the various lines, and relieve the great pressure at present experienced. With the completion of the Spit tramway, and other lines on the north side of the harbour proposed to be constructed, a considerable increase in electric power will become necessary. The main power is drawn from Ultimo, in addition to which there are batteries at Mosman, Flat Rock, and the one in course of construction.—Some difficulty has arisen between the Auckland City Council and the Auckland Electric Tramway Company, of London, owing to the company asking for an extension of time before proceeding with the work. At a meeting of the Council, the Mayor explained that if the tramways were not started within 12 months from June, 1900, the Government had the power to revoke the Order in Council. By the agreements the company had to lay the permanent way within 12 months from June, 1900, and complete the work by June, 1902. If the permanent way was not laid within the specified time, the company forfeited its deposit of £1,000. After some discussion, the Mayor was authorised to send the following cable to the company in London: "That the Council will not consent to any alteration in the time fixed by deed for the completion of the various works therein specified."—It is reported that Mr. W. G. Bingham has cabled to his attorney in Adelaide, asking him to intimate to the City Council that he is prepared to release them unconditionally from their agreement with him respecting the electric tramways, but he considers that the Council are bound by their honour to advocate his claims for obtaining a similar contract with any trust that may be formed.

PROPOSED NEW BILLS.

(*Second List.*)

The following notices of intention to apply for Bills have appeared in the *London Gazette*:

Electric Tramways and Railways.—Electric railway (South-Western and Isle of Wight Junction Railway); Victoria, City, and Southern Electric Railway (company); Finchley and Hendon (company), Kingston-on-Thames (Corporation), Tyneside (company), Wigan (Corporation), Metropolitan and District Railway (British Westinghouse Company), Manchester and Liverpool Electric Express (company), Swindon (Corporation), Littleborough (U.D.C.), London United Tramways (company), South Lancashire (company), Central London Railway (company), West Riding (United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited), King's Norton and Northfield (U.D.C.), Scarborough (company), West Cumberland (company), City and South London (company), Liverpool (Corporation), Worcester (Worcester Tramway Company, Limited), Folkestone (Corporation), Metropolitan and Metropolitan District Railway (British Westinghouse Electric Company), Leeds (Corporation), Derby (Corporation), City and West end Railway (company), Bexley (U.D.C.), Wimbledon (U.D.C.), Brompton and Piccadilly-circus Railway (company), Weston-super-Mare (Weston-super-Mare and District Electric Supply Company), City and North-East Suburban Electric Railway (company), Middleton and Chadderton (Corporation and U.D.C.), Crompton (U.D.C.), Dover (Corporation), Gosport (Portsmouth Street Tramways Company), Shipley (U.D.C.), Leamington (Leamington and Warwick Tramways and Omnibus Company, Limited), Pontypridd and Rhondda Valley (British Electric Traction Company), Birkdale (U.D.C.), King's Head Railway (company), Piccadilly and City Railway (company), Charing Cross, Hammersmith, and District Electric Railway (company), West and South London Junction Railway (company), Watford and district (company), Royton (U.D.C.), North-East London Railway (company), Manchester (Corporation), Portmadoc, Beddgelert, and South Snowdon Railway (Northern Counties Traction Company), Pontypridd (U.D.C.), Gateshead and district (company), Folkestone, provisional order (Corporation), City of Birmingham Tramways (company), Charing Cross, Euston and Hampstead Railway (company), Cheriton Tramways (U.D.C.)

Electric Lighting.—Crawley, electric light powers (Crawley Gaslight Company, Limited), Richmond (Richmond Gas Company), Foots Cray (Kent), (Bromley R.D.C.) Carnarvon and district (E. W. I. Peterson), Trowbridge (U.D.C.), S. York, electric power (company), Aberdare (company), St. Austell (company), Hoddesdon (U.D.C.), Ware (U.D.C.), Dorchester (Corporation), Workington (Corporation) East Cowes (Isle of Wight Electric Light and Power Company, Limited), Crompton (U.D.C.), Hampton (U.D.C.), Tredegar (U.D.C.), Mitcham (Croydon R.D.C.), Honley (U.D.C.), Pokesdown (Bournemouth and Poole Electricity Supply Company, Limited), Benwell and Fenham (U.D.C.), Dover, electricity supply (Corporation), Marylebone (Marylebone Electric Supply Company), Barry (U.D.C.), Teddington, Hampton, Hampton Wick, and Ham (Richmond, Surrey, Electric Light and Power Company), Shildon (Northern Counties Electric Supply Company), Handsworth (Northern Counties Electric Supply Company), Benfield Side (Northern Counties Electricity Supply Company), Consett (Northern Counties Electricity Supply Company), Annfield Plain (Northern Counties Electricity Supply Company), Norton (Northern Counties Electricity Supply Company), Thornhill (Northern Counties Electricity Supply Company), Heston and Isleworth (Richmond, Surrey, Electric Light and Power Company, Limited), Sittingbourne (County of Kent Electrical Power Distribution Company, Limited), Goole (U.D.C.), Alnwick (Northern Counties Electricity Supply Company), Harpenden (Harpenden Gaslight and Coke Company, Limited), Neath, Briton Ferry, and Aberavon (Electric Power Distribution Company, Limited), Pickering (Northern Counties Electricity Supply Company), Midland Electric Power Distribution Corporation, Pudsey (Corporation), Bromsgrove (C. Steer and others), St. Marylebone (B.C.), Macclesfield (Electrical Power Distribution Company, Limited), Dorking (Surrey Electrical Power Distribution Company, Limited), Stoke Newington (North Metropolitan Electrical Power Distribution Company, Limited), Neath (R.D.C.), Rickmansworth (North Metropolitan Electrical Power Distribution Company, Limited), Frome (U.D.C.), Wellingborough (U.D.C.), Cannock (U.D.C.), Pontypridd (U.D.C.), Todmorden (Corporation), Newbury (Urban Electric Supply Company, Limited), Warwick (British Electric Traction Company, Limited), Worsley (U.D.C.), Isle of Thanet (Isle of Thanet Electric Tramways and Lighting Company, Limited), Llandaff and Dinas Powis (R.D.C.), Deptford (County of London and Brush Provincial Electric Lighting Company), Rishton, Great Harwood, and Clayton-le-Moors (C. Chadwell), Barrow-in-Furness (Corporation), Mansfield (Corporation), Arlesey (company)

Tram and Electricity.—Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board (Corporations).

Electric Power Supply.—Yorkshire (company), Derbyshire and Nottinghamshire (company), Cleveland and Durham County (company).

Various.—The following proposals are included in omnibus Bills: Eccles, tramway, electric light (Corporation), Blackburn, electricity supply (Corporation), Willesden, tramways (U.D.C.), Bradford, tramways (Corporation), Tottenham, railway extensions (Tottenham and Hampstead Junction Railway Company), Brighton, electric apparatus, tramways, improvements, etc. (Corporation), Bournemouth, tramways (Corporation), Burton-on-Trent, tramways (Corporation), Handsworth, electric tramways and lighting (U.D.C.), Bolton, tramways (Corporation). Lowestoft, electric tramways, lighting, extensions, etc. (Corporation) Kingston-upon-Hull, tramways electric power (Corporation), Smethwick, electric supply and tramways, etc. (Corporation), Blackpool, new tramways (Corporation).

PROVISIONAL PATENTS, 1900.

NOVEMBER 19.

26853. Improvements in and relating to arc lamps for projection purposes. Charles Vickery Drysdale, Clairville, Hadley-road, New Barnet, Herts.

Digitized by Google

20868. Improvements in electric lamps for use in photography. Jean Schmidt, 18, Buckingham-street, Strand, London.

20870. Improvements in electrical signalling for railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Leone Olper, Italy.)

20873. Improvements in the manufacture of carbons for electrical and other purposes. Henry Richard Gregory, 55, Chancery-lane, London.

20878. Improvements in telegraphic receiving and translating arrangements. Alexander Muirhead, 323, High Holborn, London.

NOVEMBER 20.

20926. Improvements in electric arc lamps. Crompton and Co., Limited, Sidney Linton Brunton, and Arthur John Hodgson, Arc Works, Chelmsford. (Complete specification.)

20929. Improvements in phonographs and the like instruments. Wilhelm Peisker, Fritz Schlomka, and Herrmann Kautz, 70, Deansgate, Manchester. (Complete specification.)

20931. An improved method of illuminating dining tables and the like by electricity. Herbert Edward Evans, High-street, Woodford Green, Essex.

20938. Improvements in or applicable to the diaphragms or membranes of phonographs and the like instruments Wilhelm Peisker, Fritz Schlomka, and Herrmann Kautz, 70, Deansgate, Manchester. (Complete specification.)

20942. Improvements in systems of motor control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

20943. Improvements in safety devices for electric motor control systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Maxwell W. Day, United States.) (Complete specification.)

20945. Improvements in electric telegraphs. Charles Adams-Randall, 98 Prince of Wales-mansions, Prince of Wales-road, London.

20946. Improvements in electric telephony. Charles Adams Randall, 98, Prince of Wales-mansions, Prince of Wales-road, London.

20960. Reversible galvanic cells or so-called storage batteries. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20961. Improvements in electric cables. David Cook, 70, Palace-chambers, Westminster, London.

20967. Improvements relating to incandescent electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Peyton Pinckard, United States.)

20982. Improved construction of electric meter. Frank Moore, 166, Fleet-street, London.

NOVEMBER 21.

20995. Improvements in poles for electric railways, electric lights, and telephone and telegraph lines. Edward Wellman Serrell, 33, Chancery-lane, London. (Complete specification.)

21004. Improvements in primary batteries. Robert Frederick Hall, 24, Temple-row, Birmingham.

21017. Improvements in typewriters and in printing telegraphs. James Dundas White, Fairfield, Redhill, Surrey.

21022. Improvement relating to the excitation of the field magnets of electric generators and electric motors. John Rutherford Blaikie, Electric Lighting Station, Penrose-street, Walworth, London.

21025. Improvements in electric railway systems and switches therefor. The British Thomson Houston Company, Limited, 83, Cannon-street, London. (Frederick W. Hild, United States.) (Complete specification.)

21026. Improvements in electric railway systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

21027. Improvements in ground detectors for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William H. Pratt, United States.) (Complete specification.)

21028. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Philip Farnsworth, United States.) (Complete specification.)

21029. Improvements in tachometers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Caryl D. Haskins, United States.) (Complete specification.)

21030. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States. (Complete specification.)

21036. Improvements in switches for electric lamps and the like. Henry Max Salmony, 226, High Holborn, London.

21031. Improvements in systems of electric motor control. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Albert H. Armstrong, United States. (Complete specification.)

21042. Improvements in electric arc lamp carbons. Thomas Archer Rose and Albert Barnes, 9, Adam-street, Strand, London.

NOVEMBER 22.

21086. Improvements in electrical ceiling roses for suspended and like fittings. George Sperryn and William Henry Wood, 104, Colmore-row, Birmingham.

21100. Improvements in or applicable to electric converters or transformers. Joseph Platt Hall, 70, Deansgate, Manchester.

21135. Improvements in the manufacture of plates for secondary batteries. Theodore Pescatore and the Tudor Accumulator Company, Limited, 322, High Holborn, London.

21144. Improvements in electric motor starting apparatus. William Watson and Edwin Preece, 24, Southampton-buildings, Chancery-lane, London.

21149. Electrolytic process for the precipitation of metals and alloys from their solutions, as also for the deposition of metals or alloys on other metals or alloys or on other substances. Jules Meurant, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

NOVEMBER 23.

21179. Improvements in telephone switch jacks. Alfred Whalley, Ashville, Helsby, near Warrington.

21180 An excess electric current indicator, controller, and cut-out. Percival John Pringle, Morningside, Sidcup, Kent.

21182. Improvements in gas pendants, chandeliers, electroliers, and the like. Millicent Frances Hawkes, of Thrift and Enterprise Company, 24, Temple-row, Birmingham.

21196 Improvements in marine electric light fixtures and switches therefor. George Lincoln Martin, 13, Park-row, New York, U.S.A.

21216. Improvements in method of graphitising electrodes. Philip Middleton Justice, 55, Chancery-lane, London. (The International Acheson Graphite Company, United States.) (Complete specification.)

21217. Improvements in current regulators. Philip Middleton Justice, 55, Chancery-lane, London. (The Erie Exploration Company, United States.) (Complete specification.)

21223. Improvements in or relating to electrodes or the wires or conductors connected thereto in electrolytic cells, meters, or other electrolytic apparatus. The Bastian Meter Company, Limited, and Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

21233. Improvements in secondary batteries. Theodore Pescatore and the Tudor Accumulator Company, Limited, 322, High Holborn, London.

NOVEMBER 24.

21252. Improved means of eliminating and retarding certain electric and other rays for surgical, medical, and other purposes. Charles Morley Johnson, Denmark House, Redhill, Surrey.

21255. Improvement in methods of jointing electric conductors. C. V. de Falbe, trading as the Electrical and General Contracting Company, and Thos. Harden, 17, Shaftesbury-avenue, London.

21292. Improvements in means for obtaining magnetic adhesion of locomotives or motorcars in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (The Union Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

21293. Improvements in insulated electric conductor and method of making the same. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

21294. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

21304. Improvements relating to electric meters. Fritz Lux, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21311. Improvements relating to electric traction. Harold Charles King, 27, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Dec. 15.

1899.

23141. Controlling arrangements for switches for direct-driven cage hoists and general electric and motor work. Goddard.

Digitized by Google

16899. Electrical transformers. Berry.

23153. Switches for use with rheostats for starting and controlling electric motors for lifts or the like. Hirst and Hunt.

24567. Controlling apparatus for electric lifts and other electric machines. Stevens, Major, Stevens, and Stevens.

24701. Manufacture of submarine electric conductors. Siemens Bros. and Co., Limited, and Dieselhorst.

24833. Recording and reproducing arrangement for phonographs, graphophones, and other machines for reproducing speech and the like. Grivolas.

25275. Clock-controlled electric switches. Webster.

25429. Alternating-current induction motors. Lamme. (Date applied for under International Convention, May 24, 1899.)

25509. Methods or means of insulating electric wires. Hodges, Smith, and Burrows.

25741. Lightning arresters. Wurts. (Date applied for under International Convention, June 8, 1899.)

1900.

466. Apparatus for facilitating the escape of gas from electric storage batteries or accumulators. Wells and Allan and Adamson, Limited.

758. Controlling devices for the motor circuits of electrically-propelled vehicles. Wetter. (Elektrizitäts-Aktiengesellschaft, vorm. Schuckert und Co.)

1024 Electrical switches. Heywood and Heywood.

1267. Permanent way for tramways and points therefor, specially applicable to electric tramways. Brodie.

1531. Electric light dimmer. Hatmaker.

3031 Electricity meters. Little.

3501. Electric alarums. Hill.

5528. Electric accumulators. Gumiel.

11438. Casings for the jointings of underground electrical cables. Siemens Bros. and Co., Limited, Dieselhorst, and Budd.

11944 Switching arrangement for Nernst and vacuum incandescence lamps. Feeny. (Allgemeine Elektricitäts Gesellschaft.)

13356. Telephonic repeaters. Thompson. (Tice, Urmson, Parsons, and Bell.)

15774. Electric signalling apparatus for fire-alarm and other purposes. Clar.

16699. Lightning arresters. British Thomson-Houston Company, Limited. (Bell.)

17119. Arrangement of connections for sets of electric glow lamps in series so as to maintain the circuit in case of the extinction of one or more of the lamps. Siemens Bros. and Co., Limited. (Siemens und Halske Aktiengesellschaft.)

18089. Electrically-driven road vehicles. Porsche.

18451. Circuit controller for electric street railway cars and other uses. McCallum.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Nov. 24	594	473	+ 121	18,105	15 554
Birmingham Trams.	,, 24	4,245	4,081	+ 164	—	—
Blackburn Corp'rat'n	,, 17	418	402	+ 16	18,395	20 689
Blackpool Corporatn.	,, 22	200	139	+ 61	27,187	20,022
Blackpool-Fleetwood	,, 24	162	159	+ 3	19,575	19,575
Bolton Corporation..	Oct. 28	1,254	.	—	42,293	—
Bradford City Trams	Nov 25	714	369	+ 345	18,404	13,161
Bristol Tramways Co.	,, 23	2,703	2 650	+ 53	—	—
Carlisle Tr'mw'ys Co	,, 17	143	—	—	3 772*f*	—
Central London Ry.	,, 24	5,755	—	+ 349	87,921*e*	—
City & South London	,, 25	1.849	1,035	+ 814	33,957	20,509
Cork E. T. and L. Co.	,, 22	324	356	- 32	19,319*c*	17,857
Dover Tramways ...	,, 24	162	158	+ 4	9,762	9,308
Dublin & Lucan E.R	Oct. 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	Nov. 23	3,127	2,726	+ 401	—	—
Dublin S.D. Electric	,, 23	684	674	+ 10	—	—
Glasgow Corporation	,, 24	8,840	9,046	- 206	—	—
Halifax Corporation	,, 24	627	575	+ 52	26,745	21,239
Hull Corporat'n E.S.	,, 24	1,306	641	+ 665	44,324*a*	—
Liverpool Corporat'n	,, 17	8,157	6,964	+ 1,193	364 534	317,213
Liverpool Overhead	,, 25	1,525	1,477	+ 48	35,074	34,276
St. Helens Tramways.	,, 21	—	—	+ 209	—	—
Sheffield Corporation	,, 25	2,594	—	—	—	—
Southampton Trams	,, 22	603	293	+ 309	—	—
Southport Corporat'n	,, *24	328	—	—	—	—
Swansea Tramways..	Oct. 5	447	263	+ 184	7,093	4,462

a Since April 1. *c* Since Jan. 1. *e* From July 30. *f* From June 30.
* Fortnightly returns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	–	¾-1
British Insulated Wire, Ord., 1-40,000	5	–	10-11
—— 40,001-70,000	5	..	10½-10⅝
—— 6 per cent. Cum. Pref., 1-40,000	5	..	6⅝-6¾
—— 5 per cent. Mortgage Debentures	100	–	98-100
British Electric Works, Ordinary, 50,001-95,000	1	–	7/16-½
—— 6 per cent. Cum. Pref., 1-50,000	1	–	¾-1
—— 4½ per cent. First Mortgage Debentures	100	–	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	–	4¾-4⅞
Brush Electrical Engineering, Ordinary	2	–	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2	–	2-2⅛
—— 4½ per cent. Debenture Stock	100	..	108-111
—— 4½ per cent. 2nd Debenture Stock	100	–	108-110
Callender's Cable, Debentures	100	–	110-114
—— Ordinary	5	–	13½-13⅝
—— 5 per cent. Pref.	5	–	5-5⅛
Crompton and Co.	5	–	9¾-10
—— 5 per cent. Debentures	—	–	99-101
Edison and Swan United, Ordinary	5	–	13-13⅛
—— 5 per cent. Debentures	5	–	6¾-6⅞
—— 4 per cent. Deb. Stock, Red.	100	–	90-93
—— 5 per cent. Second Deb. Stk., Prov. Certs.	70	–	96-100
Electric Construction	2	–	2-2⅛
—— 7 per cent. Cumulative Pref.	2	–	2⅝-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	–	103-105
W. T. Henley's Telegraph Works, Ordinary	5	–	13½-13¾
—— 4½ per cent. Preference	5	–	6¼-6⅝
—— 4½ per cent. Debentures	100	–	108-111
India Rubber, Gutta Percha, and Telegraph Works	10	–	11-11⅝
—— 4 per cent. Debentures	100	–	103-106
Telegraph Construction and Maintenance	12	–	17-17⅝
—— 5 per cent. Bonds	100	–	101-104
Telegraph Manufacturing, Ordinary	5	–	10¾-11¼
—— 5 per cent. Cum. Pref.	5	–	5¼-5⅝
Willans and Robinson, Ordinary, 1-80,000	5	–	10¾-11¼
—— 6 per cent. Cum. Pref., 80,001-60,000	5	–	6⅝-7⅛
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	105-107
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-1
Bournemouth and Poole, Ordinary	10	..	13½-13⅝
—— 4½ per cent. Cum. Pref.	10	–	10-11
—— Debenture Stock, Red.	100	..	105-106
Brompton and Kensington, Ordinary	5	–	7-8
—— 7 per cent. Preference	5	–	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	–	6¼-6⅝ xd
Charing Cross and Strand	5	..	9¾-10¼
—— 4½ per cent. Cum. Pref.	5	–	5¼-5⅝
Chelsea Electricity Supply	5	–	6¼-6⅝
—— 4½ per cent. Debentures	100	–	110-113
City of London, Ordinary	10	..	9-10
—— 6 per cent. Cumulative Pref.	10	–	13-14
—— 5 per cent. Debenture Stock	100	–	108-109
County of London and Brush Provincial, Ordinary	10	–	8¾-9⅛
—— 6 per cent. Cum. Pref.	10	–	11-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	–	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	–	4¼-4⅝
—— 4½ per cent. First Mort. Deb.	100	–	101-104
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	–	5¼-5⅝
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7¼-7⅝
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	–	9⅝-10⅛
London Electric, Ordinary	3	–	13⅜-13⅝
—— 6 per cent. Pref.	5	–	4¾-5⅛
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	–	100-102
Metropolitan, Ordinary	10	–	13-14
—— 4½ per cent. First Mortgage Debenture Stock	10	–	112-115
—— 5 per cent. Mortgage Debenture, Red	100	–	97-100
Notting Hill Electric Lighting	10	–	14¼-14⅝
Oriental, 1879	1	–	1⅛-1⅜
—— £5 Shares	5	–	7-7½
—— £4½ Shares, New	4½	–	5⅞-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	–	5¾-5⅞
River Plate Electric Light and Traction, Deb.	100	–	75-85
Royal Electrical Company of Montreal	$100	..	100-200
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	103-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	–	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	–	2¾-3⅛
St. James's and Pall Mall, Ordinary, 101-20,080	5	–	13-14
—— 7 per cent. Pref.	5	–	8-9
—— 3½ per cent. Deb.	100	–	100-103
Westminster, Ordinary	5	–	12-13
—— 80,001-109,437	5	–	11½-13⅛
Electric Railways.—			
Central London, Ordinary	10	–	10-10½
—— Pref. Half-Shares	5	–	5-5⅛
—— ,, ,, deferred	5	–	5-5⅛
City and South London, Consolidated Ordinary	100	–	42-46
—— Ordinary	10	–	4¼-4⅝
—— 4 per cent. Debenture Stock	100	–	118-120
—— 5 per cent. Pref. Stock '91	103	–	128-133
—— ,, ,, '96	100	–	130-135
Liverpool Overhead, 5 per cent. Pref.	—	–	13-13½
Waterloo and City, Ordinary	100	–	99-99
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	–	14-16
Brisbane Tramway	100	–	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	–	9⅝-10⅛
British Electric Traction, Ordinary	10	–	13¾-14¼
—— 6 per cent. Cm. Pf. 80,001-60,000	10	–	13-15
—— 5 per cent. Perpetual Debenture Stock	100	–	120-125
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	–	4¾-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	–	4-4⅜
—— 5 per cent. Deb. Stock, Red.	100	–	104-107
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	–	9⅝-10⅛
New General Traction, Ordinary	5	–	3¾-4
—— 6 per cent. Cum. Pref.	5	–	4¾-5⅛
Oldham, Aston, and Hyde Tramway, Ordinary	10	–	16-17½
—— 5 per cent. Cum. Pref.	10	..	10¼-10⅝
Potteries Electric Traction, Ordinary, 26,667-40,000	10	–	10¼-11¼
—— 5 per cent. Cum. Pref., 1-20,000	10	–	10-11
—— 4½ per cent. Debenture Stock	100	–	102-103
Telephones.—			
National Telephone, Ordinary	5	–	4¾-4⅞
—— 6 per cent. Cum. First Pref.	10	–	13-14
—— 6 per cent. Cum. Second Pref.	10	–	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	–	5-5⅛
—— 4 per cent. Deb. Stock, Red.	100	..	101-104
—— 3½ per cent. Deb. Stock, Red.	100	–	86-89
Oriental Telephone and Electric Company	1	–	2-2⅛

Digitized by Google

NOTES.

Electric Pumps.—A report of the commissioners connected with the branch of the South Staffordshire mines refers to the fact that electric pumps are to be largely used in the future in various operations in that district.

African Telegraph Lines.—Amongst the German Government estimates for 1901 is an item for £10,000 towards the expense connected with the beginning of the telegraph line which will connect Dar Es Salam, in German East Africa, with Lake Tanganyika. This line will eventually join the Cape-to-Cairo wire. At present, however, it is only intended to push on with the line to Mpapua, a distance of about 270 miles from the coast.

South London Electric Railway Accident.—The Board of Trade report on this accident shows that it was due to a driver running past the signal at danger. This is another case illustrating the need of providing a safeguard by which drivers will be informed if they do not implicitly obey the signal given. If an electric railway is provided with both compressed air and magnetic brakes, the switching off of the current on the third rail could, when the signal is at the "danger" position, easily be arranged to do this.

Electricity and Mining.—It is reported from Rossland British Columbia, that the electrical power company at Kootenau River which supplies the Rossland mines, has found it worth their while to extend their plant in order to meet the increased demand for power for all purposes at these gold mines. The amount to be expended in new plant is about £400,000, and this should enable the company to give a full and sufficient power supply to all who require it. A hoist having some 1,000 h.p. was to have been installed during the past week, and it is expected that much benefit will be derived from its use.

The Electric Eel.—The following is the catastrophe referred to by one of the speakers at the Institution dinner on Monday last: At the Zoological Gardens, London, recently, a large electric eel was swimming in its tank with more activity than usual when a big foreign cockroach dropped into the water. It began to swim vigorously across the tank, spreading out its wing cases and making a disturbance on the surface of the water. The eel turned round, swam past it, discharged its battery at about 8in. off, and the cockroach instantly stopped stone dead. The eel afterwards swallowed it.

Aberdeen Tramways.—Aberdeen is likely to have an exhibition of the various ways in which electric tramways can be worked on the contact system. Two firms have already offered to equip experimental lines to display the advantages of their particular arrangements, and it is most likely that both of these will be accepted. The firm making the first offer was Messrs. McIlroy and Grunow, while the other system is the Johnson-Lundell, which Mr. Leonard W. Holmes wishes to introduce into Aberdeen. If all goes well, there will be an additional attraction to induce electrical engineers to spend their holidays in 1901 in Scotland.

Educational Articles.—Our American contemporary, *Electricity*, announces in its issue for Nov. 14 that a series of articles of an educational nature will be given week by week in its columns. Readers are warned that no "mathematical gymnastics" will be indulged in, which we presume would be paraphrased by Prof. John Perry to mean that the articles will be specially adapted to lazy engineers who will never excel. We agree with our contemporary, however, that it is, at the present time, much better to avoid in a technical journal higher mathematics as much as possible, in order to meet the reading capacity of the bulk of the readers.

Power Transmission in the Tyrol.—As in most countries where water power is available to any considerable extent, we find that electric power transmission is making rapid headway in the Tyrol. The latest proposal is to utilise a waterfall on the Stilluppback near Mairhofen. About 2,000 h.p. is available from this source, which it is proposed to convert into electrical energy for transmission to the neighbouring township, besides to some gold mines, and possibly to a railway now being built in the Ziller valley. The scheme is the outcome of private enterprise, and the whole of the work in connection with the same has been entrusted to Messrs. Otto Kury, München-Innsbruck.

The Electric Shunting Pole.—We gather from the daily Press that a Glasgow gentleman has recently devised a means of making the shunting work which has to be done by many railway servants somewhat more safe. The idea consists of a combination of an electric lamp with the shunting pole, so that when the man is operating the couplings he can for the time being light up the space between the railway trucks. A switch in the handle of the pole is arranged somewhat after the manner of a switch in a telephone receiver, so that the small accumulator is only discharged through the lamp when the light is required. By means of red and green glass respectively the pole can also be used for signalling purposes.

The Nernst Lamp.—At a recent meeting of the Frankfort-on-the-Main Association of Electrical Engineers, Herr Wolff, manager of the Frankfort branch of the Allgemeine Elektricitäts-Gesellschaft, showed and explained the working of a new form of Nernst lamp. The necessary initial heating of this lamp is effected by a spiral of platinum embedded in some fireproof composition. By means of a switch neatly concealed within the base of the lamp, this spiral is automatically cut out of circuit after the lamp has been rendered sufficiently conductive by the imparted heat. The lamp exhibited was of 25 c.p; hitherto no lamps of the Nernst type for lower candle-powers have been constructed.

Personal.—We have to congratulate the directors and shareholders of the Central London Railway in that they have succeeded in securing the services of Mr. P. D'Alton as engineering chief of their line. Mr. D'Alton's experience in general engineering has been most extensive, and his period of command of the Deptford station of the London Electric Supply Corporation gave him an intimate acquaintance with the worst side of electrical engineering. Mr. D'Alton for several years was connected with the most successful attempts which have ever been made in connection with submarine vessels, and these, we presume, are in some way a recommendation for managing a railway line which runs in the depths of the earth. We wish him every success in his new post, and are sure that his appointment will conduce to the economical working of the system.

Electrical Engineers Volunteers. — The South African contingent of the Electrical Engineers (Royal Engineers) Volunteer Corps will find a warm reception awaiting them on their arrival in England. The welcoming ceremonies commence on Saturday, the 15th inst., when the detachment will be entertained at dinner by the other members of the corps. Then on Monday, the 17th inst., another welcome-home dinner will be held in the Prince's Restaurant, under the presidency of Prof. Perry. On the

Digitized by Google

next night we are informed that the Institution of Electrical Engineers are arranging a reception to be held at the Covent Garden Opera House, which has been generously placed at their disposal by Mr. Rendle and Mr. Forsyth for this purpose. On this occasion ladies will be invited, and we trust that the Electrical Volunteers will not be unduly embarrassed by the welcome from the fair sex.

Import Duties.—The success of the airship of Count Zeppelin has induced other inventors to state in the daily papers how successful they are sure they could be if they had the requisite opportunities. One of these inventors, hailing from Italy, states that he will be building an airship next February or March, and that he is now in negotiation with important builders with regard to its construction. He also states that it will be built in Italy to avoid import duty. We were not aware that the building of airships was already a recognised profession, and should think that in any case an airship would give one of the best opportunities of avoiding import duty. When our coastguards are expected to guard against smuggling, their task is rendered possible by the limited number of landing places, but this does not apply to an airship, which should result in considerable trouble to the Customs officials.

Light Railway Procedure.—A curious point was recently raised in connection with the procedure of the Light Railway Commissioners before Sir Courtenay Boyle. An order was practically agreed to by the Commissioners in 1897 subject to certain additions being made to the scheme, which were not complied with till 1899. In the meantime a firm had acquired some scheduled property, and had converted the same into a recreation ground for their workpeople. When the case was heard this firm had no opportunity of protesting, in spite of the fact that a large outlay would be rendered almost valueless if the scheme were proceeded with on the original lines. Sir Courtenay Boyle's solution of the difficulty was that the parties affected should meet and arrange the matter mutually. It is evidently unfair that the Commissioners should hang up a scheme for two years and then give a decision without the interested parties being heard.

Cork Foundations.—In Germany cork is said to have been used with success in isolating the vibrations and consequent noise caused by machines installed in or near dwelling-houses. A sheet made up of flat pieces of cork in mosaic fashion of corresponding size to the bed-plate of the machine, and held together by an iron frame, is laid under the machine. The source from which we gather this information also alludes to the isolation, by means of cork, of each bolt or connection between the bed-plate of the engine and its foundation, but does not describe in what manner such isolation is effected. It is, of course, apparent that the mere sandwiching of a sheet of cork between the bed-plate of a machine and its foundation would not necessarily absorb troublesome vibrations, since each anchor bolt is a medium whereby the vibrations of the engine may be transmitted to its foundation, and hence to the floor and walls of the building unless effectively isolated from the same. How this effective isolation is obtained by the use of cork sheeting remains to be explained. For our part, we should be more inclined to rely upon a specially-prepared foundation of extra area and solidarity and to a careful balancing of the reciprocating parts of the machine.

Royal Institution.—The following are the lecture arrangements at the Royal Institution before Easter: Sir Robert Ball, six lectures (adapted to young people) on "Great Chapters from the Book of Nature"; Prof. J. A. Ewing, six lectures on "Practical Mechanics (experimentally treated), First Principles and Modern Illustrations"; Dr. Allan Macfayden, Fullerian Professor of Physiology, R.I., four lectures on "The Cell as the Unit of Life"; Dr. Arthur Willey, three lectures on "The Origin of Vertebrate Animals"; the Rev. H. G. Graham, three lectures on "Society in France before the Revolution"; Sir Wyke Bayliss, two lectures on "Shakspear in Relation to his Contemporaries in Art"; Prof. R. K. Douglas, two lectures on "China"; Mr. F. Corder, three lectures on "Vocal Music: its Growth and Decay" (with musical illustrations); the Right Hon. Lord Rayleigh, six lectures on "Sound and Vibrations." The Friday evening meetings will begin on Jan. 18, when a discourse will be delivered by Prof. Dewar on "Gases at the Beginning and End of the Century"; succeeding discourses will probably be given Dr. A. W. Ward (the Master of Peterhouse), the Right Rev. Monsignor Gerald Molloy, Prof. G. H. Bryan, Prof. J. J. Thomson, Sir W. Roberts-Austen, Mr. H. Hardinge Cunynghame, Mr. W. A. Shenstone, Dr. Horace Brown, the Right Hon. Lord Rayleigh, and other gentlemen.

Advantages of Electric Traction.—The advantages of electric traction for suburban or local railways are summed up by a Bohemian authority somewhat as follows: The principal advantages of electric traction consist in that a lighter type of rail, and, moreover, bridges of lighter construction, may be employed; many of the existing arrangements at stations are rendered unnecessary, while station platforms may be considerably shortened; and, lastly, heavier gradients and curves of smaller radii allowed, whereby considerable saving in excavations, etc., may be effected. It is pointed out that a serious drawback hitherto experienced has been that the cost of constructing local lines is scarcely less per mile run than that holding for main-line work, nor is the subsequent cost of working the same much less in comparison. It is therefore necessary to adopt means of communication, the initial outlay on which and subsequent cost of working are in better unison with the financial means locally available. In order to make a success of local lines in Bohemia, it is therefore recommended that attention should be turned to light railways of normal gauge, the cost of which, in comparison with main-line work, would be considerably less. Above all, the possibilities of electric traction should be kept in mind. If the above advice is acted upon, Bohemia should soon be added to the list of markets open to traction engineers and manufacturers.

Accumulators for Ships.—In a contribution to the *Elektrotechnischer Anzeiger* Mr. Fritz Forster discusses the use of accumulators for lighting purposes on ocean steamships. It appears that a German firm, who make a speciality of ship installations, have recently installed experimentally quite a number of batteries of accumulators in Hamburg ships. All these ships previously possessed generating plants, the dynamos being either shunt or compound wound machines. But in each case they were designed to yield only the normal difference of potential required for the lighting, whence it was necessary to provide for charging the accumulators, subsequently introduced, in two parallel batteries, in order to avoid essential modifications of the existing plant. The accumulators, fitted with acid-tight covers of vulcanite, were placed in a compartment as near the switchboard as possible in each case, and firmly secured. A diagram which accompanies the article shows the connections adopted to facilitate cutting out the compound winding of a dynamo when charging, so as to enable it to be run temporarily as a shunt-wound machine, whereby to avoid the danger of a back E.M.F. reversing its polarity. As the writer suggests, experience alone can prove the adaptability of accumulators for shiplighting purposes.

Digitized by Google

But it is not impossible that accumulators may play an important part in the future of this branch of electrical work, and they will be specially useful when a ship is in port and the boilers not under steam.

Accumulator Cars.—In discussing the capacity of batteries for electrically-propelled motorcars, our contemporary *L'Electricien* remarks that it is usual to adopt a battery consisting of 44 elements, which gives an available mean difference of potential at the terminals of about 85 volts. The mean output of energy per ton-mile of a well-constructed car is about 136 watt-hours, whence it follows that an average output of 1·60 ampere-hours per ton-mile may be relied upon. If we denote by m the ratio between the weight of the car under service conditions and the weight, P, of the battery—P being expressed in pounds—the total weight of the car will then be m P pounds. To accomplish a journey of M miles with this car, we must have 0·000643 m P M ampere-hours. On the other hand, if we denote by c the specific capacity per pound of a single element relative to the aggregate weight—the weight of the element being $\frac{P}{44}$—then the total capacity will be $C \cdot \frac{P}{44}$. In order that the car may accomplish M miles, we must have $C \cdot \frac{P}{44} = 0\,00071\ m\ P\ M$, whence we get the equations $C = 0315 \cdot m\ M$ and $M = \frac{31{\cdot}7\ c}{m}$, which enable us to determine the specific capacity requisite for a given number of car miles. Or, inversely, we may determine the number of miles which a car equipped with a battery of the given specific capacity will be able to accomplish. As a rule for an ordinary car $m = 3$, but for a car specially designed for racing m may be set down as 2. An ordinary car ($m = 3$), with a battery of 4½ ampere-hours capacity per pound of element, may have a range $M = \frac{31{\cdot}7 \times 4{\cdot}5}{3} = 47{\cdot}5$ miles. In order to accomplish a 150-mile run, a racing car ($m = 2$) must be equipped with a battery having a capacity per pound weight of each element of $C = {\cdot}0315 \times 2 \times 150 = 9{\cdot}5$.

The Dublin Conversazione.—On Thursday, Nov. 29, the Dublin Section of the Institution of Electrical Engineers held their first conversazione at the lecture theatre of the Royal Dublin Society. Those present were received by Prof. G. F. and Mrs. FitzGerald, and the proceedings, which were highly successful, comprised an exhibition of various electrical experiments and apparatus by members and others. There was also a short lecture on rotating magnetic fields, illustrated experimentally by the chairman, Prof. G. F. FitzGerald, F.R.S.; a similar lecture, illustrated by lantern slides, by Prof. W. F. Barrett, F.R.S, on the permeability of certain alloys of iron and steel. In addition there was an excellent short musical programme, and an exhibition of an Edison grand concert phonograph by Mr. J. Gibson. Among the very numerous exhibits may be specially mentioned a new form of meldometer, for determining the softening points of minerals, Dr. J. Joly, F.R.S.; the action of radioactive material on electric discharge, Dr. F. J. Trouton, F.R.S; frictional electrical machine, date very early in eighteenth century; original Page electromagnetic engine, exhibited in the Great Exhibition of 1851, A. E. Porte and J. R. Sykes; meteorological instrument with electrical recorders, A. Yeates; X-ray exhibition, Dr. W. Haughton; electric lamp (movable on rails), A. Guinness, Son, and Co., Limited; tramway and power distribution (material and instruments), A. Jacob; system of telephoning as applied to electric traction, J. Y. Fletcher; tram material as used in Dublin, J. W. Towle, R. H. Humphries, P. S. Sheardown, and S. G. Redman; various types of house meters, G. F. Pilditch.

Electrolysis by Alternating Currents.—In decomposing matters by means of electricity we have, remarks the *Elektrotechnische Rundschau*, to distinguish between direct and indirectly produced decomposition. In the case of indirect electrolysis, it is really the heat emitted by the electrically incandesced carbon rods or blocks which produces the decomposition. This fact renders it immaterial whether the heat be generated by alternating currents or by direct currents. But for direct electrolysis alternating currents are only applicable in certain cases. For instance, it is advantageous in nickel plating or coppering to reverse the direction of the galvanising current for a brief period at times, when it follows that the surface of the cathode—nominally the receiving portion of the combination—must become virtually the anode or giving portion during the reversal, thereby causing a modification of the molecular construction of its surface. It is evident that this process may, under certain circumstances, conduce to results which cannot, perhaps, be so satisfactorily effected by other means. But the combination of two direct currents so as to obtain successive impulses in opposite directions constitutes in reality a kind of alternating current, the individual phases of which are very long. This circumstance has been put to account by a Norwegian inventor, who proposes to employ for electrolytical purposes alternating currents of varying impulse lengths, so that the impulses given in the one direction have a greater influence on the electrolytic bath than those in the other. The desired result may be effected either by making the impulses in the one direction of longer duration than those in the other, or by giving them relatively greater current strength. As an alternative, both methods might be combined, or the potential allowed to increase as well as the current strength. In fact, many modifications are possible, experimental researches with regard to which may lead to useful results. The new process is undoubtedly worthy of careful consideration, especially in its possible adaptability for the electro-deposition of metals in any desired thickness without the fear of stripping.

Electricity as a Stimulus.—At a recent meeting of the Medico-Psychological Association of Great Britain and Ireland, Dr. H. Lewis Jones read an interesting paper upon the application of electricity in certain forms of mental disease. In view of the charges which had been brought by certain medical men against the extra pressure introduced into commercial life by the devices perfected by electrical engineers, it is interesting to note that electricity is able in certain cases to remove the mental diseases which indirectly it has helped to cause. In the paper in question Dr. Lewis Jones referred to the most fact that the important development of electricity in the last 10 years has been in the direction of general electrification for general effects, and this line of treatment has had the advantage of being very carefully worked out by a physiologist who is not at the same time a medical man, Prof. D'Arsonval. He has shown that a profound effect can be produced upon the general nutrition of the body in this way, and has established by measurement the increase of carbonic acid, of body heat, and of urea in animals and in people submitted to general electrification. Clinical experience has also demonstrated the immediate effect which follows general electrification in various forms of debility. The author proceeded to describe the way in which he recommended the electrical stimulus to be applied to patients who were suffering from overmentation, and quoted a number of cases in which most beneficial results had accompanied the treatment. Alter-

Digitized by Google

nating currents were largely employed in the cures, and the general effect is a stimulus, from which the appetite improves, the patient gains weight, and is able to sleep. Another doctor concurred with the author in his statements, while a question was raised by one member as to how far the water in the electric bath contributed towards the cure. We would suggest to central-station engineers that when they are feeling overworked they should bathe in the water-tank providing the artificial load for their station. The current passing through the body could then be varied by altering the angle between it and the general line of flow of the current. We are indebted to the *Lancet* for the abstract of Dr. H. Lewis Jones's paper.

Electric Travelling Cranes.—With respect to the largely increasing use of electric travelling cranes in factories and foundries, Mr. A. D. Williams, in a paper recently presented to the Pittsburgh Foundrymen's Association, gave some useful practical hints concerning these. Thus, he states that the electric motors, controllers, and wiring on cranes should be so placed as to be easily accessible for repairs. Good insulation on the conductors he considers to be a very important point, and one which should be insisted upon. Another matter which is important, and is stated at the same time to be one of the weak points of electric cranes, is the controller. In this, as with the motors, all parts should be easily accessible, and so arranged that those subject to wear can be removed and replaced with a minimum amount of trouble. The resistance coils should be arranged so that close control over the crane can be obtained, without which delicate handling is impossible. The device by which the operating levers are centered, or held in the position at which the current is off, should be so constructed that the operator is not likely to throw the lever too far and reverse unintentionally. Any weakness in this device is a great source of danger, but it is at the same time desirable to have easy working controllers. The electric motors should be enclosed in dustproof casings, and the author considers that it is very desirable to have all parts standardised to facilitate their renewal when worn. The armature and commutator should be easily removed, and he thinks that, although increasing the first cost somewhat, it is desirable to have a set of spare armatures added, as this may save delay at a very inopportune time. The use of an automatic or load brake is advised in preference to the magnetic brake, but careful and frequent examination of the brake is recommended in any case. Although the parts which go to make up a crane are not very numerous, Mr. Williams lays stress on the necessity for putting them up properly, and not anyhow. The selection of good girders is a very important item, and when selected great care should be taken to have these put up true and level. The author points out that the old jib crane, which is very useful for very heavy loads, should not be discarded on the advent of the electric travelling crane, but it should be supplemented in most instances by a number of light cranes so that the traveller can be used at its maximum efficiency on loads proportionate to its capacity.

Patent Office Practice.—An interesting patent issue is shortly to be tried in America, in which a Mr. G. B. Selden claims a royalty from practically all motor vehicles using hydrocarbon engines. The history of the patent issued to the gentlemen in question is an instance of the faulty patent laws in the United States. We understand now that the law by which Mr. Selden has reaped so much advantage was amended in 1897. According to the *Scientific American*, the record of the case in the Patent Office shows that Mr. Selden's first application for a road engine was made on May 8, 1879, and rejected on May 31 of that year. According to the then law, a patent application could not be considered to be abandoned unless two years had elapsed since the last official action. Mr. Selden proceeded to file an amendment on May 26, 1881, nearly two years later. A second rejection on June 17, 1881, was followed on May 15, 1883, by another amendment; and a third rejection on May 26, 1883, was met by an amendment filed on May 18, 1885. An official letter sent to Mr. Selden on June 15, 1885, was not acted upon until June 13, 1887, only two days before the expiration of the two years of grace allowed by the statute. Another rejection on June 21, 1887, was answered by a letter dated April 13, 1889, and by an amendment filed June 10, 1889. Mr. Selden was required on June 14, 1889, to furnish a "smooth copy" of the specification prior to issue; but although the application was otherwise ready for allowance, it was not until June 5, 1891, nine days before the statutory limit, that the substitute specification was filed. An official letter of July 1, 1891, demanded a new oath prior to issue, but it was not until June 28, 1892, that Mr. Selden obeyed the order. The case was then transferred to another examiner, by whom some of the claims previously allowed were rejected on July 29, 1893. The next amendment was filed on April 1, 1895. The patent was finally granted on Nov. 5, 1895, just at about the time when the motor carriage began to make its appearance in the streets of the large cities. All of the 19 original claims were cancelled. By his intimate knowledge of the law Mr. Selden managed to delay the granting of his petition over 14½ years, during which time he had an opportunity of amending and improving his schemes. A more unjust system could not be conceived, as the patent dates from the day of issue in America, and not from the day of application.

Shiplighting.—A long article in the *Elektrotechnische Zeitschrift* by Mr. Grauert deals with electrical installations on new ships of the German navy. It appears that in the German service separate lead and return wires have been generally adopted, concentric cables being used in the neighbourhood of the ship's compasses. Attempts to employ the ship's structure as a return have not conduced to successful results, and so far as large vessels are concerned, this practice has been entirely superseded. But in the case of new torpedo-boats, where economy in weight is a vital consideration, the practice still holds. In all places exposed to the danger of mechanical injury, such as the engine-rooms and stokeholds, lead-covered iron-armoured cables are employed, while elsewhere cables well insulated with rubber, but otherwise unprotected, except in some cases by thin rust-proof wire, are used. The wood casing formerly employed has been abolished, owing to its inflammability. Hitherto the telegraph and telephone cables have been of the lead-covered iron-armoured type, but the newest ships have been provided with a central subway, like a corridor, as well as side corridors below the armoured deck, which may be used for the electric cables, telegraph and telephone wires, etc., thereby avoiding all danger of mechanical injury to the same. Having regard to this, it is proposed to dispense with the steel armour in future, even for the lighting and power cables, retaining only the lead protection. The practice of soldering branch connections has also been discarded in favour of branch fuse boxes, in which the connections are made to terminal bars. These branch circuit boxes are made for two, three, four, six, and eight lamps. They are, of course, watertight. Their introduction seems to have been a complete success, facilitating as they do systematic supervision of the ship's wiring. Although slate is at present generally used for

Digitized by Google

switchboard bases in the service, it is interesting to learn that iron is proposed as a substitute, owing to the unavoidable breakages which occur. Small machine boards with iron bases have already been successfully introduced, but the difficulty of insulating the terminals and connections has hitherto prevented the adoption of the plan on a large scale. With the exception of the connections to the measuring instruments, all the switchboard connections on the "Fürst Bismark" were for the first time made with bare copper bars, whereby a neat, solid construction is obtained which is also accessible. The necessary protection against moisture is provided by enamel, which also serves to distinguish the poles, red and blue being used. This type of board is particularly advantageous where the available space is limited in depth, since the connections behind require no supervision, and the screw terminals may all be withdrawn from the front of the board.

The Royal Society.—The annual meeting of the Royal Society was held last week, and was followed by the anniversary dinner, which took place at the Hôtel Métropole. A report of the council for the year now passed discloses that the society has done good work, and it is taking the leading part it ought to do both in scientific matters of the United Kingdom and also in the furtherance of the general science of the world. The first item dealt with in the report is the National Physical Laboratory, which was to have been carried on in the buildings of the Kew Observatory. Owing to the unexpected opposition to the erection of a laboratory in the Old Deer Park, valuable time has been wasted. The council express regret at the decision of the Government in this respect, but they are pleased to accept the site offered to them by her Majesty's Treasury at Bushey House. There some 30 acres of ground will be available. Reference is then made in the report to the committee appointed by the Board of Trade to investigate the interference of electric railways with magnetic observatories. The instruments used in making the observations in order to lay experimental data before this committee were devised by Mr. W. Watson, the assistant professor of physics in the Royal College of Science. The Board of Trade's decision on the matter is awaited with grave anxiety. It is announced in the report that the catalogue of scientific literature of the world will be commenced on Jan. 1, 1901. The contract for the printing and publishing of the same for the International Committee having the matter in hand is made in the name of the Royal Society. Her Majesty's Government has guaranteed £1,000 a year for five years to make good to the Royal Society part of any loss which may be incurred in consequence of this publication. It is hoped, however, that this guarantee will not be called upon. With respect to the bequest of £4,000 under the will of the late Prof. Hughes, the Royal Society has determined to award the income annually as a prize, either in money or in the form of a medal, for original discovery in physical science. The award will be called the Hughes Medal. It will be awarded without distinction as to either sex or nationality. Discoveries connected with electricity and magnetism will have the preference when the award is being considered. It is also announced in the report that the electric lighting installation at the Royal Society's house is being extensively altered to bring it up to modern requirements, and that both the alternating and direct currents will be henceforward available in the building for demonstration purposes. The reconstruction of the installation is being carried out under the guidance of Prof. Ayrton. Lord Lister distributed the prizes for the past year, amongst which, we note, were the Coplin Medal to Prof. Marcellin Berthelot (foreign member) for his brilliant services to chemical science; the Rumford Medal to Prof. Antoine Hewir Becquerel for his discoveries in radiation proceeding from uranium; and a Royal Medal to Major Percy Alexander MacMahon, F.R.S., for the number and range of his contributions to mathematical science. A distinguished number of guests attended the annual dinner.

Wireless Telegraphy.—Some interesting experiments have recently been carried out in Germany by Prof. Braun, of the physical laboratory of the Strasbourg University. The experiments have been made with the object of increasing, if possible, the range to which these wireless telegraphy messages can be dispatched. Up to the present, however, the statements made by the authorities in Berlin do not disclose any claim for distances as great as have been successfully signalled over by Mr. Marconi. The experiments were made between the Brocken (the highest mountain in North Germany) and the Kyffhauser (in Thuringia). The actual distance was about 40 miles, and messages were successfully transmitted and received. Up to the present only untechnical descriptions have been given, from which it is not easy to understand exactly what the arrangements are. It seems, however, that there is a transformer between the discharge circuit of the condenser and the circuit in which the oscillatory currents sending the message are induced. The professor's system is also in use between Cookshaven and Heligoland, a distance of about the same length, and is said to work well. As regards the Marconi system in our own country, it is being boomed quite as much as ever in the daily papers. Without doubt the company has the right to manage its own affairs in the way it likes, but the methods adopted are not those which recommend themselves to scientific men. It may be advisable from their point of view to withhold information from those who are able to judge of the value of the system, but this should not be accompanied by very numerous interviews with the editors of half-penny papers, who draw quite erroneous conclusions. A perusal of the remarks made by the interviewers, as published in several papers during the past week, would lead the untechnical man to conclude that it is only the obstinacy of the Post Office officials which prevents the Marconi system displacing the ordinary systems of telegraphy in the British Islands. Even this faulty conclusion would be harmless were it not for the fact that it may result in the public paying fancy prices for the shares in the Marconi Company. In certain situations the Marconi system of telegraphy is useless, and there has been nothing done up to the present which shows any signs of enabling it to compete with ordinary telegraphy over land lines, or even with submarine cables, unless the conditions are exceptional—as, for instance, when connecting between the mainland and an isolated lighthouse round which a violent sea washes. An example of the telegraph we refer to is one which has just reached us in connection with experiments to be carried on from Southend Pier. We are informed that automatic signals are to be continuously sent from a 30ft. mast erected on the pier, which signals are intended to warn steamships coming into the Thames in a fog of their danger. To give weight to the note, one is told that experts from the Board of Trade, Trinity House, Lloyd's, and other public and private corporations are to witness the trials. The fact remains, however, that although in a fog the signals may be received on board a boat, the occupants of that boat will be unable to know either in what direction the danger is or the distance they are away from the sandbank or rock from which the warning is supposed to issue.

Digitized by Google

THE ARRANGEMENT OF THE DISTRIBUTING NETWORK.

BY CHAS A. GILLIN.

(Continued from page 766)

Continuance of Supply of Electric Energy.—Supply station engineers generally recognise the necessity of an uninterrupted supply of electric energy, and it is the purpose of this section to consider the points relevant to the subject matter of this article which that question raises. There are two chief causes of interruption in the supply of electricity—viz.: (*a*) the breaking down of generating machinery or steam auxiliaries; (*b*) short-circuits or very bad "earths" on the distributing network.

Of these causes we are only concerned here with the latter, which is undoubtedly the more important for a twofold reason—viz., because it will be by far the most frequent cause of interruption of supply when the cables begin to show signs of deterioration; and, secondly, because of the fact of the cables being out of sight, and very often, therefore, not receiving the attention and care which they otherwise would receive. When a short-circuit or a serious "earth" occurs on any system of mains, it is necessary to localise the fault and disconnect the faulty cables from the main network until the necessary repairs

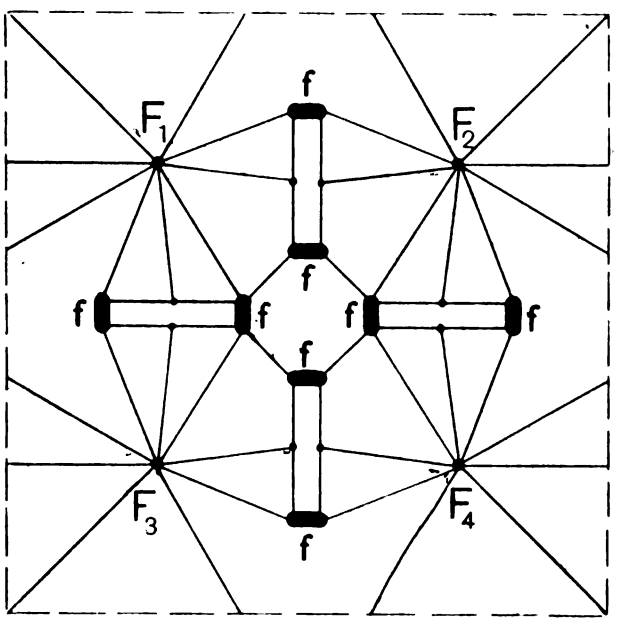


FIG. 4.

have been effected. If the fault is of so serious a nature as to endanger the whole undertaking, its position will perhaps be self-evident; but in any case it will be of the utmost importance to locate it and cut it out without loss of time.

The detailed arrangements for facilitating the localisation of faults are treated of in the following section of this article (Section 4). Our present problem is to design the network so as to reduce to a minimum the number of consumers who would have their supply of electricity cut off in the event of the development of any fault on the system, while at the same time keeping in mind the limitations already laid down in other directions (*vide* Sections 1 and 2). The Board of Trade rules and regulations prescribe that the system of distributing mains must be so arranged that if it becomes necessary to stop the supply of current through any mains for a longer period than one hour, the maximum number of consumers from whose premises the supply is cut off must not exceed 80, and that in no case must the stoppage exceed in amount a maximum power of 200,000 watts.

Fortunately, the plan we have already adopted in Sections 1 and 2 lends itself admirably to the present purpose, for the better interpretation of which reference must be made to Fig. 4, which, it will be observed, is based on Fig. 2. The feeding points are shown, as before, at F_1, F_2, F_3, F_4, and the sections into which the network is divided are indicated by dotted lined squares, while the points at which the different sections are connected to each other are indicated by the letter *f*. In Fig. 4 prominence is given to the points of connection between the several sections of the network, because the first object at which we must aim is to be able to readily isolate any section harbouring a fault, without unduly interfering with the remainder of the distributing system. One method of obtaining this desideratum is to have each individual section connected to all its contiguous ones at a very few points, so that it can be disconnected in a very short space of time. These connections might, with advantage, be made by means of fuses or carefully-adjusted automatic circuit breakers, so that if a heavy rush of current, due to a fault on the system, takes place to any given section, the circuit would be broken at these points, and the section containing the fault completely isolated. The fault may then be easily traced to a short length of cable, and this length being cut out, the whole section remaining can be connected up again.

Probably some difficulty would be experienced in connecting the section to the main network if a reasonable number of consumers had put their switches on. As a matter of fact, if these switches connected continuous-current motors to the distributing mains, it would be a practical impossibility to *directly* reconnect the section to

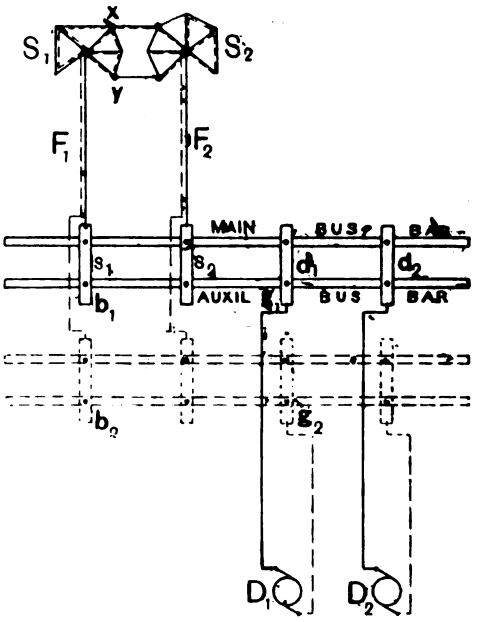


FIG. 5.

the main network, for the armatures of the motors would represent a complete short-circuit across the mains to which they were connected. To safely effect the reconnecting, therefore, the switchboard at the generating station or distributing stations should be arranged so that one or more generators could be used for supplying any individual section of the network; because when, after having been disconnected, any section is again ready for receiving its supply of current, it will be always advisable, if not always necessary, to run a generator on that section from zero voltage, and gradually increase the pressure until the normal voltage is reached before throwing it in parallel with the main network.

The arrangement of the switchboards, etc., is shown diagrammatically in Fig. 5, where D_1 D_2 represent generators connected through their switchboards to the plug-boards d_1 d_2, by means of which they may be connected either to the main 'bus bar or to the auxiliary 'bus bar. S_1, S_2 represent two sections of the distributing network, which are joined through their respective feeders, F_1, F_2, to the plug boards s_1, s_2, by means of which they also can be connected either to the main 'bus bar or to the auxiliary 'bus bar. The dotted lines in the diagram represent the negatives, the full lines representing the positives. If after an interruption in the supply of current S_1 is isolated by being disconnected at *x* and *y*, and it is required to recommence the supply, plugs must be inserted at b_1, b_2, g_1, g_2, and the generator D_1 must be run up gradually to the

Digitized by Google

normal voltage, when S_1 can be easily reconnected at x and y in parallel to the main network. The feeder F_1 can then be again connected to the main 'bus bars, the generator D_1 being also paralleled to the main 'bus bars, or taken off altogether as the circumstances require.

An objection to the employment of fuses for the above-mentioned purpose is that the fuse or fuses joining a section to the main network at any single point may burn out, and the cause thereof may be simultaneously removed, thus leaving the remainder of the fuses joining that section to its neighbouring sections quite intact. This would probably cause a slight difference in pressure in the premises of consumers in close proximity to each other, and consequently give reason for complaint; and as there may be no indication at the station of any of the fuses having burnt out, no steps would be taken to immediately replace them. Possibly, however, some means of indicating the fact may be thought out, and this objection thereby removed.

In the case of employing automatic circuit breakers, it is a very easy matter to arrange to indicate the opening of the circuit breakers by means of pilot wires connected to some signalling arrangement at the station, a bell being rung or a lamp lighted until the circuit breakers are replaced.

It is desirable to have these fuses or circuit breakers in specially-constructed boxes placed above the ground so as to render them more accessible, and their positions more conspicuous. The adoption of the above-described method, whatever its objections, would ensure continuance of supply in at least the larger portion of the network, the details, of course, being modified to suit special requirements.

4. *Facility in the Localisation of Faults.*—With the ageing of the cables the localisation of faults will become a very important item in the working of electricity supply stations, and when the area of distribution increases, and mains are extended into almost every street in the more densely-populated parts of the district, the work of localisation will become correspondingly more difficult. To obtain any great facility in the localisation of faults, the network must be arranged perfectly systematically from the commencement of the undertaking, and all subsequent extensions of mains must be made to comply with this systematism.

Whatever the methods of localisation adopted, it is manifest that the arrangement of the network will play an important part in the time within which the position of a fault will be found, and if that arrangement of the network is effectual for the expeditious localisation of faults by any particular method, it naturally follows that it will be equally effectual for readily locating faults when any other method of localisation is employed. The arrangement which we have previously adopted of dividing the whole network into sections again commends itself to our purpose, for it is possible by means of pilot wires running to various points in the network, and connected to indicators at the generating station, to show, immediately a fault occurs, the section in which it is situated. This method of locating a fault to one particular district is used with great success in Berlin, in addition to the system of fault signalling, generally known as the Berlin system, which in most cases requires a test wire in every cable.

Reference was made in Section 3 to the desirability of having only a very small number of connections between each section and the main network, so as to confine the effects of a breakdown to one section without interfering with the whole network. This will also serve to expedite the work of locating a fault within narrow limits in the event of either of the Berlin systems not being used; for, after isolating all the sections (from each other), that one which is harbouring the fault may easily be found without interrupting the supply of current to any of them, by any one of several well-known methods—such as holding a search coil, connected to a detector or telephone, over the cable feeding the faulty side of the section, while momentarily earthing the other pole of the same feeder; or by noticing which of the current indicators in the feeder circuits is most affected by momentarily earthing the 'bus bar of the opposite polarity to the cable bearing the fault; or finding, by using the pilot wires, at which feeding point the least difference of potential to earth exists while earthing the opposite 'bus bar at the station, etc. By working in this manner a fault can be located to a small district in a very short time without causing any inconvenience through interrupting the supply.

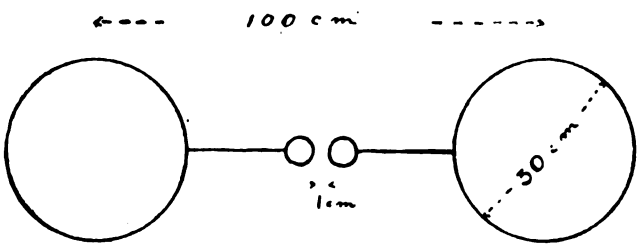
(*To be continued.*)

ELECTRIC OSCILLATIONS.

The second of the four Cantor lectures now being delivered at the Society of Arts by Prof. J. A. Fleming, was given on Tuesday last. To begin with, the lecturer referred to the experiments of the first lecture, and proved that the inductance of a circuit through which these oscillatory currents were passed was due rather to the form of the circuit than the permeability of the materials composing that circuit. He had given in the last lecture the formula by which the frequency of the oscillations set up in the circuit by the discharge of a condenser could be determined. It now became necessary to distinguish between free vibrations and forced vibrations. For instance, an alternating current of high frequency could be sent through a circuit, the natural period of vibration of which was not the same. Mechanical illustrations were given to show that a spring could be forced to vibrate at any period desired, in spite of its natural period being a definite quantity. It was now established that all charge and discharge effects in an electric circuit behaved as if a Leyden jar were being charged and discharged. The exchange of energy which took place was always accompanied by the disappearance of a certain amount of that energy. This was due not so much to the resistance of the circuit as to the electric waves set up in the atmosphere, which dissipated energy. In the elementary case, if a sphere were charged with electricity and placed in an ordinary room, the walls acted as the outer coating of a Leyden jar, of which this sphere was the inner coating. The period of the vibration set up by the discharge of such a charged sphere had been determined by Prof. J. J. Thomson. He found that the period was equal to $\frac{R}{4{,}153 \times 10^6}$, where R equals the radius of the sphere in centimetres. From this formula, in a sphere 32in. in diameter the period of vibration would be 100-millionth of a second. The period of the earth considered in the same way would be one-sixth of a second, while the sun would have a free period of $16\frac{2}{3}$ seconds. It was, however, exceedingly doubtful if the earth was charged and discharged as a whole, and whether it could be considered to act in the same way as a small sphere placed in a large room. In that case the stars might be considered as an outer coating of the Leyden jar. It was very probable that the upper layers of the atmosphere acted as the other coating, and in this case another formula was applicable. This had also been worked out by Prof. J. J. Thomson, who found that, assuming the upper layers of the atmosphere acted as an outer coating, the period in the earth's discharge would be one-eleventh of a second. The amplitude of the vibration would be decreased one-thirty-fifth each vibration. Prof. Fleming proceeded to classify electric circuits into two classes—*i.e.*, good electric radiators and bad electric radiators. Anything in a circuit which tended to dissipate energy, lengthened the time during which oscillations took place. It also followed from this that in order to get a good number of oscillations for each discharge, one had to employ what was a comparatively poor radiator. The next division of the subject taken up was that of the synchronism between different electric circuits. As an example of what could be done with low-frequency alternating currents, the Campbell frequency indicator was exhibited. In this instrument the frequency of the alternating current supplied is ascertained by altering the period of vibration of a steel spring until it moved in synchronism with the alternating-current periods. The well-known interactions which take place with these low-frequency currents between capacity and self-induction were illustrated by the lecturer, who then proceeded to show some

Digitized by Google

experiments on synchronised circuits with high-frequency oscillations. He took the same connections as in the first lecture, in which a small incandescent lamp was lighted in the secondary circuit of a transformer working with oscillatory currents. With about 8in. between the primary and secondary coils of this transformer the small lamp was incandesced. If, however, the secondary coil was moved farther away, the lamp went out. Prof. Fleming then connected in series with the lamp a small condenser which had the correct capacity for making the period of free vibration of the secondary circuit the same as that of the primary circuit. It was then seen that the lamp could be lighted up although the coil was removed to a distance of about 50in. from the primary circuit. In the circuit as used the magnetic force falls off inversely as a cube of the distance from which the wonderful effect of the tuning could be gathered. The incandescent lamp required about half an ampere to incandesce it, and this current passed through the glass of Leyden jar. The next experiment consisted of adding another Leyden jar parallel with the first, which put the circuit out of tune and extinguished the lamp. It was explained in the first lecture that the inductance of the circuit also altered the period of free vibration, and accordingly a coil of wire was introduced into the primary circuit of the oscillatory current transformed. This coil of wire was made on what the lecturer called the accordian principle, as the adjacent layers could be brought together or placed further apart at will. The experiment of adjusting this inductance so that the primary circuit was again tuned to the secondary was successfully accomplished. In order to show how accurate the tuning had to be, an exceedingly small condenser, the plates of which were about the size of a halfpenny stamp stuck on each side of a mica sheet, was connected in parallel with the condensers, and this was quite sufficient to extinguish the lamp. Prof. Fleming said that it was quite possible that expert tuners of electric circuits would rank as professional men with pianoforte tuners in the future. He also hinted that local authorities might succeed in distributing electrical energy through certain blocks of ether, and they would provide their consumers with apparatus tuned to receive the electric oscillations of the frequency which they dispatched. This scheme would not succeed if the Postmaster-General claimed the whole of the ether as his property. In order, however, to get these resonance effects, the oscillations must persist. In other words, a good number of oscillations must take place at each discharge, and the discharges want to be more frequent. The lecturer then gave some calculations made by Hertz as to the energy



which could be dissipated by the Hertzian waves. With a discharge in a circuit of the dimensions given in the illustration the energy available was $\frac{1}{2}\frac{15\,(3{,}600)^2}{2\times 9\times 10^{-11}}=\frac{54}{10^4}$ joules. The loss of energy for the first oscillation worked out at $\frac{24}{10^4}$ joules. In consequence of this, no more than five oscillations were to be expected. The time of vibration was $\frac{1\cdot 6}{10^8}$ seconds, and the rate of doing work 45 h.p. The great problem, however, was how to keep these oscillations going, and this, if solved, might lead to the transmission of energy by means of electric waves. He thought the best possible result up to the present was a period of discharge in which oscillations set up lasted one-tenth of the time taken to charge the condenser. He also considered that 1½cm. was the largest gap over which oscillatory discharges had taken place up to the present. The next experiment consisted in using these oscillatory discharges to light up a vacuum tube at the end of two long parallel wires stretched across the room, and it was shown that there existed one point at which these wires could be short-circuited without extinguishing the tube. This point divided the circuit up into two parts of equal free vibration period. After referring to a theory by which all colour effects could be explained by electro-magnetic resonance, Prof. Fleming went on to describe the success which had attended Mr. Marconi's efforts in the use of tune circuits for wireless telegraphy. Messages between adjacent instruments in signal stations were sent and received without interference and over a distance of 65 miles. The method used could not be disclosed at present, but there was no reason why 20 different messages might not be sent and received at the same time from one point. The two signalling stations between which these experiments were carried out were on opposite sides of a line between the Admiralty stations for experimenting with wireless telegraphy, and it was worthy of note that the signalling on this Admiralty circuit had not been interfered with. It was announced that the next lecture would take place on Monday, the 10th inst.

ON THE SUPERSESSION OF THE STEAM BY THE ELECTRIC LOCOMOTIVE.

BY W. LANGDON, VICE-PRESIDENT.

(Concluded from page 779.)

In his presidential address to the Institute of Mechanical Engineers in 1898, Mr. S. W. Johnson, the locomotive engineer for the Midland Railway, furnished valuable data in relation to the cost of moving railway trains. From this data I, by his courtesy, am enabled to furnish the details shown on Table VI., which shows that the average cost for 24 years for drivers and firemen was £358,635, or 2·650d. per train mile; and that for repairs and renewals, £357,460, or 2·641d. per train mile. To arrive at the cost for drivers and attendants for the electrical locomotive, I might revert to Table IV. and deduce from it, at a given rate of wage per hour, for the number of trains occupying the line for that period, the kilowatt-hour cost, but this, it appears to me, would not be quite right. There can be no question that the cost incurred by the locomotive department is extremely heavy,† but it is a charge incumbent upon the working of the traffic, and whatever are the conditions which militate against a reduction in this charge with the locomotive department, presumably they would hold good against the electric unless the traffic could, under the latter, be so facilitated as to enable it to be got through with greater speed and less shunting. It is not clear this could be done. I am therefore, very reluctantly I must admit, obliged to adopt the extremely heavy cost incurred by the steam locomotive, for there would be very little, if any, difference in the rate of pay to the respective class of men. The repair and renewal of electrical machinery, whether in relation to the generating or the locomotive plant, should be considerably less than that of the steam locomotive plant, for the reason that there will be extremely few moving parts, while many small units, used for pumping and other like purposes, would be provided for from the central generating station at a less cost or entirely abolished. The train mileage (Table IV.) run by the 14 trains during one hour is 479. Assuming that the cost attending the repair and renewal of the electrical machinery will be 2d. per train mile, as against that for the steam locomotive power and works—viz., 2·641—we shall have a result of 0·1916d. per kilowatt-hour. There is yet one more addition to make. The cables and contact rail are peculiar to the electrical system. I do not include them in the above 2d. per train mile for repair and renewal of machinery. Having regard to the value of the recovered material, I assume 2½ per cent. on the primary outlay will meet the renewal of cables, and 4 per cent. that of the contact rail. This means 0·0249d. per kilowatt-hour. Table VII. furnishes all these items, against each of which is also shown the cost per train mile—*i.e.*, the cost per kilowatt-hour multiplied by the total output—viz., 5,000 kw. for the hour's work—divided by the train mileage worked during the hour—viz., 479.

Therefore, if my deductions are correct, it would appear that the cost of working by electricity as against that for the steam locomotive is, per train mile, so far as the Midland is

* Paper read before the Institution of Electrical Engineers, Nov. 29.

† Assuming the weekly wage of driver and fireman to amount to 90s., probably an excessive sum, it would seem that the weekly mileage travelled would be but 407. If the wage were 70s., the mileage would be but 317.

Digitized by Google

TABLE V.—Estimated Cost of Generation and Distribution of Current.

Details of Charges.		Per annum. £	Per kw.-hour. d.
1. Capital outlay, £470,000—interest at 3½ per cent.		16,450	0·0901
2. Generating station: Salaries and wages—			
1 chief engineer	£500		
1 assistant ditto	250		
3 switchroom attendants, at £150 each	450		
1 clerk	120		
7 engine-room attendants, at 40s. each per week	728		
7 assistant ditto, at 35s. each per week	637		
12 stokers, at 30s. each per week	936		
15 labourers and cleaners, at 22s. each per week	858		
		4,479	0·0245
Coal, at 3·0lb. of coal per kilowatt-hour—58·667 tons, at 7s. 11½d. per ton		23,345	0·1279
Water, at 25lb. per kilowatt-hour, and 2d. per 1,000 gallons		913	0·0050
		28,737	0·1574
3. Sub-stations (5): Salaries and wages—			
5 assistant engineers at £200 each	£1,000		
20 attendants at 40s. each per week	2,080		
20 assistant attendants at 35s. each per week	1 820		
10 cleaners at 22s. each per week	572		
		5 472	0·0299
4. Outdoor service: 5 rail-jointers and fitters at 40s. each per week	520		
Material, etc.	230		
		750	0 0041
5. Oil, waste, and sundries		2,000	0·0109
Total estimated cost of generation and distribution of current		£36,959	0·2023

TABLE VI.—Steam Locomotive Charges.

Average Midland Railway Total Locomotive Expenditure, etc., during 24 years, 1873-96.		Cost per train mile. Pence.
Running Expenditure.		
Wages: Drivers and firemen	£358 635	2·650
Cleaners, coalmen, etc.	94,422	0·698
Water	28,575	0·211
Oil and stores	44,842	0·331
Coal and coke	289,595	2·139
Total running expenditure	£816,069	6·029
Repairs and Renewals.		
Wages	178,718	1·320
Materials	178,742	1·321
Total repairs and renewals	£357,460	2·641
Salaries	24,187	0·179
Turntables and buildings	2,861	0·021
Gas	9,868	0·073
Gross expenditure	£1,222,899	8·943
Tons of coal and coke consumed		727,889
Cost per ton		7s. 11½d.
Train mileage		32 485,530

TABLE VII.—Electrical Charges.—Cost in Pence per Kilowatt-Hour and per Train Mile.

	Per kw.-hour.	Per train mile.
Generating charges	0·1574	1·643
Sub-station charges	0·0299	0·312
Outdoor attendance	0·0041	0·043
Oil, waste, and sundries	0·0109	0·114
Locomotive drivers and assistants (this item is shown at the cost incurred under present mode of working)	0·2538	2 650
Repair and renewal of machinery, motors, etc.	0·1916	2·000
Renewal of cables and contact rail	0·0249	0·259
Total cost for power and haulage	0 6726	7 021
Interest at 3½ per cent. on primary outlay—viz., £470,000	0·6901	0·941

concerned, as 7·021d. to 8·943d., being an apparent saving of 1·922d. per train mile, or £260,155 on the average yearly cost for the 24 years indicated.

A closer comparison of the chief items may help us to learn where and how so large a saving is effected.

Coal stands in Mr. Johnson's data at 727,889 tons, at a cost of £289,595. Based upon the figure adopted by me—viz., 3·0lb. per kilowatt-hour—the tonnage required is 454,145 $\left(\frac{5{,}000 \text{ kw.} \times 3{\cdot}0}{479} = 31{\cdot}315.\ \frac{32{,}485{,}530 \times 31{\cdot}315}{2{,}240} = 454{,}145 \text{ tons}\right)$ and the money £180,712 $\left(\frac{{\cdot}1279\text{d.} \times 5{,}000 \text{ kw.}}{479} = 1{\cdot}335073\text{d. per T.M.}\right.$ 32,485,530 T.M. × 1·335d. = £180,711). The steam locomotive consumes on the average 50·191lb. of coal per train mile. My figures place the quantity required for electrical energy at $\frac{(5{,}000 \times 3{\cdot}0)}{479}$ 31·315lb. The saving under this head is, therefore, 273,744 tons, which at 7s. 11½d. will account for £108,927. We have to bear in mind that the calculation on which the cost of electricity is based makes no provision for shunting operations. It is based entirely upon the train mileage run. Shunting work is, of course, included in Mr. Johnson's figures, and will account, to some extent, for the difference. The main gain, however, is to be found in the economy of a stationary as against an itinerant generator, as well as in the fact that much coal is consumed by goods and mineral trains when shunted, and by all trains when standing at stations, the whole of which would be saved if worked by electricity. With stationary engines, a less expensive coal than that used for locomotives would be available, thereby effecting a reduction probably more than sufficient to meet the cost for shunting previously alluded to. It may be pointed out that coal is more costly at present. Such is the case, and were my calculations based upon the present rate of coal, the result would largely enhance the advantage of electricity. Say, for instance, that coal stood at 10s. instead of 7s. 11½d., the locomotive cost would be 727,889 tons at 10s. = £363,944, instead of £289,595; that for electricity would be 454,145 tons at 10s. = £227,072, instead of £180,701. The result would be that electricity would show, under coal at 10s. a ton, a saving of £136,872 instead of £108,927, on precisely the same mileage, with a proportionate increased saving at prices ranging above that figure. The fact that dear coal enhances the comparative value of an electrical system—especially with the possibility of coal at a higher rate than 7s. 11½d.—cannot be too strongly emphasised.

Water.—The steam locomotive calls for £28,573, or 0·211d. per train mile; electricity, £7,066, or ·0522d. per train mile—a difference in favour of the latter of £11,507. It is difficult to attempt a comparison between the cost of a largely-scattered supply—water pillars at numerous stations—and a concentrated one—one to every 50 miles or so of line. The site for such a generating station would naturally be selected with a view to cheap water supply, and, as a rule, no great difficulty would attend its selection. A further point to be borne in mind is that, naturally, all machinery would be of the most modern and economical type, and that the working would reach the highest ideal for an electrical plant—viz., an actually constant and perpetual demand.

Drivers.—It is quite clear that whatever may be the cause of the existing heavy charges, it will apply equally to electric as to steam locomotives. The engine must stand by its train, and the men along with it. Any reduction that may be effected will be in the mode of dealing with the traffic. The present condition—viz., that of a mixed traffic travelling at various rates of speed, one class of train being required to make room for another of a more important character—is not destined to effect economy in this branch of expense.

Repair and Renewal.—I have assumed that the cost of repair and renewal would be practically one-fifth less with electricity than steam. I think I am more than justified in this. The wear and tear of stationary engines or motors cannot possibly be so great as that of the steam locomotive. The number of electric locomotives would necessarily be as great, but their wearing parts would be immensely less than those of the latter. Many local units would be entirely dispensed with.

Oil and Stores.—These form a somewhat large item in the running expenses of the steam locomotive. Much of this is for the lubrication of moving parts which would be non-existent in electric engines. Moreover, with stationary engines it is possible to recover, and again use, a great portion of the lubricator employed. It would appear that considerable economies in oil should accompany the employment of electricity.

We may now perhaps glance at possible economies on that which is indispensable for the steam locomotive, but which is unnecessary, or not so largely necessary, with electricity. Water-pillars, turntables, engine-sheds, coal stages—all these are expensive items which with electricity are either not required or capable of considerable modification. Water-pillars, supplemented in many instances by fixed engine power for pumping the water into reserve tanks, involving power-houses, sheds, and other structures, form part of all large stations and many other points at which the locomotive requires to take water. With electricity, water to any extent would be required only at that point at which the central generating station is placed. If this station served 50 miles of railway, then it would take the place of all the pumping plants, water-pillars, etc., otherwise required throughout that section for the steam locomotive. Every pumping station involves the

Digitized by Google

provision of labour, fuel, etc. All water-pillars require special attention during hard weather. Economies in first outlay and annual charges on this account should accompany the use of electricity. Turntables would be unnecessary. The annual outlay for repairs in this respect is not great, but the cost of laying down the large turntables now required is very heavy. As the number of locomotives increase, so increases the demand for engine-sheds. Electric locomotives would of course need housing as well as the steam locomotive, but the space which they would occupy would probably be about half that now required. Wherever we find an engine-shed, there we see an area of land covered with coal; lines of rails applicable thereto; coal stages to which the coal has to be carried, and from which it has to be distributed to the locomotives. First the coal has to be stacked, then loaded into trucks and carried to the coal stage, and thence weighed and placed on the engine's tender. This is the course of procedure at each engine depôt. If we compare it with the work of a large central station, such as that sketched out in this paper, I think it will come home to us that although the work would be large, it could not be nearly so large as at present. If stacking were at all necessary there would be the less quantity to stack, and it would all be dealt with in a more concrete form and at comparatively few centres. Again, in this respect there is reason to look for economies in land, in buildings, and labour. All these are assets directly due to the employment of electricity. Others, not considered in the figures which I have advanced, would, with its presence, be available: the lighting of the trains, stations, goods warehouses and yards, marshalling grounds, etc.; signalling, to some extent, might become automatic; while at large centres where signal boxes have become both numerous and cumbrous, it would appear but reasonable that, with the aid of such a power, points and signals might not only be actuated, but the means for operating them might be so condensed as to admit of the entire duties being embraced within such a space as would enable one man to deal with them. Labour and space would be economised, and less time would be occupied in giving effect to the various operations than is possible with the existing means. To this we may add that obviously it would also provide for the operation of lifts, and other local demands for power which at present have to be met by isolated plants.

Let us now turn to what may perhaps be regarded as difficulties to be encountered. The first question that will arise will be: Are we safe in placing so many of our eggs in one basket? With the steam locomotive we have a travelling unit which has to manipulate its own load, and is in no way responsible for the duties of others. If it breaks down, the inconvenience is chiefly confined to the vehicles it is hauling, and in due course they are extricated from their difficulty by the aid of another engine. With electricity we are locating our power at one spot in so many miles of line, and if that breaks down that section of line is practically dead. But with the usual spare parts—the duplication, if necessary, of the generating units—there should be no reason to anticipate such a failure. The same argument in a measure applies to the power at the distributing stations. Here, however, the case may be met not only by duplication, but by, in emergency, connecting one section through to its neighbour. For the time being inconvenience would be felt; speed would be reduced, but traffic would not be stopped. Of all this we have evidence in that which has already been done. We see railways being worked, tramways operated, and other large undertakings all dependent upon one large and central source for their life and being. Electric railways have become an accomplished fact, and we may turn to those that are in use as exponents of success or of difficulties to be encountered. Does the magnitude of the question we are considering—the eventual supersession of the steam by the electric locomotive—remove it from the category of that which has so far been done? I think not. The basis is there. It is to-day in useful operation. Improvements will come. The mode of working which we see to-day may, and probably will, be simplified, but this will only strengthen that which has already been accomplished. Still, there are points of great interest for consideration. As a rule, that which has been done has, with one or two exceptions, been confined to underground lines, and these exceptions have not, as a rule, dealt with such heavy work as the large overland railways require to compass. Overground railways have to work through all kinds of weather—rain, snow, fog—and at times to pass over rails submerged in water. Winter floods are not unusual in certain localities of nearly all overland railways. These are conditions which will effect the construction of the locomotive, the arrangement of the current collector, and the contact rail, and are subjects for thought not only in themselves but in relation to the mass of undergear which now appertains to all passenger railway stock, as also to the relative position and construction of roads, their repair, and renewal. A question may here intervene whether a similar economy would attend the operation of small branch lines of railway where the trains are few and far between. Consider! Why are the trains so few and far between? The traffic is, we will say, a fixed quantity. There are only so many tons of goods and so many passengers passing over it daily. The steam locomotive is available only at certain times, and to attain economy it is necessary that so many trips only should be made. The accommodation is limited to this. But if the power for working the trains were constant, although reduced, any number of trips might be made. The additional cost would be that only of the driver, for the rest the branch would be no more costly, while the frequency of the communication would tend towards the development of the district, and the consequent increase of trade.

I have now, I believe, fairly set forth the salient features of this question. The data which I have produced speak greatly in favour of electrical energy as a motive power for the movement of railway trains. The economies which it would apparently effect are, indeed, so large as to raise a doubt whether my deductions—whether the figures I have adopted—are fair and reasonable. It must not be forgotten that my calculations are based upon a mileage run clear of stoppages or other contingencies. Stoppages are unavoidable. They *will* arise, and provision must be made to meet them. But I find it difficult to identify them further than I have already done. Stoppages will not affect the coal bill. I have taken the present cost of drivers and firemen to apply to that for drivers and assistants for electric locomotives. My allowance for repair and renewal of machinery will, I think, be generally supported. Necessarily the subject has to some extent had to be dealt with more in the abstract than in detail, but I venture to hope my figures will not be found illiberal. We must not lose sight of the fact that the conditions are a constant load and continuous output for every hour of the year. I believe the cost of shunting at stations and in goods yards may be met by the economy attending the use of a cheaper coal than that which is necessary for the steam locomotive; but assuming that some provision should be made for this, for administration and contingencies, I conclude that 20 per cent. (say £50,000) of the accredited saving will cover it. We thus bring the net annual advantage to approximately £208,124, and if we deduct interest on the primary outlay it will further reduce it to £191,674. Whether it is, in face of the savings to be effected in engine-sheds, coal stages, water-cranes, etc., fair to make a debit in full of this amount, I must leave those who are interested in the question to determine. Broadly, it appears to me to mean this: that were a new company to start with electricity as their motive power, they would not need to take into consideration the interest on the entire additional outlay, because they would save a great portion of it in other directions. But were an established company to adopt it, they would already have incurred the cost for the lands, buildings, etc., and the expense for establishing electric working would unavoidably prove to them, for some years, an addition to their capital charges. Although I feel that my reason for pursuing such a course will be obvious, it may be desirable that I should emphasise the fact that my sole object in availing myself of the data afforded by Mr. Johnson's presidential address to the members of the Institution of Mechanical Engineers is that I might deal with data extending over a long period of years, rather than draw a comparison with a period which might be regarded as possessing some abnormal feature. It must, however, be noted that recent figures tend to greatly magnify the result. I have shown that, with electrical working, certain economies are to be anticipated. The annual amount of these economies is based upon the ascertained saving *per train mile*, multiplied by the average annual mileage for the 24 years—viz., 32,485,580. The mileage for 1899 is 45,453,438, and the expenditure £2,006,069, as against the 24 years' average £1,122,899; and the train-mile cost has risen to 10·59d. as against 8·943d. Assuming that the saving per train mile remained the same—it would probably be larger, consequent upon the increased cost of coal—the resultant saving would be, independent of any deductions for interest or contingencies, £364,006. Large as is the apparent economy thus presented, it would, were it possible to employ a gas plant for so large an output, be increased by the use of the "Mond" gas system. Such a system would appear to invite consideration, at all events for smaller installations, as, for instance, for the operation of branch lines.

Here it may perhaps be asked: What good can attend the production of these figures or the results they advocate, seeing that the railway system generally is wedded to the steam locomotive? Is it probable that any railway company will cast on one side their present equipment for the purpose of taking up that which, although holding out fair hopes of a large economy, is yet in a measure, or in the large measure to which it would have to be applied, mainly an untried agent? To this I reply: Railway companies are under the direction of business men—men who know the value of money. Satisfy them that economies are to be effected—and do not let us forget that the economies are not confined solely to those with which this paper has dealt, but probably to many others indirectly associated therewith, and that the economy embraces a reliable means of working—and they will not be found undesirous of testing its worth.

Digitized by Google

The life of a steam locomotive is not an indefinite quantity. Its replacement by one of more modern construction or of greater power, quite apart from its ultimate destruction by wear and tear, is an appreciable fact. As traffic increases, so additions have to be made. We see so many new engines ordered year by year. What is to prevent a railway company, instead of thus perpetuating its annual costs, setting apart portion by portion of their system for operation by electrical energy, and, instead of ordering for, say, that portion of their system, steam, to order electric locomotives; and thus to bring, piece by piece, their entire system under electrical operation? No sane railway management would do otherwise; and I assume that, should my figures stand unrefuted, no railway company would desire to follow any other course. Prove its economy, prove its reliability, and there is nothing in the fact that railways are, for the time being, the slave of the steam locomotive, to militate against their supersession by electrical energy.

That this paper deals with a problem which, sooner or later, will force itself upon the attention of all who are interested in railway progress, few will be disposed to dispute. So far it has been considered solely in the realm of economical working—in the interest of the railway shareholder. But are we justified in looking at it only from this standpoint? Does it not embrace a question of still greater magnitude? Is it not one of even national interest? If, by the aid of electricity, we can save no less than 18·876lb. of coal per train mile, it is clear we could save *no less than three million tons* a year (396,241,265 train miles ×18·876lb. =3,339,040 tons) if all our railways were worked by that agency. View it again from still another standpoint. Twenty thousand locomotives moving about throughout the land cannot fail to leave their mark behind them. Our railway stations, the telegraphs which traverse the railway routes, the trees which grow on its borders, all bear evidence of their presence. The supersession of the steam locomotive by the electric locomotive will bring with it a purer and a more cleanly atmosphere—cleanly railway stations, cleanly railway carriages, a higher and a purer sanitary condition of life.

Discussion.

Dr. John Perry, from the chair, said that there were a number of locomotive superintendents present, who, he hoped, would speak on the subject before them, but that he proposed to call upon Mr. Mark Robinson to open the discussion.

Mr. Mark Robinson complimented the Institution on the most interesting and valuable paper read by Mr. Langdon. The matters raised in it were of the utmost importance to the country, and particularly to the industrial sections of the community. Also he considered the author's conclusions the more valuable because he had taken such an impartial and moderate view of the problems involved in the conversion of railways to electric driving. He proposed to discuss particularly one detail of the proposed scheme for equipping the section of railway between London and Bedford. Thus Mr. Langdon suggested one large station with 10,000 kw. of plant in it, and five sub-stations along the route. No doubt this arrangement had been carefully considered, but he would raise the question as to whether this large station would really be more economical than five stations each containing 2,000 kw. of plant placed where sub stations are indicated in the diagram. In the large station, with its 16,000 h.p. of plant, there would probably be four engines, each of 4,000 h.p. There was considerable doubt in his mind as to whether the extra economy gained by the use of such large engines would make up for the losses in the transmission lines and in the transforming apparatus at the sub-station. There was an economy gained from increasing the size of the engines, and this had been largely taken advantage of in America. They had, however, used slow-speed engines, in which the advantage from the larger size was more than with high-speed engines. This was because the ratio of the volume of steam to the surfaces exposed to radiation was greater the larger the engine was made. It had been proved by the late Mr. Willans that with high-speed engines this hardly applied, and one of the advantages of the increased speed was that good economies could be obtained with small-sized engines. Thus it was only a 40-h.p. engine on which Mr. Willans made his historical experiments, and on which he obtained a steam consumption as low as 12½lb. per indicated horse-power. If his suggestion were adopted of placing the plant in the sub stations, three engines of 800 h.p. each or four of 700 h.p. each might be used. He thought that the first cost would not be as much as with the high-tension feeders, and the transforming gear would be saved. There would also be rather a larger factor of safety by providing a generating station for each section. When working, the loss given by the author as 17 per cent. in the high-tension line and transformers and 10 per cent. in the rotary converters would be saved. In consequence of this, they would also be able to reduce the capacity of the generating plant by about 22 per cent. He estimated that the first cost could be decreased from £470,000 to £273,000. He would finally state that while for metropolitan lines a high-tension system of transmitting power from a station in the suburbs might be the right thing, he did not think it was in the country, where additional advantages with respect to cheap sites for works could be obtained. He concurred with the author in his statement of the advantage to be derived from placing motors on trains and keeping the steam plant in stations.

Mr. G. C. Cuningham, of the Central London Railway, also complimented the author on his paper. The real question was the consumption of coal per ton-mile with electric driving as compared with the quantity taken by the locomotive. Some years ago he was connected with the Southern Canadian Railway, which ran through an exceedingly level country, and was almost free from curves—in fact, it represented the best possible condition for low coal consumption. He found that it took on the average ·4lb. of coal per ton-mile on goods trains, and 0·8lb. on passenger trains. On the Liverpool Overhead Railway, which was also practically level, the average was about ·4lb. of coal per ton mile. On the Central London, after deducting for the power required for lifts and for lighting the generating works, he found that they required about ·5lb. of coal per ton-mile. The energy also came out at 70 watt-hours per ton-mile,* whereas on the Montreal electric tramway system, where the grades were very heavy, no less than 300 watt-hours were required per ton-mile. In Montreal they did not succeed in reducing the coal consumption to less than 3·6lb. per kilowatt-hour, while the total cost of generation and distribution, excluding interest and capital charges, came out at about ¼d. per unit. Everything depended on having an economical power-house on a site where water was abundant.

The Hon. C. A. Parsons said he had carefully checked Mr. Langdon's figures, and considered them liberal; 3lb. of coal would be quite sufficient to allow per unit. With respect to the size of the generating station, this largely depended upon the facilities on various parts of the line for such a station where coal and water were abundant. The one advantage of the high pressure distribution was that the best position could be selected, and he thought that the consideration of the artisans' dwellings available should not be neglected. Another most important point in favour of the electric line was that the traffic on country sections could be improved by running smaller trains at more frequent intervals without extra cost.

Mr. H. A. Hoy, of the Lancashire and Yorkshire Railway, said that a study of the subject had led him to fall in with the views expressed by Mr. Robinson in favour of smaller generating units. He thought the dynamo should be constructed to give the 600 volts required for the line. While not going so far as had been tried by Mr. Heilmann in France, he thought that when the railways were converted to electric working it might be convenient to have a generating plant which could be transferred to that section on which excessive demand arose for limited periods. He had recently seen the third-rail line near Hartford, in America, in which the voltage required for the third rail was generated direct, and he gathered from the engineers of that line that they proposed in equipping extensions to provide additional generating works along the line of route on the same system.

Mr. J. S. Raworth commented on the most valuable papers on varied subjects which Mr. Langdon had from time to time contributed to the Institution's *Proceedings*. Their value was increased by the impartiality of their author. He proceeded to divide the most prolific readers of papers other than Mr. Langdon's into two classes. One was represented by the man who hoped by so doing to hasten the universal use of high-speed engines, while the other was the professor who was so charged with information that he must read papers or burst. He would remind the meeting that the main issue was that they should convince the financial element in railway companies—*i.e.*, the shareholders and directors—that electric locomotives would save them money. These people did not mind at all about the systems, but wanted to be assured of the financial results. He did not quite follow Mr. Langdon's way of arriving at the power required for the St. Pancras to Bedford section of line, but he had gone through calculations on his own account as to the foot-pounds required, and with 16 trains he found that 9,850 kw. of generating plant were needed. Mr. Langdon's comparison of the coal and wages on the steam lines for the last 24 years, and for that required for electrical working, was in favour of the steam locomotive, as the coal assumption per train mile had gone up very much of recent years. He also considered that the author should not have taken the 3½ per cent. interest on the cost of conversion into his calculations, as the figures for the steam locomotives included no such charge.

Mr. Henry Maver asked, on behalf of the Glasgow local section, that the discussion of Mr. Langdon's paper should be kept open until the 12th inst., in order that that section might take part in the discussion.

Colonel R. E. B. Crompton much regretted that he would be unable to be present at the next meeting, as he would like to have gone more into detail than he was then able to do. He had had to work out for the Government of India particulars for an electric line across the Himalayas. In the course of calculations for the same he had to make assumptions as to the traffic on the line, whereas Mr. Langdon had actual figures to go by. The first thing that he (Mr. Crompton) was struck with was the great discrepancy between the actual horse-power required on the line and the full horse-power of the locomotives—in other words, the load factor was so bad. This low load factor was, he thought, the explanation why the question was still raised by locomotive engineers as to the advantages of compound locomotives. This discrepancy between the horse power required and the horse-power of the locomotives disappeared as soon as the power was taken from a number of fixed stations, as in an electrically equipped line. On the question of wages, Mr. Langdon stated that good drivers must be obtained, and hence they should be paid the same wages on electric locomotives as at present. He knew that highly-trained men were required, but the training required for driving

* This is equal to 7·15lb. of coal per Board of Trade unit.—Ed. *E. E.*

Digitized by Google

electric locomotives was not to be compared with that required for working steam locomotives. Without the most highly-trained drivers a steam locomotive could not be got to give its full power or speed, and even then it was apparent that the limits of power with steam locomotives had practically been reached. With an electric locomotive, on the other hand, there was ample margin, and he thought a great saving could be effected in the wages account. Again, on the question of repairs, he thought this item for the electric locomotive would not be anything like so great as with the steam. With the electric motors, only circular bearings, which could be rendered dust-proof, were required. On the other hand, in a steam locomotive the maintenance of sliding surfaces in spite of the grit was difficult. He had, in Africa, had recent experience of this, and it was distressing to see the condition into which these flat surfaces got in consequence of grit. Again, the cost of keeping locomotive boilers in repair was high, and, as hinted previously, the limit of power for locomotive boilers with the present gauge of rails had practically been reached. In fact, engineers had already had to reduce the size of driving wheels in order to get larger boilers. There was no limit to the power which could be generated on the train by electricity, especially if motors were placed on the carriages.

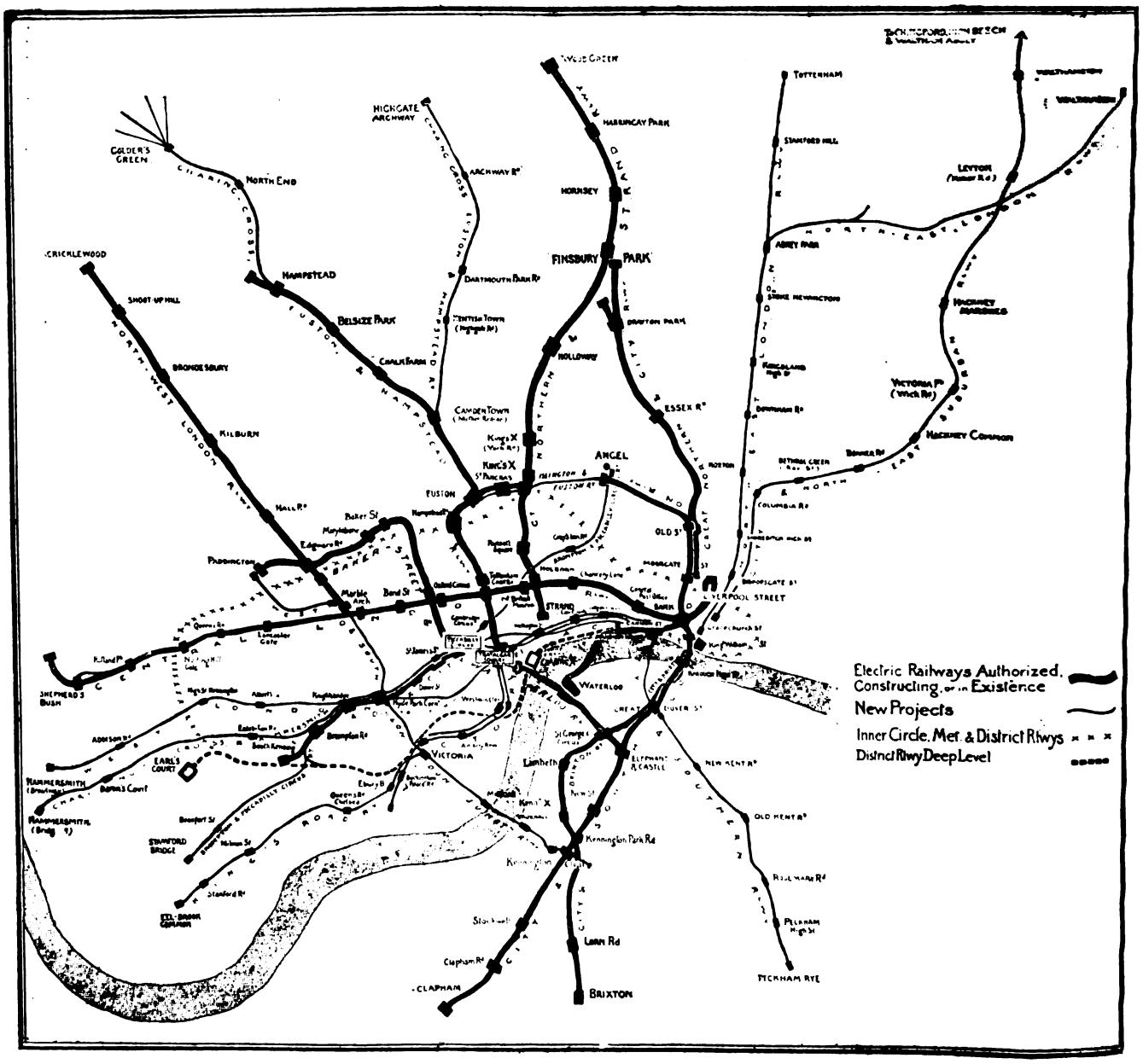
PROJECTED LONDON RAILWAYS.

The accompanying map, which we have ventured to reproduce from the *Daily News*, shows at a glance the respective routes taken by the electric railways authorised, constructing, or projected in and around the Metropolis. The same authority tabulates and comments upon these several schemes as follows.

Old Schemes, Constructing or Authorised.	Miles
Baker-street and Waterloo	5
Brompton and Piccadilly-circus	2
Charing Cross, Euston, and Hampstead	5
City and Brixton	3½
City and South London (Moorgate-street to Angel extension)	2
District Railway Deep Level: Mansion House to Earl's Court	4½
Great Northern and City	3½
Great Northern and Strand	5
	30½

New Projects and Extensions of Railways already Authorised.	
Brompton and Piccadilly-circus	4
Central London (extension to Liverpool-street and loop lines)	1
Charing Cross, Euston, and Hampstead extensions	5
Hammersmith and District	5
City and North-East Suburban	17
City and West End	6½
Islington and Euston	1½
King's-road	2½
North East London	11
Piccadilly and City	2
Victoria, City, and Southern	7
West and South London Junction	4½
	97½

Basing the cost of construction and equipment upon the cost of the Central London Railway, which worked out at £600,000 per mile, we have here revealed by a simple sum in addition a capital sum of not less than £58,540,000 sterling proposed to be sunk in these enterprises. Add to this figure a further million for the electrical conversion of the Inner Circle inferno, and we get a total of £59,540,000.



The Projected London Railways.

Brief consideration of the map enables us to determine

Digitized by Google

for ourselves what justification there is for the adverse comments which have been made with regard to the projected schemes. It has been contended that the new schemes are being promoted without the slightest regard for the needs of London as a whole, and with no fixed idea of interchange of traffic or thought for the general welfare. A glance at the map is all that is needed to drive home the truth of this terse criticism. The total absence of any system in the schemes, taken as a whole, is at once apparent. It may be said that the several schemes are not even calculated to serve their mutual interests. We are threatened with a multiplication of lines, commencing nowhere particularly and terminating nowhere particularly, without any attempt at intercommunication or access from a common terminus. The result, if all the proposed schemes were carried out as they stand, would be to make the present confusion more confounded, an eventuality which would go a long way toward destroying public faith in private enterprise, so far at least as the long needed improved means of local transit are concerned. The best solution of the matter would seem to be two series of deep-level lines radiating from, say, the Bank and Oxford Circus, where common terminii for interchange of traffic should be constructed.

POLYPHASE ELECTRIC TRACTION.*

BY PROF. C. A. CARUS-WILSON.

PART I.—THE POLYPHASE SYSTEM.

The factors which determine where electricity may be substituted for steam on existing railways with the greatest advantage are too numerous to permit of adequate discussion in a single paper. The author therefore proposes to draw attention to some features of the polyphase system bearing on this question, particularly those relating to punctuality and frequency of train service. With steam traction it is necessary to make up trains of considerable length in order to meet expenses, hence where the traffic is small the train interval is large. This is felt most on cross-country lines, where the long intervals between trains is generally a cause of much inconvenience, not only on account of the poor service it affords between adjacent towns, but also because of the great difficulty of making connections at main-line stations. With electric traction, on the other hand, experience has shown that single independent motorcars, carrying, say, 40 passengers, can be run economically at frequent intervals, so that a line which when worked by steam has, say, a train interval of two hours, when worked by electricity might have trains every half hour. If the principal cross-country lines, by which stations on the different main lines are linked together, were equipped electrically, they could be provided with a train service many-fold more frequent than at present obtains, and greatly increased travelling facilities could be offered to the public.

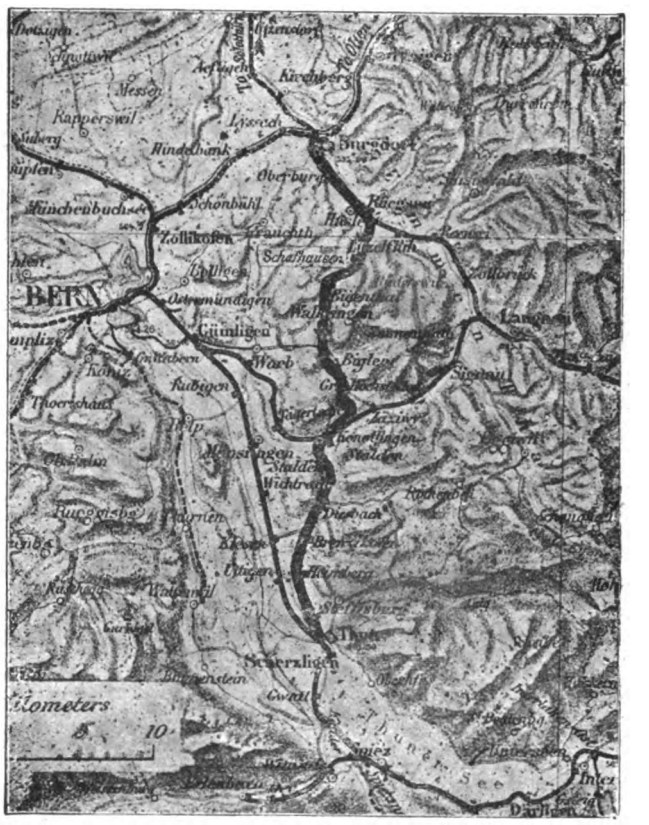


FIG. 1.

The breaking up of the traffic into small units, rendered possible by the substitution of electricity for steam, besides greatly facilitating cross-country travel, would have a marked influence on the punctuality of the train service. The more continuous and uniform movement of the traffic would enable the employés of the line to be more uniformly occupied. The infrequent arrival of long trains with large numbers of passengers and corresponding quantities of luggage would give place to more frequent arrivals of single cars, thus enabling the existing staff to handle the traffic with greater promptitude and facility. The more frequent

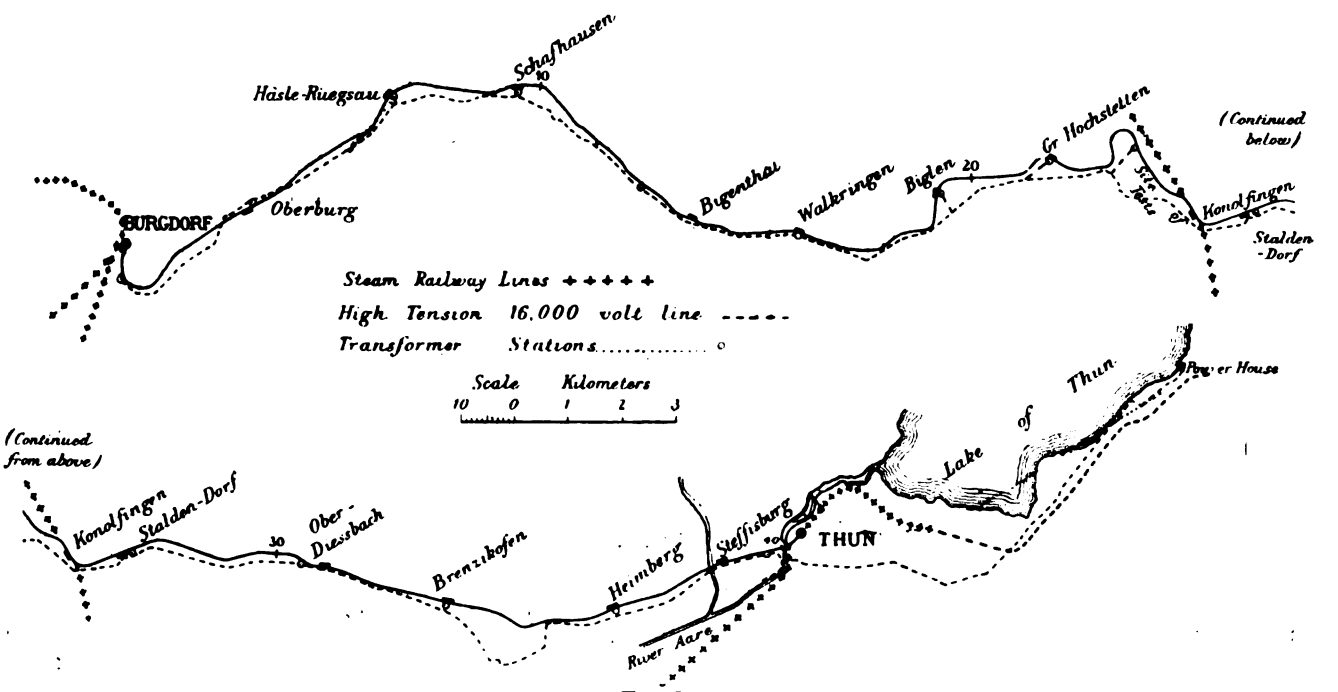


FIG. 2.

* Paper read before the Institution of Mechanical Engineers.

Digitized by Google

service would thus be a more punctual service, since the strain on the staff in keeping the trains running to time would be more evenly distributed over the hours of the day, and the work involved in getting each train off diminished in proportion as the train interval is reduced. The advantage of the new system would be most apparent when temporary increases in the traffic had to be handled, as it is on such occasions that the staff is most severely taxed, and the consequent unpunctuality most noticeable. The punctuality of a steam railway is affected not only by the difficulty of handling temporary increases in the traffic at the stations, but also by the influence of such increase on the actual running speed of the trains, particularly on

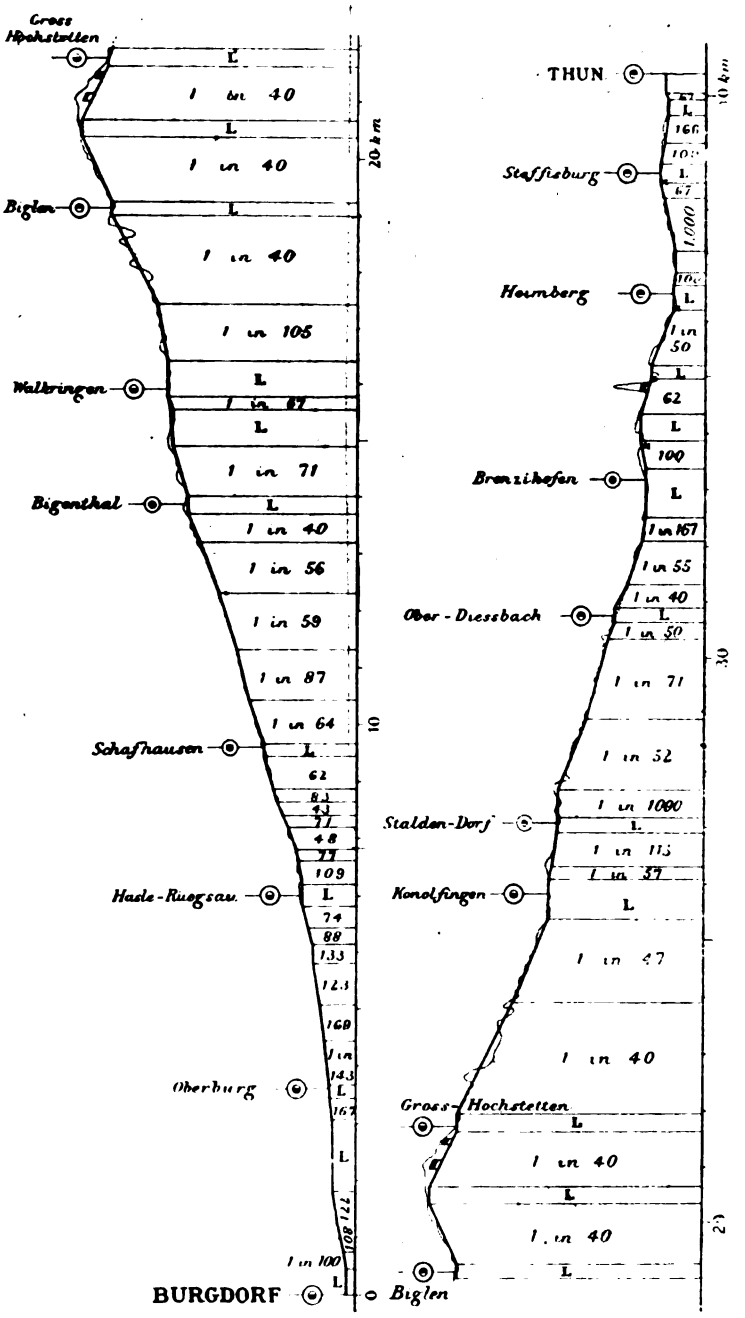


FIG.

lines where the grades are at all considerable. The same difficulties have to be met in an electric railway, and the problem of maintaining a uniform speed under varying load thus becomes one of great importance.

The continuous-current motor, as generally used for electric railway work, shows a large reduction in speed at heavy loads. Thus, in Fig. 28, it is seen that when running light with a 16-ton car the speed is 24 miles per hour, and when hauling seven 16-ton trailers the speed is 15 miles per hour. Hence it has become the practice on electric railways to meet temporary increases in the traffic by adding motorcars each capable of handling its own load. Thus on the South Side Elevated Railway, Chicago, the trains are made up of motorcars weighing 19 tons, each driven by two 52-h.p. motors, the number of cars depending on the traffic, and varying from time to time during the day. The expense of working the separate motors on each car may be reduced by devices such as Mr. Sprague's multiple-unit system, by which one motorman controls all the motors in a train by a single controller. Such systems, however, involve complications in the controlling arrangements, and large first cost in providing each car with a complete motor equipment. In the alternating-current polyphase system the motors run at a practically uniform speed entirely independent of load or grade. Figs. 27 and 28 contrast the action of continuous-current and polyphase motors under conditions of varying loads and grades. Thus a railway equipped with polyphase motors can carry a temporary increase of traffic without influencing in any appreciable degree the scheduled speed, the only exception to this statement being that an increase of load affects the time of starting; this will be considered later on. Experiments have been made, of which records will be given subsequently, showing no appreciable variation of speed when the load on a motor-car was increased from 32 to 68 tons, and 2 per cent. fall when a 50-ton train ran from a level up a grade of 1 in 40. Hence with the polyphase system a temporary increase in the traffic can be carried by adding trailers to the motorcars up to the full power of the motors, with no complication of controllers or increase in the working staff,

Digitized by Google

and without any appreciable influence on the speed. The Burgdorf-Thun Railway in Switzerland is a cross-country line worked on this system, and presents so many features of interest illustrating the points which have here been raised that the author proposes to describe it in some detail.

The Burgdorf-Thun Railway.—This line links together three of the main lines radiating from Berne—namely, those to Olten, to Lucerne, and to Interlaken (see Fig. 1). The first of these is met at Burgdorf, the second at Konolfingen, and the third at Thun. From Burgdorf to Hasle the line runs side by side with the main line to Olten. At Burgdorf connection is also made with Solothurn. The distance from Burgdorf to Konolfingen is 16 miles, and from Konolfingen to Thun is nine miles, making the whole line 25 miles in length. The line is of normal gauge, and carries the ordinary rolling-stock of the other Swiss railways to which it is connected. It is worked entirely by electricity on the polyphase system, the power-house being situated at Spiez at a distance of five miles from Thun. A plan of the line is given in Fig. 2, and a profile in Fig. 3. The train service is shown by the time schedule, which is given in Fig. 5. From Burgdorf to Thun there are 11 trains daily, and 12 from Thun to Burgdorf. From Thun to Konolfingen there are 15 trains daily, and 14 from Konolfingen to Thun. Each train generally consists of one motorcar and one trailer, together capable of seating about 100 passengers. Some of the above-mentioned trains are supplementary trains, running at about 10 minutes headway; these are shown in the time scheduled by dotted lines.

The Electrical Connections.—These are represented diagrammatically in Fig. 25. The generators in the power-house at Spiez generate current at 4,000 volts, which is transformed to 16,000 volts in the step-up transformers. The current is carried at this tension from the power-house along three overhead copper wires of 5mm. diameter to the step-down transformers situated at intervals of two miles along the line between Thun and Burgdorf (Fig. 2). The current is here transformed down from 16,000 volts to 750 volts, and carried from thence to the two hard copper trolley wires, 8mm. diameter, and to the rails forming the third wire. From the trolley wires two sliding contacts convey the current to the stator of the motors, the third connection being through the wheels of the carriages. The rotors of the motors are provided with rheostats and sliding contacts for purposes of control.

The Passenger Motorcars.—A general view of one of these cars is given in Fig. 11. Details of the construction are shown in Figs. 13, 14, and 15. The main frame is 49ft. long and 6ft. 6½in. wide. The distance between the centre line of the bogies is 31ft. The wheel base is 7ft. 2½in. The car, when completely equipped, weighs 32 tons empty, and has seating capacity for 66 passengers. Each bogie is provided with two motors, geared to the driving axles of the car. A general view of one of the bogies is given in Fig. 12, and details of the method of suspending the motors in Figs. 16, 17, 18. There are 83 teeth in the spur wheel, and 28 in the pinion, giving a gear ratio of 2·96. The diameter of the driving wheel is 40$\frac{5}{32}$in. when new. The trailers used are of lighter construction than the motorcars, and weigh 12 tons. Each motorcar is fitted with one of Messrs. Peyer and Favarger's tachygraphs for recording automatically the speed of the car.

The Motors.—These are of the three-phase type, with eight poles, and designed to give 64 b.h.p. each when connected to a line having a tension of 750 volts and a frequency of 40. The speed of synchronism of the motor is 600 revolutions per minute, making the speed of the car 35·5ft. per second, or 24·2 miles per hour, or 39 km. per hour. The torque curves for these motors with different rotor resistances are given in Fig. 34, showing the resistance per phase that has to be put in the rotor circuit to obtain any required speed. The action of the four motors is regulated by either of the two controllers, that in the forward vestibule being the one generally used. The four stators are connected in parallel, while the four rotors are each connected to four rheostats placed under the body of the car, and electrically independent of one another. The rheostats are worked simultaneously by rods and mitre gear from the controllers, as shown in Figs. 13, 14, 15. The first motion of the controller connects the stators to the line and puts the full resistance in the motor circuits. The subsequent motions gradually take out the resistances, leaving the rotors short circuited. The whole of the electrical equipment of this line was designed, constructed, and erected by Messrs. Brown, Boveri and Co., of Baden, Switzerland.

Automatic Speed Record.—The speed curve of the 3·41 train from Burgdorf to Konolfingen is shown in Fig. 19, which was taken with one of the tachygraphs with which the motorcars are fitted. Vertical distances represent speeds in kilometres an hour; the distance between the horizontal lines is not intended to be equal. The points above and below the record give the time in minutes. On leaving Burgdorf a sharp curve and rise of 1 in 100 reduces the acceleration, which would otherwise be uniform up to full speed, as explained above. Maximum speed is 39 km. or 24·2 miles an hour, and is kept practically constant, the slight variations being caused by irregularities in the track

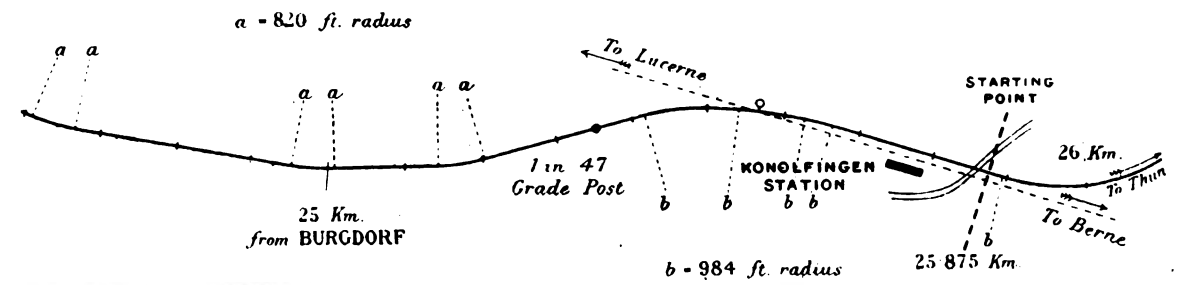
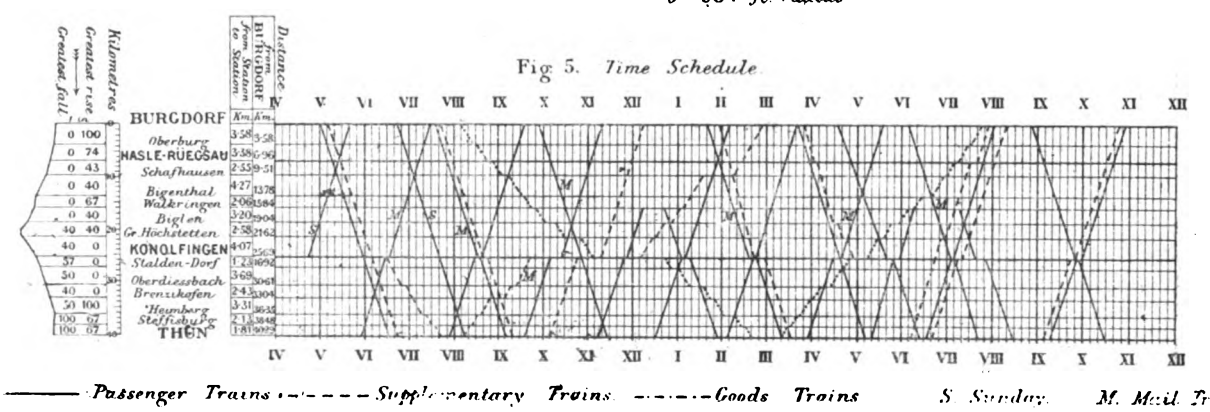


Fig. 5. *Time Schedule.*



FIGS. 4 AND 5.

Digitized by Google

and varying curves and grades. On leaving Oberberg the record shows where the train left the level and passed on to the grade of 1 in 143, thus making the acceleration curve slightly bend over; the same thing is shown in other places. This record is particularly interesting as showing the actual variations in speed when going up and down the steepest grade on the line. The first part of the distance from Biglen to Gross-Höchstetten is an up grade of 1 in 40; this is followed by a short level stretch and then by a down grade of 1 in 40. The record clearly shows the slight reduction in speed, 2 per cent., on climbing the up grade, then the return to 39 km. an hour on the level, and the slight increase of speed, 2 per cent., on descending the grade of 1 in 40. On leaving Gross-Höchstetten the acceleration curve is markedly increased when the train gets on to the grade of 1 in 40.

The Grades.—These are excessive, and have an important influence on the working of the line. The 32-ton motorcars are each equipped, as explained above, with four 64-h.p. motors. These are able, when acting together, to drive the motorcar itself and one 12-ton trailer up the maximum grade of 1 in 40. If the maximum grade on the line had not exceeded 1 per cent., four more 12-ton trailers, making five in all, might have been added when occasion required. Thus, in attempting to reduce the expense of construction by admitting steep grades, the usefulness of the electrical equipment has been seriously affected. The general impression that it makes no difference how steep the grades are on an electrically-driven line has in this case led to the adoption of such grades as largely to nullify the valuable property of polyphase motors referred to. The practical effect of the grades on the working of the line is that when the capacity of the train has to be increased beyond that afforded by one motorcar and one trailer, in order to deal with a temporary increase in the traffic, a second motorcar and trailer have to be added. (The makers of the electrical equipment are not responsible for this course.)

(To be continued.)

REPORT ON SYSTEMS OF SO-CALLED FREE WIRING.

The following is a supplement to the ordinary monthly report presented by Mr. Hamilton Kilgour, borough electrical engineer, to the Cheltenham Town Council:

It is well known that in most towns the chief obstacle to the general use of the electric light is not the price charged for electric energy, but the preliminary capital outlay in wiring and fittings.

In a town having municipal electric works this condition of affairs is doubly undesirable: firstly, because numbers of ratepayers are unwillingly debarred from fully participating in the benefits of an undertaking expressly intended for the advantage of the town generally, and in which they are practically shareholders; and secondly, because the growth of the undertaking is hindered, with the result that the cost of production and the sale price of electric energy cannot be reduced as much as would be possible if the undertaking had the larger *clientèle* legitimately to be hoped for.

The foregoing considerations have led several municipalities owning electric works to make efforts to assist persons desirous of having electric lighting to acquire installations without having to immediately pay for them in full, and, so far as I have been able to ascertain, with excellent results. Among these municipal authorities are the Hanley, West Ham, Worcester, and, I believe, the Bootle Town Councils, all of whom have been granted sanctions of the Local Government Board to borrow moneys for carrying out their schemes; and the following have also adopted, or are about to adopt, schemes for the same purpose—viz., Barrow, Bolton, Croydon, Dudley, Gloucester, Hoylake, Ilford, Northampton, Shildon, Willesden, and West Bromwich.

There are four different methods possible by which a municipal authority may assist a person to acquire an installation without his having to immediately pay for it—viz.:

The municipal authority may provide, either itself or through a wiring contractor, the installation, and may

(1) Charge, as declared annual rental of the installation, the customer a fixed percentage on the capital outlay;

(2) Charge—and thereby virtually obtain an annual rental for the installation—the customer a slightly increased price per unit for electric energy;

(3) Recover the capital cost, together with the cost of the time accommodation, from the customer by payments at fixed intervals spread over a term of years; or,

(4) The municipal authority may contract with the National Free Wiring Company to act as its collector of a virtual annual rental: the company to provide the installation at its own cost and risk, and the municipal authority to charge the customer a slightly increased price per unit, and to hand over the proceeds of this increment to the price to the company quarterly.

Scheme No. 4 has several rather obvious disadvantages: it introduces, under the most favourable conditions and with authority, a competitor to local wiring contractors; it is apt to lead to excessive competition, and, as a necessary consequence, to bad work; it involves the complication, and the inspection by the company's agent, of the accounts of the electric undertaking; the interests of the company, in respect to the provision of light at a customer's, are not identical, but rather clash, with those of the customer and with those of the municipal authority; the virtual annual rentals obtained from installations which have involved precisely equal capital costs are not necessarily equal, and are often enormously different, since these rentals depend on the candle-powers of the lamps used and on the average numbers of hours the lamps are used per annum.

Schemes Nos. 1 and 2 are open to the objection that the municipal authority has a continuous interest in (to some extent) perishable goods placed on not everlasting premises belonging to others. In both cases difficulties due to faults (from whatever cause), to breakages, and to differences as to what constitutes fair wear and tear, are certain to arise. Of the two, No. 1 is unquestionably the better, since No. 2 has superadded all the disadvantages of No. 4, except those due to the introduction of a formidable competitor to local wiring contractors. Notwithstanding its many disadvantages, Scheme No. 2 has been adopted by more than one municipal authority, and has secured a number of clients.

Scheme No. 3 has the advantage of leaving the customer absolutely free to select his own contractor, and to provide exactly what he desires in the way of an installation: further, the municipal authority is relieved of all responsibility in respect to the contractor's work, and undertakes no risk of loss of capital. The municipal authority under this scheme simply advances, upon approved security and under certain approved conditions, moneys to pay for the installations of intending customers; the scale of payments will provide for the cost of raising the necessary moneys, whether by loan with the sanction of the Local Government Board in the ordinary way or by arrangement with a bank: it is nearly immaterial whether the matter is treated as belonging to capital or revenue account.

After very careful consideration I am strongly of opinion that the committee will do well to adopt Scheme 3, and to take the necessary steps to bring it into useful operation. I am convinced that a scheme of this sort will add many desirable customers to our books, and will result in great benefit both to those whom it is intended to reach and to the electric undertaking.

The details of the scheme I suggest for your consideration are as follows:

1. The minimum value of an installation to be dealt with under this scheme to be £7.
2. The rate of interest charged on outstanding balances, due from the customer to the Corporation, to be about 5 per cent. per annum.
3. The customer to be given, in general, the option of one, two, or three years as the term of repayments, and in special cases—*e.g.*, of very large contracts and of charitable and similar institutions—of one, two, three, four, or five years as the term of repayments.
4. All the payments of each separate customer to be of

Digitized by Google

equal amount; the first to be made immediately after a satisfactory test has been taken and before electric supply is given, and following payments to be made on the next and following quarter-days.

5. The landlord, when possible, to be joined with the customer (if a tenant) in the contract, and in default of this the customer to find security (if required) to the satisfaction of the town clerk.
6. A short descriptive pamphlet and special application form to be issued in connection with this scheme, the former to be generally circulated and the latter to be given to contractors or to intending customers in the manner adopted with the present application form.

The following table gives the amounts of the initial and quarterly payments, and the aggregates of them for the case of an installation costing £100, the payments being spread over one, two, three, four, and five years respectively:

Number of years in term.	Value of each payment. £ s. d.	Aggregate value of payments. £ s. d.
1	20 10 0	102 10 0
2	11 13 5	105 0 10
3	8 5 7	107 12 5
4	6 9 8	110 4 11
5	5 7 6	112 18 2

It will be observed that the total amounts paid in the five cases are almost exactly governed by the following simple rule: for a contract value of £100 add as many fortieths as there are years in the term of repayments, or, in other words, add 2½ per cent. to the cost of the installation for each year in the term of repayments.

Exact compliance with the foregoing rule results in your getting precisely 5 per cent. in the case of a one-year loan, and 4·921 and 4·847 per cent. in the cases of loans of three and five years respectively—the minimum interest you get is nearly 4⅞ per cent. and the average about 4$\frac{15}{16}$ per cent.

I therefore recommend your adoption of the rule of adding 2½ per cent. for each year of the term of repayments.

If you choose to give the customer the option of quarterly, half-yearly, or yearly payments, the only result will be that you will get a slightly higher rate of interest if he pays half-yearly than if quarterly, and again a slightly higher rate if he pays yearly; this is a consequence of his first payment being smallest when the number of payments to be made is largest.

In conclusion, I may draw your attention to two instances in which a scheme of this kind has proved immediately beneficial—viz, Hanley Corporation and the Kensington and Brompton Electric Light Company. In the case of the former, the number of lamps added in the years before and after adoption of the scheme were 5,390 and 7,066 respectively, and the increases in the numbers of units sold per annum 104,000 and 122,000 respectively. In the case of the latter, the lamp increases were 11,100, 13,900, and 15,000 in three following years, and the sold energy increases 168,000, 141,000, and 290,000 respectively.

HAMILTON KILGOUR.

Vienna.—Effective means of preventing future accidents through the breaking of overhead wires in Vienna have been decided upon. All telephone and telegraph wires which cross the trolley wires of the local tramways are to be placed underground, in the form of cables at the point where the crossings occur, as soon as possible. But as it may be some time before the desired change can be effected, temporary protection in the shape of guard wires is to be provided. Moreover, policemen and firemen are to carry pliers with insulated handles, whereby a broken wire may be at once severed. Also all section switches in connection with the trolley lines are to be within arm's reach from the road-level. The measures here enumerated are akin to shutting the stable after the horse has fled. It is a pity that it has required a few fatalities to suggest these elementary precautions, but we are afraid Vienna is by no means the only sinner in respect to this lack of foresight, parallels to which are to be found much nearer home if looked for.

FORTHCOMING EVENTS.

FRIDAY, DEC. 7.

Institution of Electrical Engineers.—At 4 p.m., students' visit to the Electrical Standards Laboratory of the Board of Trade, 8, Richmond-terrace, Whitehall.

Faradian Club.—At 8 p.m., at 8, Charing Cross-road. Lecture on the "Modern Steam Engine," by Mr. J. S. Raworth.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Dock Gates," by Mr. F. K. Peach.

SATURDAY, DEC. 8.

Institution of Electrical Engineers.—Students' visit to the Manchester-square Station of the Metropolitan Electric Supply Company.

Institution of Junior Engineers.—Visit, at 3 p.m., to the electric generating station of the London Electric Tramway Company, 88, High-road, Chiswick.

MONDAY, DEC. 10.

Society of Arts.—At 8 p.m., Cantor lecture on "Electric Oscillations and Electric Waves" (lecture III.), by Prof. J. A. Fleming, F.R.S.

Society of Engineers.—At 7.30 p.m., annual general meeting, at the Royal United Service Institution, Whitehall.

TUESDAY, DEC. 11.

Institution of Electrical Engineers (Manchester Section).—At 7.30 p.m., meeting at Owens College. "The Proposed Manchester and Liverpool Express Railway," by Mr. F. B. Behr, with lantern-slide illustrations.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. The following papers will be read and discussed: "The Signalling on the Waterloo and City Railway" and "Note on the Signalling of Outlying Siding Connections," by Mr. Alfred Weeks Szlumper, M.I.C.E.; and "Signalling on the Liverpool Overhead Railway," by Mr. Stephen Butler Cottrell, M.I.C.E.

WEDNESDAY, DEC. 12.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., ordinary general meeting. Discussion on the paper on "The Supersession of the Steam by the Electric Locomotive," by Mr. W. E. Langdon.

Society of Arts.—At 8 p.m., fourth ordinary meeting, under the presidency of Mr. R. Brudenell Carter, F.R.C.S. Prof. Frank Clowes, D.Sc., on "The Treatment of London Sewage."

Electro-Harmonic Society.—Smoking concert at St. James's Hall.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the engine works of Messrs. James, Simpson, and Co., Grosvenor-road, S.W.

Society of Engineers.—Annual dinner.

THURSDAY, DEC. 13.

South-East Coast Institution.—Annual dinner at the Assembly Rooms, Westgate-road, Newcastle-upon-Tyne.

Institution of Electrical Engineers.—Ordinary meeting at the Institution of Civil Engineers. Paper on "The Rapid Variations in the Current through the Direct-Current Arc," illustrated by experiments.

FRIDAY, DEC. 14.

Institution of Mechanical Engineers.—At 8 p.m., ordinary general meeting, Sir Wm. H. White, F.R.S., in the chair. Discussion on Mr. Herbert A. Humphrey's paper on "Power-Gas and Large Gas-Engines for Central Stations."

Institution of Engineers and Shipbuilders.—General meeting in Newcastle-upon-Tyne.

Institution of Junior Engineers.—At 8 p.m., meeting, at Westminster Palace Hotel. Paper, "The Metallurgy of Tin," by Mr. J. H. Davy James.

Physical Society of London.—At 5 p.m., meeting, in Royal College of Science (by invitation of Prof. Rücker). The papers to be read are: "Electric Inertia" and "The Effect of Inertia on Electric Currents in a Rotating Sphere," by Prof. A. Schuster, F.R.S.; "Exhibition and Description of a Quartz-Thread Gravity Balance," by Prof. R. Threlfall, F.R.S.; "On the Theory of Magnetic Disturbances by Earth Currents," by Prof. A. W. Rücker, F.R.S.; "Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents," by Dr. R. T. Glazebrook, F.R.S.; "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rücker, F.R.S.; and "Exhibition of a Set of Half-Seconds Pendulums," by Mr. W. Watson. Council meeting at 4 p.m.

Faradian Club.—At 8 p.m., club dinner, at Hotel Florence.

SATURDAY, DEC. 15.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "Technical Colleges in Germany," by Prof. A. MacLay, B.Sc.

North-East Coast Institution.—At 8 p.m., ordinary meeting at Newcastle-upon-Tyne.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	793	Glasgow International Exhibition, 1901	813
The Arrangement of the Distributing Network	798	Manchester	813
Electric Oscillations	799	Light Railways	814
On the Supersession of the Steam by the Electric Locomotive	800	New Committees	814
Projected London Railways	804	Questions and Answers	814
Polyphase Electric Traction	805	New Companies	819
Report on Systems of So-Called Free Wiring	808	Legal Intelligence	819
Forthcoming Events	809	Companies' Meetings and Reports	820
Electric Railways	810	Contracts for Electrical Supplies	820
Wireless Telegraphy	811	Traction Notes	821
Correspondence	811	Lighting Notes	823
The Institution Dinner	811	Provisional Patents	827
Institution of Electrical Engineers	812	Specifications Accepted	828
The Trans-Pacific Cable	812	Traffic Returns	828
		Companies' Stock and Share List	828

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

ELECTRIC RAILWAYS.

The paper read before the Institution of Electrical Engineers last week on the "Supersession of the Steam by the Electric Locomotive," has opened up a discussion on a most important subject. The paper itself shows every evidence of careful preparation, but the fact remains that it is Mr. Langdon's opinion, which should be supported by actual facts. These are available to a large extent from the experiments which have been made in France, and from the actual working over a number of years of short lengths of heavy railways in the States and of longer lines in Switzerland. In England the figures obtained on the Liverpool Overhead Railway and on the deep-level lines in London could be used to support Mr. Langdon's conclusions. All these undertakings, however, have not to do with such heavy and varied traffic as exists on the section of the Midland Railway Company's system between St. Pancras and Bedford. The figures given by Mr. Langdon for the traffic on this section, and of the present cost of working it by steam locomotives, are most useful. Up to the present, also, we have no statements by a supporter of the present steam locomotives that Mr. Langdon's figures are unduly favourable to electric driving. In brief, the conclusions of the paper are that it will take ten thousand pounds per mile to equip main lines for electric power. In this figure the electric locomotives are not included, it being presumed by the author that they will be ordered from year to year instead of steam locomotives, which have each year to be supplemented. From the expenditure of ten thousand pounds per mile, or half a million for the section from St. Pancras to Bedford, Mr. Langdon shows an annual saving of roughly a quarter of a million. This saving is after adding to the expense 3½ per cent. on the additional outlay. About half of this saving is in cost of coal, while the water, oil, and stores required for the locomotives and the repair items are responsible for the rest. From this it will be seen that if Mr. Langdon's figures can only be borne home to the directors of our main lines, there should be no financial difficulty in connection with the conversion of such lines for electrical working. Our object at the present time is not to examine the items of saving in detail, but rather to allude to the important point which is not emphasised by the author. All his calculations are based on the assumption that the traffic after conversion will be the same as the traffic before. This will certainly not be the case, especially on local lines. While at present on these lines it does not pay to run more than a few trains each way per day, the frequency of service with electrically propelled trains can be increased to three or four times the present service. It must be remembered that with electrical propulsion the efficiency and cost per ton-mile is practically the same for a single carriage equipped with motors, as for a heavy train made up of a large number of carriages behind a locomotive or with motors on a number of the carriages. In consequence of this,

Digitized by Google

a frequent service can be provided as cheaply as the present infrequent one, and passenger and goods traffic on these local lines will be largely augmented. It will also react on the main-line trains, so that a considerable increased traffic return will result. We need hardly add that this increased return will be earned with a comparatively insignificant increase in the present large capital of the railway company. As a result, the public will get an improved service and the shareholders of the railways companies a larger dividend.

WIRELESS TELEGRAPHY.

In his second Cantor lecture at the Society of Arts, Prof. Fleming indicated that great improvements had been introduced by Mr. Marconi in his system of wireless telegraphy. It is to be hoped that Mr. Marconi will soon feel able to enlighten the world as to what is being done and what has been achieved. Quite early after the introduction of wireless telegraphy it was pointed out that, while of great value under particular conditions, as a general commercial system it was inapplicable, because each receiver within range of any one transmitter would be affected; hence no message sent could be looked upon as secret. Mr. Marconi has gone a long step beyond this, and we are told that he can now send from one point messages that can only be read by one receiver. We may, without being far wrong, say the instruments are tuned to be in unison. The weak point still is that both transmitter and receiver can be tuned over a considerable range, and while the transmitter is tuned at A to send a message to B, and under ordinary circumstances to B only, the instruments at C, D, E, F, etc., within range, if in the hands of evil-disposed persons, can be tuned similarly to B and E, and all can thus receive from A. Hence there is no absolute certainty of secrecy. If Mr. Marconi has or can improve the apparatus so as to obtain secrecy, not only when secrecy is unimportant, but also when it may be fatal, then he has done something at which the scientific world will wonder. Let us put the matter in another way, if possible, to make it clearer. Assume the analogy to sound to be perfect, and then within certain limits the instrument A can be tuned to produce a required note. B is also so tuned to be in synchronism, and so A and B correspond, while C, not tuned to A's note, does not receive the message. But A can be tuned to C's note, and C to B's, so that interchangeability of receiving and sending is perfectly feasible. The solution required is one which makes it impossible for any person to so adjust C as to enable it to take B's message.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

FATAL ELECTRIC SHOCKS.

SIR,—With reference to the several recent casualties in central stations from accidental contact with exposed parts of switchboards or other high-tension apparatus, I beg to say that by lapping such parts with a special cured rubber strip or splice, such as I am now supplying, they would be rendered quite harmless. I may say, further, that when such material is properly applied, and by slightly warming after each lap or layer, an actual rubber tube results, giving an insulation resistance well up to that of the usual classes of covered conductors in the market. For 'bus bars, etc., where such lapping cannot be applied without dismantling the switchboard, my armalac varnish or paint will also serve well. The makers claim that it gives a resistance equal to the puncture strain of 1,500 volts for each $\frac{1}{1000}$in. in the thickness of the films in which it is applied, hence its great success amongst machine builders here and elsewhere. Whilst, however, calling attention to these most successful materials, I quite agree with the correspondent who wrote about these accidents and suggested that, when possible, gear more modern and carefully designed should be brought into use as the most certain preventive. Still, where such drastic alterations cannot be carried out, the before-mentioned means of insulation may appeal to the engineers of such stations as the next best method of guarding their staff from similar mishaps.—Yours, etc., JNO. J. DOWN.

Harpenden, Herts.

[Mr. Down has shown us the preventives referred to above, and as such they are to be recommended. The faulty design, which is the cause of many fatal accidents, can only be partially rectified in this way. A more drastic course should be adopted to prevent the recurrence of such accidents, and any verdicts reporting that culpable negligence had been displayed would do good.—ED. *E. E.*]

NALDER BROS. AND CO.

SIR,—Notice has recently been published of a report of the liquidator of Nalder Bros. and Co., Limited, who are winding up voluntarily. As some misapprehension may possibly arise owing to the somewhat similar name, we wish to point out that this in no way affects our business, which was purchased some four years ago from Nalder Bros. and Co.; Nalder Bros. and Co., Limited, being of later formation. We shall be greatly obliged if you will kindly publish this.—Yours, etc,

NALDER BROS AND THOMPSON, LIMITED.

London E.C., Dec. 5, 1900

THE INSTITUTION DINNER.

The annual dinner of the Institution of Electrical Engineers was held on Monday last at the Hotel Cecil. The chair was occupied by Prof. John Perry, the president. For the first time in the history of these dinners the company was honoured by the presence of a lady—Mrs. Hertha Ayrton. As Mrs. Ayrton is a full member of the Institution, she was, of course, entitled to an invitation, and her name was duly mentioned in the opening remarks of every speaker. The company numbered about 350, and amongst those present were: Lord Morris, Lord Kelvin, Lord Alverstone, Sir W. MacCormac, Sir A. A. Weldon, Mr. C. E. Spagnoletti, Prof. W. G. Adams, Sir William Corry, Sir E. Carbutt, General Sir R. Harrison, Lieutenant-Colonel R. E. Crompton, Major-General Sir John Donnelly, Sir Courtenay Boyle, Sir J. Kitson, M.P., Sir F. Mowatt, Mr. A. Siemens, Mr. J. Denison Pender, Mr. A. G. Sandeman, Sir A. Geikie, Sir Philip Magnus, Sir Henry Roscoe, Sir W. de W. Abney, Prof. W. E. Ayrton, Sir J. Wolfe-Barry, Sir Andrew Noble, Sir George Kekewich, Sir J. N. Lockyer, Mr. James Swinburne, Sir W. Roberts-Austen, the Hon. Sir D. Tennant, Sir J. Crichton-Browne, Sir H. Trueman Wood, Admiral S. Holland, Mr. S. Z. de Ferranti, Major-General W. Salmond, Sir H. Mance, Mr. R. Kaye Gray, Major-General Festing, Commander G. C Robinson, Mr. S. W. Higginbottom, M.P., Dr. T. E. Thorpe, Mr. J. W. Swan, Dr. Ludwig Mond, Prof. J. M. Thomson, Councillor J. T. Skinner, Bailie A. D. Mackenzie, Mr. A. B. Kempe, Prof. A. W. Rücker, Mr. C. Hawksley, the Rev. C. Stower, and Mr. McMillan. After the dinner and the usual loyal toasts,

Digitized by Google

Mr. S. Z. DE FERRANTI proposed the "Army, Navy, and Auxiliary Forces, including the Corps of Electrical Engineers (Royal Engineers) Volunteers." There were four names on the list to respond to this toast, but the first-named (Admiral Sir W. J. L. Wharton) was not present.

General Sir RICHARD HARRISON, in reply, referred to the fact that two years ago he was present at the dinner when the Electrical Engineering Corps was just inaugurated, and when they were given a *résumé* of the duties of the corps by their commanding officer, Lieut.-Colonel Crompton. Electricity was used in the army for two general purposes at present, the first being the carrying of messages and the second that of giving light. He considered that the military telegraph and telephone system was in a fairly-well organised state, but they had much yet to learn as to the use of electric light in the field. The corps of the Electrical Volunteer Engineers had done good work in this last department, and he considered that their South African detachment had distinguished itself as much as any other force at the front. The good work being done by the corps at home, however, must not be forgotten. He had recently had to inspect a number of coast defences, and was struck by the aid which the corps was giving towards rendering the defence of the British Islands against invasion more certain.

Lieut.-Colonel CROMPTON, replying for the Electrical Engineers (Royal Engineers) Volunteers, said he was proud to be the responsible head of such a corps. The men in Africa had worked well, and Lord Roberts had expressed to him his appreciation of the services rendered. When the corps was formed it was deemed somewhat an experiment to get highly trained and educated men to act in the ranks as soldiers, but the experience in Africa had assured him that the experiment was a most successful one. Not only had they done extensive work as individuals in the telegraph and telephone system connected with the army, but collectively they had done good work with electric light as a means of defence. The engineering education of the men had been very largely used in other departments, and a number of mechanical engineering repairs had been made by them. In fact, there were now eight or ten men still to be kept in South Africa because their services could not be spared. He was pleased to say that the detachment had a larger percentage of men coming home safely than any other contingent. Only four out of a total of eight officers and 58 men had lost their lives. It was not to be inferred from this that they had not held dangerous positions, as the work connected with the military telegraph was almost the most dangerous in the present war.

Lord ALVERSTONE proposed the next toast, which was "Science and Engineering," and referred to the marvellous discoveries in science and improvements in engineering which had been made in the nineteenth century. While these exceeded by a vast amount the inventions and progress of any other century in the past, he would be a bold man who would say that the progress of the twentieth century would not surpass them.

Lord KELVIN responded to the first half of the toast, and in the course of his remarks pointed to the exceedingly rapid growth of our knowledge of electrical subjects. Quoting from Dr. Perry's presidential address, he agreed that there was no record in historic times of any use made of electricity before the present century.

Sir JOHN WOLFE BARRY also replied. Engineers, he said, had been classed by a previous speaker as artists. Unfortunately there was not much artistic merit in certain of our large bridges, and he thought that the chimneys erected in connection with electric lighting stations also lacked, too frequently, any artistic merit. The engineer, however, must remember that there was no need to make his work ugly in order to make it successful. After referring to the interconnection between science and engineering, Sir John Wolfe Barry expressed his belief that the future of civil engineering would be most closely connected with electrical engineering.

Sir JAMES KITSON, in proposing "The Institution of Electrical Engineers," referred to the efforts Parliament had made in the last session to remove legislative obstruction to electrical progress. He hoped that through the expansion of electrical power distribution, engines as small as 10 h.p. and 15 h.p. would soon be things of the past.

Sir COURTENAY BOYLE also joined in proposing the toast, and referred to the great possibilities of electric traction.

The PRESIDENT, in reply, sketched the history, as far as the age was concerned, of telegraphs and telephones, electric lighting, and wireless telegraphy. The lives of these departments of electrical engineering were about 50 years, 25 years, 10 years, and one year respectively—in fact, the electrical profession was still a baby, though a giant baby. They were its nurses, and they were just as ignorant of what their baby was going to be as nurses usually were. They only knew that what they did now would very greatly affect all the future life of the giant. The work of the Institution was growing in quantity and in quality, and the number of their members and the quality of their members were also growing.

The last toast of the evening was "Our Guests," proposed by Mr. JAMES SWINBURNE, and replied to by Lord MORRIS, Prof. RUCKER, and Mr. Bailie MACKENZIE. Lord Morris, in the course of his remarks, called the attention of the engineers present to the large water power which was available in his native country (Ireland), and which he hoped would do much to remake the prosperity of that country, which suffered from the want of coalfields.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following were the candidates balloted for at the ordinary general meeting on Nov. 29:

Members.—Herbert Broadbent, Perth, Western Australia; John Somerville Highfield, Wrindle House, St. Helens, N.B.

Associate Members.—James Anderson, 7, The Parade, Walton-on-Naze, Essex; Arthur Woodroffe Manton, Tudor Lodge, Sylvan-road, Wanstead, Essex; Marcus Nash, Borough Electricity Works, Tunbridge Wells.

Foreign Member.—Otto Peder Kragh, Frederiksberggade, 28, Copenhagen, Denmark.

Associates.—Harry Watkins Kimber, Llanwarne, Kingston-crescent, Portsmouth; Thomas Mills, 43, Claverton-street, Pimlico, S.W.; Arthur Henry Pook, Avondale, Simla, Punjab, India; David Shanks, Newton-chambers, Cannon-street, Birmingham.

Students.—William Beale Cole, Womersley House, Dickinson-road, Crouch hill, N.; John Marshall, 20, Manor-gardens, Holloway, N.; Ernest Ferdinand Motta, Crystal Palace Engineering School, Sydenham, S.W.

THE TRANS-PACIFIC CABLE.

The Colonial Office announces this week that the Pacific Cable Committee have accepted the tender of the Telegraph Construction and Maintenance Company for the manufacture and laying of the much-discussed Pacific cable. The order is given to this company in the names of her Majesty's Government and the Governments of Canada, New South Wales, Victoria, Queensland, and New Zealand. The amount of the tender sent in by the successful company is £1,795,000, and the company has undertaken to have the work completed by the end of 1902. In view of the great length to be laid, this is a reasonable time, but we should not be surprised to hear that the cable will actually be ready for use considerably before it is due. The route taken by this new all-British cable from Canada to Queensland and New Zealand will be *vid* Fanning Island, Fiji, and Norfolk Island. The length from Vancouver to Fanning Island is approximately 3,500 miles, and this section when laid will thus be the longest in the world. The first section to be laid will be that from the Fiji Islands to Australia. The section from Fanning Island to Norfolk Island will be about 1,700 miles, from Norfolk Island to Brisbane 800 miles, and from Norfolk Island to the coast of New Zealand 500 miles. The total length of the cable is to be over 7,000 miles. The value of an all-British connection between Australasian Colonies through Canada to Great Britain

Digitized by Google

cannot be over-estimated in times of peace, and should we unfortunately be engaged in war with any of the Continental powers, the cable may be considered as an absolute necessity. It will be remembered that the present route by which cable messages have to be dispatched involves the calling at a number of ports which are not on English territory. Another important consideration is that the cable will be laid in exceedingly deep water, and hence it will be more secure from interruption. It is to be expected that the exact route will be known only to the Pacific Cable Committee, which, again, will seriously increase the labour of the would-be cable-cutter in time of war.

GLASGOW INTERNATIONAL EXHIBITION, 1901.

As the main buildings of next year's international exhibition are almost complete, the members of the Machinery and Electric Lighting Committee are finding plenty of work to do, and a glance at their share in the organisation of Glasgow s second great show may interest professional readers. The contracts for the fitting up of the wiring and fittings in connection with the electric lighting of the three principal sections have been placed, the successful bidders being Claud Hamilton, Limited, £694. 9s. 6d., for the Industrial Section; and Messrs. Loudon Bros, £327. 11s., for the Machinery Hall, and £214. 17s. for the Grand Avenue. A tender by Messrs. Stewart and Menzies for the supply of steel steam-pipes for £530 has also been accepted. The engineer (Mr. Thomas Young) is now engaged with the scheduling of fittings, etc., required for the lighting of the refreshment rooms, and he has submitted the following additional list of firms who are willing to supply machinery, appliances, etc., on loan: Messrs. Bothman Patent Filtering Syndicate, filters; Messrs. G. MacLellan and Co., high-pressure packing and steam-pipe joints; Messrs. Railton and Campbell, feed-water filter and ash hoist; and British Schückert Company, Limited, 470-h.p. electric pump electric motors, and a searchlight. Mr. Young has been authorised to accept such of the above as he can use.

MANCHESTER.

Under the circumstances now ruling at Manchester in regard to electrical matters, we think the following report of part of the proceedings at the last meeting of the Town Council is interesting.—ED. *E. E.*

Dr. Bishop proposed the adoption of the proceedings of the Electricity Committee, and also that the joint sub-committee, consisting of representatives of the Electricity Committee and the Tramways Committee, be authorised to make final arrangements under the corporate seal with the engineer who may be selected by them to advise the Electricity Committee and the Tramways Committee as to the supply of electrical energy, and to carry out existing contracts and works in progress and in contemplation. He said, with regard to the position of the electricity works, it was not very likely those works would be carried on without interruption during the coming winter, and the Bloom street works would not be in a position to supply current for the tramways till next autumn. A special sub committee of the Electricity Committee had been appointed to confer with a special sub-committee of the Tramways Committee, and they were empowered to take certain steps if necessary. The two sub-committees met, and resolved that the best way of meeting the situation was to call in the aid of an expert who would have the confidence of both committee, and who would undertake the completion of the generating works at the earliest possible moment. That position was practically forced upon them, because the committee had received several resignations during the past few weeks of officials. First, there was the resignation of Mr. Wordingham himself, the chief of the department. Perhaps it would not be absolutely correct to use the word resignation, but Mr. Wordingham had sent a letter to the committee stating that he did not desire his agreement with the Corporation to be renewed, which was practically the same thing. That letter was accepted by the committee. Then a short time ago they received the resignation of the second engineer, who had been appointed as chief engineer at Bolton. Since then the resignation had been received of the superintendent of street mains, which would take effect on Dec. 31. Altogether the circumstances were so peculiar and so urgent that the special sub-committee felt that the only proper way out of the difficulty was to appoint an expert. The special sub committee had interviewed a number of gentlemen whose names were placed before them, but he was sorry to say he was not in a position that day to say that one had been appointed or asked to take up the duties. They thought, however, they would be able to make a selection in a week or two, or earlier if possible. If such a resolution as that he had proposed were not passed, the committee would be thrown a month behind.

Mr. Bowes asked when the recommendation contained in the resolution was made by the sub-committee?

Dr. Bishop said he had only seen it himself a short time ago, when it was placed in his hands. It was a resolution which he thought under the circumstances was justified. He thought it would be a great mistake to postpone the decision for another month.

Mr. Phythian seconded the resolution.

Mr. Alderman Richards said this resolution should have emanated from the committee. It would have been very easy for Dr. Bishop to have called the committee together to sanction it, but not a single member of the committee knew anything about it. A resolution should not be forced upon the Council in this way.

Dr. Bishop pointed out that at the meeting of the committee on Nov. 14 it was resolved that a special sub-committee be appointed to consider the desirableness of calling in an expert to advise the Electricity and Tramways Committees upon the present schemes for the supply of electrical energy, and that they be empowered to act.

Mr. Alderman Richards said the joint conference of the two committees was one thing, and he had no objection to that, but he had an objection to a motion being thrust upon them which had not been passed by the committee. He did not wish the Council to take a leap in the dark.

Mr Alderman Gibson said he did not quite understand why there should be so much hurry. There seemed to be some feeling that they were on the brink of an abyss. Where was Mr. Wordingham? He was not going till March. Had something happened to prevent Mr. Wordingham carrying out the work as he had carried it out before? Could anyone say a word derogatory to Mr. Wordingham's honesty, uprightness, or fitness?

Mr. Lambert said he should like the letter written by Mr. Wordingham to be read, because he wanted to base some remarks upon it.

Dr. Dreyfus thought there was no necessity to read the letter.

The **Town Clerk** read the letter, which was as follows: "As you are doubtless aware, in March, 1897, I entered into an agreement with the Corporation to remain as their electrical adviser for a minimum period of four years from that time. This period expires on March 31 next, and if I desire my engagement to then cease, I have, under my agreement, to give you notice to this effect on Dec. 31, 1900. I am not disposed to continue in the service of the Corporation, and I advise you of this now instead of waiting till December, in order to give you more time in which to make your arrangements. I have managed your undertaking for a period of seven years, and it is only necessary to refer to the published accounts of the department to see that the commercial results have been conspicuously successful, while the undertaking has attained such magnitude as to eclipse that of all others in the country. There are, however, at the present time a number of insinuations being made both in the public Press and elsewhere to the effect that there is something faulty in the management of the department, but whether these allegations are against me personally or against the committee itself I am unable to ascertain. Having in view the services that I have rendered to the Corporation, I think I have a right, especially having regard to the fact that I do not intend to continue my engagement with them, to ask that if the committee have any allegations of any kind to make against me they should definitely state what those allegations are, and give me an opportunity of replying to them. I am not conscious of anything whatever amiss, and if anything definitely is alleged I am confident that I can disprove it, but a vague insinuation no one can meet."

Mr. Lambert said he thought many members of the Council would be indebted to him for asking that the letter should be read, because it put on record very plainly the reason for it. Mr. Wordingham had served the city faithfully for seven years, and he now declined to remain in the service of the Corporation after March 31 while certain insinuations were hanging over his head which had not been brought to any direct charge which he could answer or remove. No one having any regard for his position and reputation could remain in the service of the Corporation without its being stated clearly that there was no reflection upon him and no insinuations made which were not withdrawn. He understood Mr. Wordingham had had no reply to his letter except a formal acknowledgment of it, and no statement had been made to him as to whether these insinuations were persevered in or withdrawn, and no letter had been written to say whether any personal charge was intended to be made against him reflecting upon his capacity, his ability, his integrity, or his honour. That being so, it surely could not be a matter of surprise that Mr. Wordingham should say he did not intend to continue in the service of the Corporation unless these insinuations and charges were withdrawn. (A voice: He did not say so.) The letter spoke for itself. Proceeding, Mr. Lambert expressed surprise that two reports prepared by Mr. Wordingham had not been communicated to the members of the Council, although their substance had appeared in the Press.

Dr. Bishop said the reports in question had not yet been considered by the General Committee because there had been no meeting since they were presented.

Mr. Lambert said the information contained in those reports should be in the possession of every member of the Council before they voted upon the proceedings of the committee. Those reports would convince every member of the Council that Mr. Wordingham, who had designed the scheme and carried it out for seven years, was quite as capable of carrying it out to its conclusion as any expert from either Glasgow or America or anywhere else. He believed Mr. Wordingham would be perfectly willing, and would, indeed, be anxious, for the sake of his own reputation, to carry out and complete the work so long as he was treated in a

Digitized by Google

proper manner and no insinuations made against him of improper conduct. He moved as an amendment that the resolution appointing the sub-committee be altered, and that instead of the words "that they be empowered to act" the words "and to report thereon" be substituted.

Mr. Alderman Richards seconded the amendment.

Mr. Wilson said with regard to Mr. Lambert's statement that Mr. Wordingham would be willing to continue his services if he were approached in a proper manner, no suggestion of that kind had been made either in the Tramways or the Electricity Committee. He thought matters had gone a little too far for that. He urged that any further delay would be a matter of considerable expense to the ratepayers in view of the arrangements made with the Tramways Committee.

Mr. Boyle said the insinuations referred to in the letter existed, he believed, only in Mr. Wordingham's own imagination. No one, so far as he knew, either in the Electricity or the Tramways Committee, had ever framed any charge. The only charge was in so far as the report of the special committee that had been appointed by the Electricity Committee to enquire into the administration of the department reflected upon him. There was in that report no insinuations, but plainly and tersely stated facts. They were not aware that Mr. Wordingham was willing to stay with them, and they were obliged to see to the appointment of the best expert advice obtainable as early as possible. So much depended upon the question under discussion that he thought the committee were entitled to the confidence of the Council in dealing with the matter at once.

Mr. Alderman Hopkinson asked the Council not to create a precedent by giving to a committee, much less a sub-committee, authority to appoint an important officer of the Corporation.

Mr. Plummer suggested that the consideration of the matter should be adjourned for a fortnight.

After some further discussion it was resolved that the consideration of the question be deferred for a fortnight, that the information asked for by Mr. Lambert be furnished to members of the Council in the meantime, and that the Electricity Committee then bring forward a recommendation as to appointing an expert.—*Manchester Guardian.*

LIGHT RAILWAYS.

Notices of intended application under the Light Railways Acts, 1896, have appeared in the *London Gazette* as follows: West Cumberland light railway (syndicate), Hayling Island light railway (syndicate), Bolton, Turton, and Darwen light railway (Lancashire Light Railway Company), Canterbury, Whitstable, and Herne Bay (O. W. Bowen), Crewe light railway (Corporation), Essington and Ashmore light railway amendment and extension (company).

At the last meeting of the Birkenhead Town Council a letter was read from the promoters of a light railway scheme by which it is intended to unite the borough of Birkenhead with the districts of Upton, Greasby, Frankby, Caldy, West Kirby, Hoylake, Meols, Leasowe, and Wallasey, and to run a service of electric cars. The communication was referred to the Tramways Committee.

At the Battle Annual Fat-Stock Show at Hastings it was stated that a light railway from Robertsbridge to Pevensey would soon start.

The Llanfyllin Town Council have appointed a committee to consider whether the Council should offer any opposition to the Tanat Valley Light Railway.

The joint order of the Middlesex Council and the North Metropolitan Company is being drawn up by the Light Railway Commissioners. This is the first order of the kind.

NEW COMMITTEES.

The following additional committees have been appointed:

BOURNEMOUTH.—*Lighting*: Councillor Gunning, chairman. *Tramways and Parliamentary*: Councillor Lawson, chairman.

CROYDON.—*Tramways*: Alderman Sir F. T. Edridge, chairman; Alderman Allen, vice chairman.

EAST GRINSTEAD.—*Special Electric Light*: Mr. Milburn, chairman.

ECCLES—*Public Lighting and Electrical Supply*: Alderman Kendall, chairman; Councillor Oldfield, vice chairman.

HAMPSTEAD.—*Electric Lighting*: Messrs. C. F. Pritchard (chairman), T. G. Randall, G. Buckle, C. W. Cunningham, J. Thwaites, S. Jones, J. E. Bousfield, J. D. Cleaver, W. R. Rea, C. H. Gadsby, and J. Aitchison.

LUTON.—*Electric Light and Power*: Councillor Wilkinson, chairman.

NEWCASTLE—*Lighting*: Alderman Barker Ellis, chairman; Mr. Fred Elliott, vice chairman.

WOOLWICH—*Electricity Supply*: The Mayor (*ex-officio*); Aldermen G. Kelham and J. Harper; Councillors J. J. Clark (chairman), H. S. Syer (vice-chairman), H. J. Butter, J. Illidge, W. Kemp, J. Lawson, P. Pringle, J. A. Turnbull, W. Turner, and J. O. Widger.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

331. Give method employed in calculating resistances for motor starters, so as to get a certain number of amperes per contact. In liquid starters what is the usual current allowed per square inch of surface of iron plate electrode? Also give way of calculating resistance of liquid, say 5 per cent. soda solution.—A. R.

332. In transmitting power to a distance, how does the load factor of the supply influence the commercial result?—P. T.

ANSWERS.

Question No. 325.—While in charge of the controlling board in a high-tension alternating-current station, the shift engineer switched in a machine without synchronising it with another machine on the 'bus bars. The former machine was high-speed—150 amperes at 2,000 volts; the latter being a low-speed—50 amperes at 2,000 volts. After the two machines were connected there was a drop of five volts on the low-tension voltmeter, and although I took all the resistance out of the shunts the voltage slowly dropped, until the light entirely faded out. Then the fuses of the low-speed machine became white hot and blew. Kindly explain the reason for the above.

Best Answer to No. 325 (*awarded* 10*s.*).—It sometimes happens that in occurrences similar to the one in question, some simple neglect on the part of one of the subordinates, which does not at the time come under the notice of the engineer, is responsible for producing an effect which might otherwise be difficult to explain. When synchronising in a lighting station, the machine is generally brought to the proper speed by means either of an arrangement for altering the tension on the governor springs (as in the Willans engine), or else by the use of a by-pass on the steam-pipe. Either arrangement permits the engine to take just sufficient steam for running light with a no-load field on, and if the machine is properly switched in, it will pick up absolutely no load until more steam is given to the engine—we will assume that some such arrangement exists in the plant under question.

Now, we are told that the 150-kw. machine was paralleled, without synchronising, with a machine one-third of its size, and that the low-tension voltage drop was only five at the commencement; so that one cannot help thinking that the shift engineer made a remarkably good chance shot, and that the machine must have been running at very nearly synchronous speed at the time. However, a certain synchronising current flowed which had the effect of dropping the volts, and the switchman increased his exciter voltage in order to bring the 'bus-bar voltage to the normal. The fields of both alternators would in all probability be taken from the same exciter 'bus bars, and consequently both fields would be strengthened. Now, if the engineman, seeing that the big machine had been badly phased, hesitated before giving the engine more steam (and this is not, I think, an unnatural supposition), the effect of the increased field upon the big machine would be to cause it to try to slow up (owing to increased eddy currents), because sufficient steam only was supplied to keep it running at the proper speed with the no-load field. It could not slow up, however, because it was in parallel, and in consequence, as the field was more and more increased, it would make larger and larger demands upon the 50-kw. machine for synchronising current. This would overload the small machine, causing its voltage

Digitized by Google

rapidly to fall, the limiting factor of the amount of current given out being the carrying power of the fuses. When this limit was reached, the fuses blew, as stated in the question. The 50 kw. machine was doing the load by itself before the incident, so that if the 150-kw. machine had been given steam after paralleling it would in all probability have been able to have blown the fuses of the small machine, besides supplying the external load, and that certainly without permitting such a drop in voltage as would cause the lights to die right out.

Of course, the assumptions made may not be correct, but I do not think they are unwarranted, for I personally witnessed a machine which had been rather badly synchronised quickly assume a direct motor current in excess of the full output of the machine, and was at a loss to know the reason for the strange behaviour until it was found that the driver, seeing the machine go in badly, had simply shut the steam off the engine.—W. G. M.

Answer to No. 325 (*awarded* 5s.).—Alternators are said to be synchronised when running at the same frequency and having their E.M.F.'s in the same phase. If the terminals of two such machines be connected by their being switched on to a common 'bus bar or otherwise, any one of three conditions may exist—viz. (*a*) the periodicities may be identical and phase lag 0deg. or less than 90deg.; (*b*) equal periodicities, but phase lag greater than 90deg.; (*c*) the periodicities may be different, and the phase lag have any value from 0deg. to 180deg.

(*a*) In this case, as also in case (*b*), it may at once be noted that since the armatures are running at the due speeds a comparatively small accelerating or retarding force will suffice to alter the phase lag. Let the phase lag

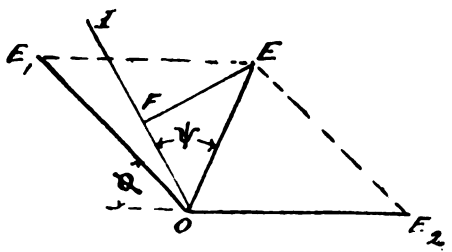


FIG. 1.

be ϕ, the E.M.F. generated in one armature be O E_1, and that at the terminals of the other be O E_2, then the resultant E.M.F. is O E, the diagonal of the parallelogram on O E_1, O E_2. Let the ratio of 2π N L to R in the leading machine = tan ψ, where N = frequency, L = self-inductance, and R = armature resistance. Then O I represents the phase of its current. If E F be drawn at right angles to O I, it is seen that the components of O E are

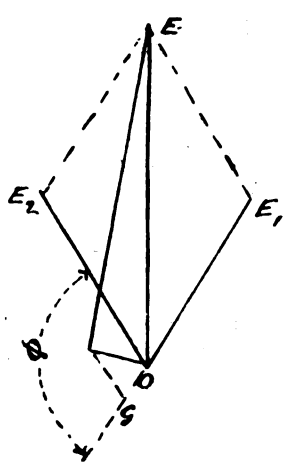


FIG. 2.

E F, the E.M.F. overcoming self-inductance and O F overcoming armature resistance. Now, the power absorbed by the machine from its engine is proportional to the current multiplied by the projection of the armature E.M.F. upon its direction. This obviously increases with the lead, being small when the lead is small, but increasing rapidly with it (see discussion and diagram, Kapp's "Dynamos, Alternators, etc."). Hence, if the engine lags slightly the load is at once reduced and speed maintained. Pushing on is prevented by the augmented load, and altogether the conditions are stable. It is to be noted that in Fig. 1 O E_1 is the E.M.F. of the leading machine, which at a first glance appears to lag owing to the fact that the E.M.F. O E_2 is opposed to its own voltage.

(*b*) In this case the E.M.F.'s at the terminals and in the armatures are, on the whole, in the same direction, and the machines are virtually running in series. The diagram corresponding to these conditions is given in Fig 2. Here the current in machine of E.M.F. O E_1 is in opposition to the induced E.M.F., being proportional to the projection, O G. Hence the watts absorbed are proportional to O E_1 × O G, and the machine runs as a motor. Any increase of lead increases the watts absorbed, lightening the load on the engine. The lead consequently increases to 180deg., the whole current circulates through the two armatures, and the fuses of the smaller machine are blown.

(*c*) In this case the current is driven through the armatures by superimposed E.M.F. waves of unequal frequency. The resultant E.M.F. in machine giving the waves lettered *m* in Fig. 3, is, therefore, the dotted curve

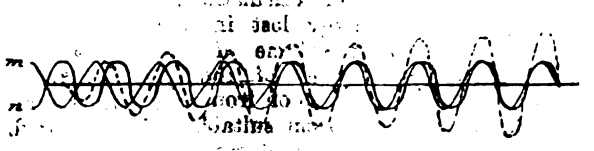


FIG. 3.

whose ordinate at any point is the sum of the ordinates of the induced and terminal E.M.F.'s. The resultant E.M.F. thus varies in magnitude between zero and the sum of the two E.M.F.'s, with a frequency equal to the difference of their frequencies, displaying the phenomenon of "beats." In practice, of course, the fuses of the smaller machine go at or before the first maximum is reached. In the case alluded to in the question it would appear that both machines were about in the same phase when connected, and that the voltage of the less machine was under the terminal voltage; the latter at once falls to about the mean of the machine voltages, so causing the secondary volts to fall. As the phase difference increases, owing to the frequency difference, the state of things explained in case (*b*) is reached. The small machine diverts more and more current from the external circuit until finally its fuses go.—ZERO.

Answer to No. 325 (*awarded* 5s.).—The two alternators were switched in badly out of phase. Their maximum E.M.F.'s would occur at different periods of the cycle. Assuming that they had both correct excitation and speed (the most favourable condition in a case of this kind), the terminal voltage of each machine would be alternately above and below that of the other. The 'bus bars formed a circuit of low resistance between the terminals of the alternators, so that heavy currents would oscillate between the machines, flowing from the machine at higher pressure to that at lower pressure at any instant. Since such large currents were developed in excess of the ordinary output, the machines were not able to meet the demand at full voltage with their proper speed and excitation, this drop in volts being due to (*a*) excessive hysteresis and eddy-current loss; (*b*) an inductive action on the field by the armature coils, choking back the lines of force, both causes being due to the enormous currents flowing.

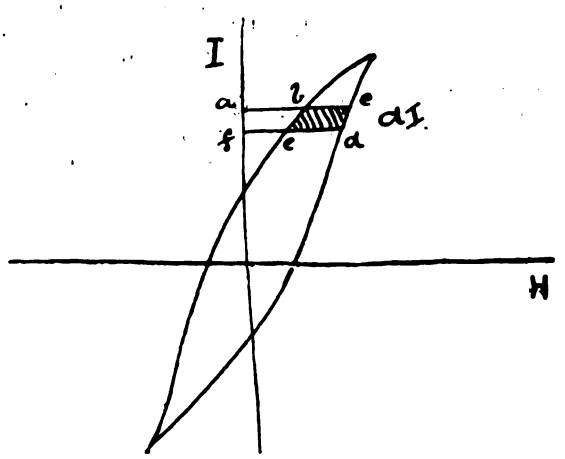
The two machines were alternately motoring each other, for the interaction between the inflowing currents and the field produces a strong forward pull. For this reason the two machines did not shut down even with such heavy currents. The fact that they did not "pull into phase" shows how badly out of phase they were put in. The effect of the motoring current in pulling the rotor of the motored machine forward, combined with that of the generating current of retarding the generator's rotor, has often the effect of pulling these rotors into such a position that the maximum E.M.F.'s of the machines coincide. A heavy rotor is, of course, not so easy to affect in this way. In the given case the machines were so much out of phase that they lost their excitation before they pulled in.

Digitized by Google

It has been mentioned that the large currents produced choke back the field. This, in turn, reduces the terminal voltage. This effect of choking the field will not be seen on the field ammeters, the action being that the field ampere-turns are neutralised by the armature coil ampere-turns. If this action is allowed to go on, the potential on the 'bus bars will, of course, drop, and the lamps, being of high resistance, will go out. The copper 'bus bars, however, are of such low resistance, that large currents at low voltage will flow. In the case cited, a stop was put to the affair by a fuse in the main machine circuit blowing due to these large currents. It speaks well for the construction of the alternators that they stood both the mechanical rocking and the electrical shock and overheating effects so well that the fuse had time to act.—J. A. S.

Question No. 326.—Describe and explain some method of determining the hysteresis loss in the armature of a continuous-current machine.

Best Answer to No. 326 *(awarded* 10*s.).*—The hysteresis loss in the armature of a continuous-current machine may be predetermined by calculation, or it may be found from actual experiment when the machine is run. We will first consider the method of calculation: This consists in summing up the energy lost in a complete cycle of magnetisation for unit volume of iron. This quantity multiplied by the product of the cyclical changes per second and the total volume of iron will give the rate of loss of energy in watts when suitable units are used. If we plot out a cyclical curve of magnetisation giving the relation between I and H, as in figure,



where I = intensity of magnetisation,
H = magnetising force per centimetre of iron.

Then if I and H are in C.G.S. units, the area of the closed figure in square centimetres is equal to the ergs expended in one cycle of magnetism.

Consider an element in figure, d I.

Then work done to magnetise element = H . d I
= area $f d c a$.

Energy given back on demagnetising = area $a b e f$.

$\therefore$ energy absorbed = area $f d c a$ − area $a b e f$.

$\therefore$ total work done = $\int$ H d I.

This expression when integrated between its proper limits gives the area of the closed curve, which is equal to the work done per cycle. If our curve of magnetisation gave relation between β and H, where

β = density of lines per square centimetre; and
H = magnetising force per centimetre of length;
I = intensity of magnetisation, where $I = \frac{\text{magnetic moment}}{\text{volume of iron}}$.

Then, according to Prof. Ewing,

$$\beta = H + 4\pi I,$$

differentiating $d\beta = dH + 4\pi dI$,

multiply by H $H d\beta = H dH + 4\pi H dI$.

Now for a complete cycle $H dH = 0$,

$\therefore H d\beta = 4\pi H dI$;

$\therefore H dI = \frac{H d\beta}{4\pi}$.

$$\int H dI = \frac{1}{4\pi}\int H d\beta.$$

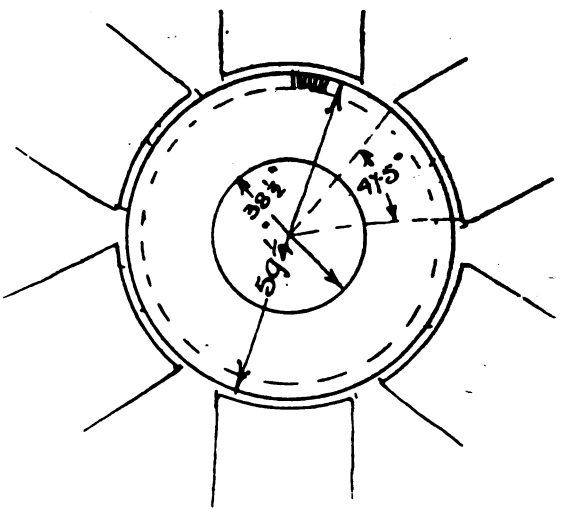
From considerations such as the above empirical formulæ have been deduced, which enable the practical man to determine with comparatively little labour any loss due to hysteresis which he may require to know.

The following formula, based on the experiments and calculations of Prof. Ewing, is found to be sufficiently accurate for calculations connected with soft annealed wrought iron:

$$H = \cdot 003 \times \beta^{1\cdot 6} \times \frown\!\!\smile \times V \times 10^{-7};$$

where H = total watts lost in hysteresis;
β = density of lines per square centimetre;
$\frown\!\!\smile$ = number of complete cycles of magnetisation per second;
V = volume of iron in cubic centimetres.

We will now apply the above formula to a particular case. Consider a six-pole machine with an armature of the following dimensions:



External diameter = 59½in. Internal diameter = 38½in.
Lines per pole = 13·3 × 10⁶.
Effective length of iron between end plates = 9·9in.
Number of lines entering armature from each pole at full load = 13·3 × 10⁶.
Number of teeth of armature under each pole = 29.
Total number of slots in armature = 220.
Size of slots = 1½in. deep × ·416in. wide.

Density of Lines in Teeth—

Area of one tooth at surface = 27·4 sq. cm.
Area of one tooth at the root = 24·6 sq. cm.

Now, as there are 29 teeth under each pole,

Area of surface of teeth under one pole = 795 sq. cm.
Area of root of teeth under one pole = 718 sq. cm.

$\therefore$ Density of lines at surface of teeth

$$= \frac{13\cdot 3 \times 10^6}{795} = 16{,}680 \text{ per sq. cm.}$$

Density at root of teeth $= \frac{13\cdot 3 \times 10^6}{718} = 20{,}000$ per sq. cm.

So that we see that the value of the density in the armature teeth increases as we go from the root of the teeth to the surface; therefore the hysteresis will increase in a similar manner and in proportion to $\beta^{1\cdot 6}$

In our calculations we shall consider the teeth as if they had a uniform density of 20,000 lines per square centimetre. This will give a value for the hysteresis somewhat too high, but it is sufficiently near for practical work.

Density of Lines in the Armature—

Radial section of armature = 565 sq. cm.

$$\therefore \beta_{arm} = \frac{13\cdot 3 \times 10^6}{2 \times 565} = 11{,}800 \text{ per sq. cm.}$$

Volume of Iron in the Teeth—

Volume of one tooth = 109·5 cub. cm.
Volume of 220 teeth = 24,200 cub. cm. (approx.).

Digitized by Google

Volume of Iron in the Armature less that of the teeth = 216,000 cub. cm.

Cycles of Magnetisation—

Revolutions of armature = 135 per minute;

$\therefore \sim$ = revolutions per second × pairs of poles.

$$\sim = \frac{135}{60} \times 3 = 6\cdot75.$$

$\therefore$ hysteresis loss in armature less that of the teeth

$$= \frac{\cdot003 \times 11{,}800^{1\cdot6} \times 6\cdot75 \times 216{,}000}{10^7}$$

$\beta_a{}^{1\cdot6} = 11{,}800^{1\cdot6}$;

$1\cdot6 \log \beta_a = 1\cdot6 \log 11{,}800$;

$= 6\cdot5$;

$\therefore \beta_a{}^{1\cdot6} = 3{,}170{,}000$ approximately.

$H_{arm} = 1{,}390$ watts lost in armature apart from the teeth.

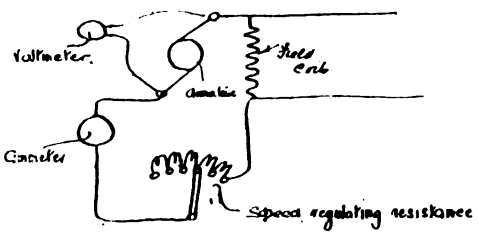
Similarly, hysteresis loss in the teeth

$$= \frac{\cdot003 \times 20{,}000^{1\cdot6} \times 6\cdot75 \times 24{,}200}{10^7}$$

$$H_{teeth} = 444 \text{ watts.}$$

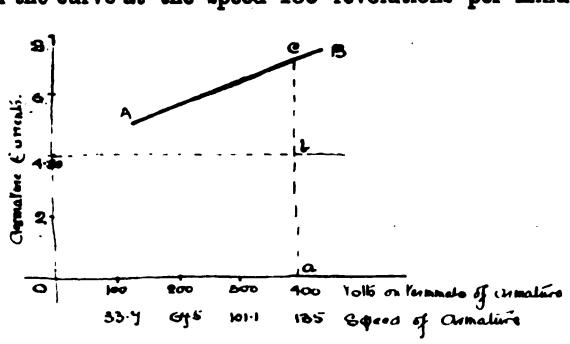
$\therefore$ total loss due to hysteresis in the armature = 1,834 watts.

To obtain the hysteresis loss in the armature of a continuous-current machine by *experiment*. The machine to be tested is connected up to its source of supply, and run as a motor on light load—that is, the motor is doing no external work. The voltage on the field coils of the machine is kept constant, and simultaneous readings of the speed and current in the armature, together with the volts on the armature terminals, are taken for various speeds; the speed is varied by a resistance which is introduced into the armature circuit. The accompanying diagram shows



the connections. The readings taken can now be plotted in the form of a curve, as shown below.

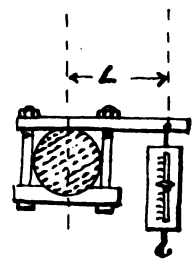
On the ordinates we mark off the armature currents and on the abscissæ the corresponding armature voltages and speeds. Let A B be our resultant curve: produce this so as to cut the ordinate, and at the point of intersection draw a line horizontally. We are now in a position to determine the hysteresis or Foucault current loss in our armature corresponding to any speed and with a fixed normal excitation. For example, find the hysteresis loss in armature from the curve at the speed 135 revolutions per minute.



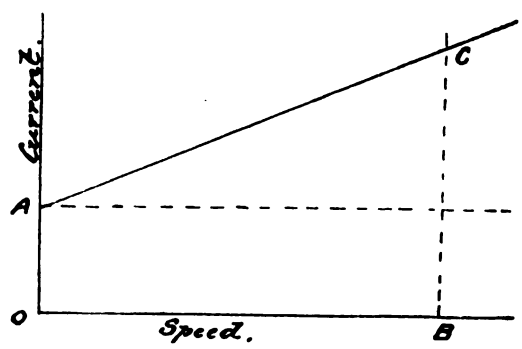
Draw a line vertically from speed of 135 revolutions per minute as in figure; then hysteresis equals $a\,b \times 400$ = 1,834 watts. We may also note that the Foucault current loss is equal to $c\,b \times 400$ = watts. The curve, therefore, enables us to separate the hysteresis from the Foucault current loss. It must be noted that in practice the value we obtain for the hysteresis from a separation curve as just described must of necessity include the energy lost by friction in the bearings, as this quantity, like hysteresis, increases in proportion to the speed.

The importance of this bearing friction may in very small machines be considerable, but with large machines the friction becomes insignificant when compared with the hysteresis loss in the iron core. This bearing friction may be measured independently by driving the machine unexcited and direct coupled to a motor. Then the difference between the power to drive the motor alone and that taken to drive the two machines coupled will give the loss in friction in the driven machine at that particular speed.—H. P.

Answer to No. 326 (awarded 5s.).—The hysteresis loss in a continuous-current armature core increases with the induction. Hence in a series or compound wound machine it increases with the load. To ascertain the energy lost in hysteresis at any particular value of the excitation, a bar may be clamped to the spindle (as shown) and a spring balance attached at some point in its length. The bearings being well lubricated and the magnets unexcited, the armature is slowly rotated by pulling the spring balance round. In this operation care should be taken that the pull on the balance is at right angles to the length of the clamped bar. Let the mean pull indicated on the balance for a complete revolution be P pounds. If the point of attachment of the balance be L inches from the centre of



spindle, the frictional torque is P L inch-pounds. Let, now, the field be switched on and adjusted to the excitation required. The turning is repeated, and some greater mean pull, P′, is indicated. The corresponding torque, P′L, is equal to the combined friction and hysteresis torque. Thus the hysteresis torque alone is (P′ − P) L inch-pounds, and the loss in horse-power is $2\,\pi\,n\,(P' - P)\,L \div (12 \times 33{,}000 = \frac{(P - P)\,L\,n}{63{,}000}$ horse-power $= \frac{(P' - P)\,L\,n}{84\cdot5}$ watts, where n denotes revolutions per minute. The principle of this method is that in carrying the iron of the core through a complete cycle a definite amount of work—viz., the "hysteresis loss" for one cycle—must be done. Now, the work done in a complete revolution by a torque is $2\,\pi$ times that torque. Hence, deducting for friction in the journals, the two expressions are equated, and the loss per revolution is found. This loss per revolution is within practical limits independent of the rapidity of reversal, and consequently the loss in n revolutions is n times that in one. Another method, which the writer judges more satisfactory, is to supply current to its brushes and run the armature light as a motor. The losses are now threefold: (*a*) friction, (*b*) hysteresis, and (*c*) eddy currents, the first two of which are proportional to the speed, and the last to the square of the speed. The magnets are separately excited to



the required extent, and the speed, current, and voltage across the brushes are noted. By varying this voltage, and consequently altering the other quantities, a number of corresponding values of the current and speed are obtained.

Digitized by Google

If these speeds be set out as abscissæ and current as ordinates, a straight-line curve is given; for the currents being small, the voltage applied across the brushes is practically the back E.M.F. of the machine. The curve produced back to cut the axis of current intercepts a length O A, so giving the value of the current that would just overcome frictional and hysteresis resistance to motion, assuming the former to have a constant value at all speeds. The product of this current and the voltage is the watts expended at any speed on friction and hysteresis. If it is desired to separate these losses, the armature may be rotated with unexcited magnets through some form of transmission dynamometer, and the friction loss so determined; or the following method may be adopted: Let the armature be rotated at speed N, and suddenly thrown free so that it rotates by its own inertia, gradually slowing down. If in the first minute after release it makes N' revolutions, as recorded by a speed indicator, its speed at the end of the minute is $N-2(N-N')=2N'-N$. Let these letters refer to the case when the magnets are not excited, and N, N'' denote speeds similarly with the field on. Then, roughly, since work done in equal tim s is proportional to differences in the square of the velocity, we have the relation—

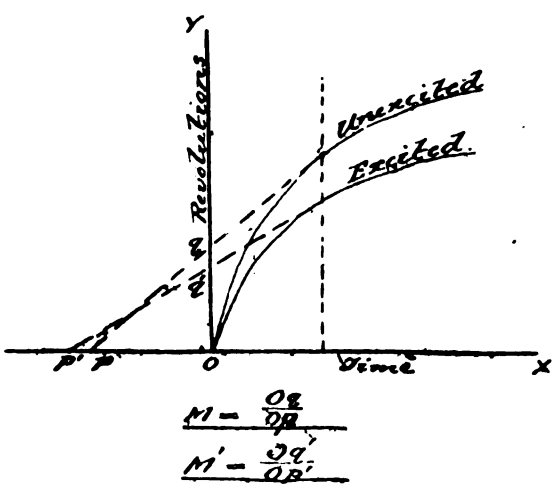
$$\frac{\text{Work lost in friction}}{\text{Work lost in friction, hysteresis, and eddies}} = \frac{N^2-(2N'-N)^2}{N^2-(2N''-N)^2} = \frac{N'(N-N')}{N''(N-N'')} = K$$

Hence, if B C be the current at any speed O B, the total loss, W, = B C × brush volts. The loss in friction and hysteresis = $\frac{O\,A}{B\,C}$ W, and the loss in friction alone = K W, so that

$$\text{Hysteresis loss in watts} = \left(\frac{O\,A}{B\,C} - K\right)W.$$

This method is subject to the error that the eddy-current loss is assumed to be the same per revolution for both N and N'', whereas it actually varies as their squares. If, however, N'' is not greatly different from N, the error is not considerable.

A more accurate form of the above method is to note times and revolutions made, counting each from the instant of throwing off the belt, and doing so both for excited and unexcited magnets. Two curves may then be set out as



shown. Let a straight line parallel to O X be drawn cutting the curves in points such that the value of the time is small, and at each point let a tangent be drawn to the curve. Then the intercepts on O Y, divided by the intercepts on O X, give the velocity in each case after the same number of revolutions have been made. If these be M with unexcited magnets and M' with excitation on, then

$$K = \frac{N^2 - M^2}{N^2 - M'^2},$$

and the further calculation is as given above.

From the form of the question, it is assumed that no sample of the core discs used is available. Were such at hand, the hysteresis loss per cycle per unit volume might be determined by any of the usual methods, and this, multiplied by the volume of iron in the core and by the speed would give the total loss.—ZERO.

Answer to No. 386 (*awarded* 5*s.*).—Leaving out of account all methods depending on measurements made on the armature iron before it is built up into a core as being quite unreliable, the following is probably the simplest and most direct method of measuring not only the hysteresis but also all the other losses occurring in the armature. For this test the machine should be run as a motor, with the field separately excited so that the voltages across armature and across shunt are separately variable. The measurements to be taken consist of readings of armature volts, armature amperes, exciting amperes and speed, with the machine running at three different speeds and with three different exciting currents at each speed, making nine complete sets of readings as a whole. More readings may, of course, be taken, but these nine are usually quite sufficient to draw all the necessary curves accurately. The speeds and excitations should be selected as far apart as possible, so as to cover the whole range of speed and excitation respectively. The current required in the armature will generally be so small that the loss in the copper (C^2R) in the armature will be negligible compared with the total input watts, so that the readings may be taken to equal the losses in bearings, brushes, windage, hysteresis, and eddy currents only. In order to separate these various losses, the nine readings should be plotted as shown in Fig. 1, using exciting amperes as the abscissæ and input watts (or total losses) as the ordinates. In this way three curves, one for each speed, will be obtained, shaped approximately as in Fig. 1.

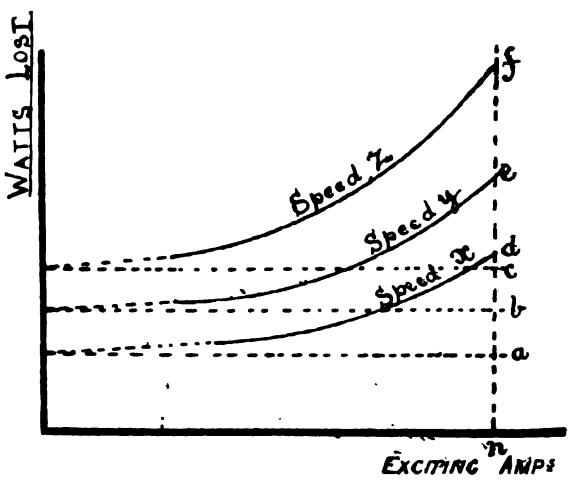


FIG. 1.

These three curves must then be produced backwards till they meet the vertical axis, as shown by the dotted portions in Fig. 1, and from the three intersections so obtained the horizontal lines, *a*, *b*, and *c*, should be drawn. The watts represented by the heights of these lines above the horizontal are the bearing friction, brush friction, and windage losses at the three speeds, since they represent that portion of the loss which is unaffected by the excitation. The remaining watts, lying between the horizontal lines, *a*, *b*, *c*, and the total loss curves, *d*, *e*, and *f*, respectively, are the hysteresis and the eddy-current losses at the different speeds.

These last two losses can further be separated from one another by drawing the curve shown in Fig. 2. This separation depends on the fact that whilst the hysteresis watts are proportional to the speed of the machine, the eddy-current losses are proportional to its square. Further, since hysteresis is proportional to the 1·5th or 1·6th power of the induction density in the iron, whilst eddy-current losses are proportional to its square, it is evident that the relative proportions of hysteresis and eddy-current loss depends on the excitation, and therefore a separate curve, similar to Fig. 2, must be drawn for each excitation for which the separation is required. Fig. 2 has the speed of the machine for the abscissæ and "core loss per revolution" for the ordinates. This "core loss per

Digitized by Google

revolution" is simply that portion of the total loss which lies above the horizontal line in Fig. 1, divided by the corresponding speed in revolutions per minute. Thus, if Fig. 2 is drawn for the exciting current marked n in Fig. 1, the values of "core loss per revolution" for the points marked P, Q, and R in Fig. 2 will be $\frac{a\,d}{x}$, $\frac{e\,b}{y}$, and $\frac{f\,c}{z}$ respectively. Having got the points, P, Q, and R, which will usually lie on a sloping straight line, produce the line backwards to cut the vertical axis, and from this point of intersection, r, draw the horizontal line $r\,t$ (Fig. 2). Then the height, $o\,r$, of the horizontal line represents the hysteresis loss [and $o\,r \times$ (speed in revolutions per minute) is the hysteresis loss at that speed] and heights above the horizontal, such as t R, represent eddy-current losses [and t R × (speed z in revolutions per minute) = eddy-current watts at speed z].

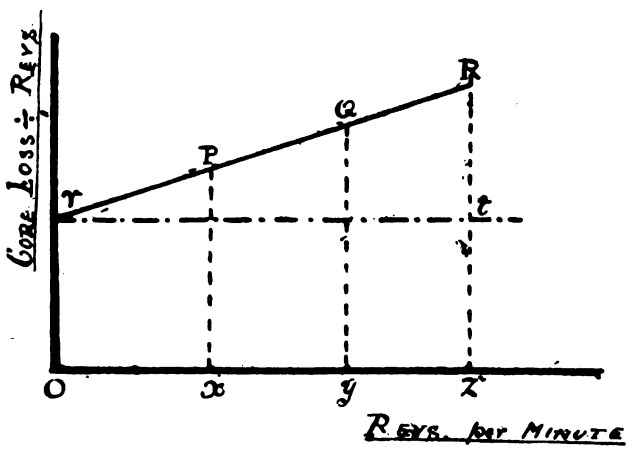


Fig. 2.

The above test is a fairly simple and reliable one, and the only valid objection to it is the fact that the core losses are only measured at *no load*, or practically no load, and it is an ascertained fact that these losses always increase somewhat with the load on account of armature distortion. There is no way of avoiding this difficulty entirely, though, of course, the actual total losses (not separated) at full load may be obtained by a Hopkinson or other similar efficiency test.—Q.

NEW COMPANIES.

The following new companies have been registered:

Whittaker Bros., Limited.—Capital of £75,000. Object: to adopt an agreement with J. H. Whittaker and B. W. F. Whittaker, and to carry on at Dudley, Kidderminster, and elsewhere the business of an electric light and power company (including telegraphy and telephony) in all its branches.

Electric Lighting Boards (British Manufacturing Company), Limited.—Capital of £75 000 in £1 shares. Object: to adopt and carry into effect an agreement made by this company with the Electric Lighting Boards, Limited, etc.

New Century Arc Light Company, Limited.—Capital of £30,000 in £1 shares. Object: to adopt an agreement with W. G. Davis, and to carry on the business of electricians, etc.

Lyndhurst Electric Lighting and Traction Company, Limited.—Capital of £500 in £1 shares (250 founders'). Object: to construct or acquire, equip and work railways and tramways, to supply electricity, etc.

Improved Nut Works, Limited.—Capital of £10,000 in £1 shares. Object: to carry on the business of bolt and nut manufacturers, mechanical and electrical engineers, etc.

Simms Manufacturing, Company, Limited. — Capital of £25,000 in £1 shares. Object: to adopt agreements (1) with F. R. Simms and (2) with Bryan Donkin and Clinch, Limited, and to carry on the business of motor, motor and other carriage builders, electricians, etc.

Isidor Frankenburg and Co., Limited.—Capital of £25,000 in £10 shares. Object: to acquire the business carried on by S. Frankenburg at the Greengate Rubber Works, Greengate, Salford, Lancashire, and to carry on the business of a manufacturer of and dealer in waterproof, rubber, and leather goods and electric cables.

Holden Motor Patents Syndicate, Limited.—Capital of £10 000 in £1 shares. Object: to carry on the business of vehicle builders, electricians, electrical and general engineers, etc.

Crown Electric Heating Syndicate, Limited.—Capital £5,000. Object: to adopt an agreement with A. R. Leask and H. Stewart, and to carry on the businesses of electricians, electrical and general engineers, suppliers of electricity for light, heat, power, etc.

George Scott and Son (London), Limited.—Capital of £15,000 in £1 shares. Object: to acquire the business carried on at 44, Christian-street, London, and 67, Lord-street, Liverpool, as George Scott and Son, to adopt an agreement with F. W. Scott, and to carry on the business of mechanical, electrical, and general engineers, etc.

Workington Iron Ore Company, Limited.—Capital of £125,000 in £1 shares. Object: to adopt and carry into effect an agreement for the acquisition by purchase or otherwise all or any part of the business and property of the Workington Hematite Iron and Steel Company; to develop the resources of land and other rights in any part of the world; to construct railroads, telegraph systems etc.

LEGAL INTELLIGENCE.

O'REILLY v. DUBLIN UNITED TRAMWAYS COMPANY.

This case was called in the Queen's Bench Division No. 1, before the Lord Chief Baron and Mr. Justice Andrews last week, when **Mr. J. F. Murphy**, on behalf of the defendants, moved to have the action remitted to the Recorder of Dublin. The plaintiff, Anne O'Reilly, a vegetable dealer, sought damages for personal injuries caused by the alleged negligence of the defendant's servants.

Mr. Gordon, manager of the tramway company, stated that on Sept. 1 last the plaintiff, who had a donkey and cart, was selling vegetables at the Botanic-road, Glasnevin. The motorman sounded the gong, and the plaintiff turned the donkey's head towards the footpath, with the result that the back of the cart collided with the tramcar. The motorman said that on the return journey he saw the plaintiff engaged at her work.

The Plaintiff denied that the motorman had sounded the gong. After the occurrence she was conveyed to the Mater Hospital. She had to remain in bed for several weeks. An affidavit from the doctor who had examined her stated she had sustained permanent injury, but counsel considered that affidavit vague, as it did not specify how she had received permanent injury.

The Court refused the motion, with costs.

CLAIM BY ELECTRICAL ENGINEERS.

In the Westminster County Court on Wednesday, before his Honour Judge Lumley Smith, Q.C., and a jury, the case of Cunnington *v.* Frazer was tried. It was an action by the plaintiffs, Messrs. Cunnington, a firm of electrical engineers carrying on business at 98, St. Martin's-lane, W.C., to recover the sum of £14. 12s. 9d., in respect of electrical work done and fittings supplied to the order of the defendant in his capacity of proprietor of the German club in Soho.

Mr. Alfred Raven was called, and said he was in the employ of the plaintiff firm, and took the order for the work in question from the defendant. It was duly carried out, and the charges made were very low. The defendant had been applied to for payment on several occasions, but for some reason or other he had not settled the matter.

Mr. F. W. Cunnington said the charges which the firm had made were very reasonable, and he could not understand why the defendant took exception to them.

The defence was that the work was defective, and that one of the electroliers which the plaintiffs fixed up over the billiard table fell down and injured the cloth, and in respect of this a counter-claim was put in for damages.

Mr. Jas. Grant, an electrical engineer, of 63, Queen Victoria-street, said he had been called in by the defendant to examine the plaintiffs' work. He had gone carefully through the whole of the items, and his estimate worked out at £8, including profit.

After hearing the evidence of other witnesses **his Honour** said he was not satisfied that the work was badly done, nor did he think the charges were too high; therefore judgment would be for the plaintiffs on the claim, and also on the counterclaim, with costs.

MRS. LEITCH v. NATIONAL CONDUIT AND CABLE COMPANY, LIMITED.

There was an action set down for jury trial before Lord Kyllach on Wednesday, in which Ann Hay or Leitch, 152, Watt-street, South Side, Glasgow, sued the National Conduit and Cable Company, Limited, for £500 damages for personal injuries sustained on Oct. 14, 1899, by falling over a heap of granite chips lying in Watt-street, and which had been placed there by the defenders. The case has been settled by the defenders paying the pursuer £150 and expenses.

ROBBERY FROM A TELEPHONE WORKS.

At the Halifax Borough Court, Collingwood Haigh, of Garden-street, who was remanded a week ago on the charge of failing to answer a witness summons, was on Friday charged with being implicated along with a man named Burnham in a robbery from

Digitized by Google

the National Telephone Company's premises in Raglan-street on Sept. 11 last. Burnham had already been committed to the sessions for trial along with two other men named Simpson, who were charged with receiving the stolen property.

Mr. J. E. Farrar appeared for the prosecution, and applied for another remand for a week. He was in communication with the Telephone Company, and the case was not yet completed. The accused left the town after the robbery, and had since been wandering about the country.

The Bench granted a remand, but decided to allow the man out on bail in two sureties of £10 each.

COMPANIES' MEETINGS AND REPORTS.

LANCASTER AND DISTRICT TRAMWAYS.

The annual meeting of the Lancaster and District Tramway Company was held at the Corn Market-street Coffee Tavern, Lancaster, on Saturday.

Mr. A. Bell (chairman), who presided, said he agreed it would be to the advantage of the inhabitants of Lancaster, of the Corporation, and of the shareholders of the Tramway Company if the negotiations for the acquisition of the undertaking by the Corporation in connection with their scheme of electric tramways were reopened. If those negotiations were reopened and conducted on a sensible businesslike basis, he had good hopes that they would result in a settlement. He saw no reason why, when they on the one hand were willing to sell, and sell at a reasonable price, and the Corporation on the other hand were willing to buy, and to buy at a reasonable price, they should not come to a satisfactory settlement. They knew as well as he that no settlement could be arrived at by the directors without a full and thorough consultation with themselves.

The balance-sheet was adopted, and Messrs. John Slinger and R. Nicholson were added to the directorate to assist in any negotiations with the Corporation.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The report, to be submitted to the meeting on 10th inst., states that the progress of the operations of the Corporation from unforeseen causes has been considerably delayed, partly on account of the difficulty of finding a suitable site for the plant and buildings contemplated. It is now found that instead of £150,000 producing a plant of 4,500 i.h.p., it will cost the Corporation £135,000 to erect a plant capable of producing 2,400 i.h.p. The Corporation's consulting engineers estimate that the net earnings on this plant will be about 16 per cent. on £200,000. The directors recommend the immediate erection of the plant. A supply of water has been cut amounting to 24,000 gallons per 24 hours, which is considered sufficient for the Corporation's needs. In sinking the well a lode formation was intersected which by assay showed gold. Should good lodes be bisected in cutting the reservoirs, it is the intention of the Board to form a separate syndicate, or company, to develop the mining rights.

KEIGHLEY TRAMWAYS.

At the annual meeting last Friday the **Chairman** stated that the negotiations between the Corporation and the directors of the Company had not proceeded beyond the initial stage, and it was not possible to make any statement. Before anything definite was done the sanction of the shareholders would be required, and a special meeting would be called. However, he had no doubt there would be electric cars in Cavendish-street before very long.

Mr. Herbert Haggas and Alderman B. S. Brigg were re-elected directors, and Mr. J. R. Whitley was re-elected auditor.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

Directors: Hon. Henry Marsham (chairman); Major Leonard Darwin; A. Weston Jarvis, Esq.; Matthew Gray, Esq. (managing director); Abraham Scott, Esq.; S. Wm. Silver, Esq.; Robert Kaye Gray, Esq. (engineer-in-chief).

Report of the directors for the year ending Sept. 30, 1900, to be presented at the thirty-seventh ordinary general meeting of the shareholders, to be held at the Cannon street Hotel, on Thursday, Dec. 13, 1900, at 12 noon:

The accounts show, after provision for doubtful debts, a net profit for the past 12 months of £67,238. 18s. Adding £31,511. 8s. 10d. brought forward, and deducting £12,500 interim dividend paid in June, there remains a disposable balance of £86,250. 6s. 10d. The directors recommend the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in June, a total payment of 10 per cent. for the year, and leaving £48,750. 6s. 10d. to be carried forward. The general business has been fairly profitable, although the price of raw material continued high. The cable steamer "Buccaneer" has been employed on charter to the Western Telegraph Company, and the ss. "Silvertown" laid a cable between New York and Canso (Nova Scotia) for the Commercial Cable Company. Since the closing of the financial year the manufacture and shipment of another cable for the same company has been completed, and the ss. "Silvertown" is now awaiting orders to proceed with the laying between Waterville (Ireland) and Weston-super-Mare. The works at Silvertown and Persan have been maintained in their usual state of high efficiency. The employment of electricity for the transmission of power in the former is being extended. The Board has sent a representative to South Africa with a view of opening an agency there. Major Leonard Darwin and Mr. Robert Kaye Gray, the retiring directors, offer themselves for re-election.

BALANCE-SHEET.

Dr. Capital and Liabilities.	£	s.	d.
Authorised share capital	812,000	0	0
Share capital—amount paid on issue of 50,000 shares of £10 each	500,000	0	0
Mortgage debentures	300,000	0	0
Reserve fund	450,000	0	0
Debts and loan owing by the Company	126,979	13	0
Bills payable	39,175	19	9
Unclaimed dividends	62	10	0
Profit and loss account: Balance at Sept. 30, 1899	56,511 8 10		
Less dividend paid December, 1899	25,000 0 0		
	31,511 8 10		
Profit for the year ending Sept. 30, 1900	67,238 18 0		
	98,750 6 10		
Less interim dividend paid June 1, 1900	12,500 0 0		
	86,250	6	10
Contingent liability—bills receivable discounted £10,264 3 6	£1,502,468	9	7

Cr. Assets and Expenditure.	£	s.	d.
Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery, and steamships	519,963	5	10
Debts owing to the Company	203,540	11	11
Bills receivable	90	5	4
Cash with bankers and in hand	14,837	5	1
Stock in-trade, including 150 miles of cable laid	362,393	18	3
Debentures and shares in other companies	188,311	6	0
Cash, stock, debts, etc., at Persan and agencies, after deducting liabilities	213,311	17	2
	£1,502,468	9	7

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Salaries, commission, rent, rates and taxes, repairs, and general expenses	64,178	13	5
Mortgage debenture interest	12,000	0	0
Bad debts	1,343	2	7
Income tax	1,881	18	1
Depreciation written off buildings and machinery	17,205	17	6
Directors' remuneration	3,915	8	8
Balance—profit for the year	67,238	18	0
	£167,763	18	3

Cr.	£	s.	d.
Gross profit for the year after making provision for doubtful debts	167,763	18	3
	£167,763	18	3

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Kendal.—The Electric Lighting Committee will shortly advertise for tenders for Contracts Nos. 1 and 2.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons and oils for one year. Tenders by Dec. 17. Details in our advertisement columns.

Brighton.—The Council invite tenders for the construction of the permanent way of the tramroads. Tenders by Dec. 18. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply and erection of storage batteries. Tenders by Dec. 22. Details in our advertisement columns.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and erection of electricity mains. Tenders by Dec. 17. Details in our advertisement columns.

Hendon.—The Urban District Council invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by Dec. 31. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for three high-speed triple-expansion steam dynamos, one balancer, and one motor-generator. Tenders by Dec. 24. Details in our advertisement columns.

Harrogate.—The Corporation invite tenders for two high-pressure 30ft. by 8ft. 6in. Lancashire boilers, with fittings complete, and economiser. Tenders by Dec. 25. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for induced-draught plant, steam and electric feed and general service pumps,

Digitized by Google

and water-softening plant. Tenders by Dec. 20. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Swansea.—The Public Library Committee invite tenders for the electric wiring and fitting of public library, schools of science and art, and art gallery. Tenders by Dec. 17. Details in our advertisement columns.

Brighton.—The Council invite tenders for the supply of unarmoured and armoured lead-covered electric cables during the year ended Dec. 31, 1901. Tenders by Dec. 24. Details in our advertisement columns.

Middleton.—The Corporation invite tenders for superheaters economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves, and accessories. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Leigh.—The Electricity and Tramways Committee invite tenders from manufacturers for the supply of 1,000 220-volt incandescent lamps during a period of 12 months. Tenders by Dec. 17. Details in our advertisement columns.

Ilford.—The School Board invite tenders for wiring and all ordinary fittings for about 200 lamps at 16 c.p., the Higher-Grade School, Melbourne-road, Ilford, Essex. Tenders by Dec. 17. Details in our advertisement columns.

Rathmines.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 10, 1901. Details in our advertisement columns.

Glasgow.—The Caledonian Railway Company invite tenders for telegraph and electrical appliances. Specifications, etc., may be obtained from Mr. J. Lorimer, stores superintendent, Charles-street, St. Rollox, Glasgow. Tenders by Dec. 17.

Boxhill.—The Council invite tenders for the supply, delivery, and erection of a water-tube boiler and pipework and one 150-kw. steam dynamo at their electricity supply station. Tenders by Dec. 10. Details in our advertisement columns.

St. Pancras.—The Guardians of the Poor invite tenders for the installation of the Cook's-terrace Infirmary, Pancras-road, N.W., with electric light, according to drawings and specification. Tenders by Dec. 20. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the whole of the work necessary in erection of buildings for new electric light station, Hylton-road. Particulars, etc., may be obtained at the Borough Electrical and Tramway's Engineer's Office, Dunning-street. Tenders by Dec. 10.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and delivery of the following motors and starting switches: one 10-h.p. motor, four 3-h.p. motors, three 2-h.p. motors, and three 1-h.p. motors. Tenders by Dec. 17. Details in our advertisement columns.

Tooting.—The Metropolitan Asylums Board invite tenders for the execution of certain wiring and other works in connection with the proposed electric light installation at the asylum now in course of erection at Tooting Bec. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Aberdeen.—Tenders will be invited shortly for the following plant for the Dee village station: Two surface condensers, with air and circulating pumps, £3,297; boilers, with heating surface of 17,112 square feet, £9 760; fuel economiser of 800 pipes, £1,500; storage battery, £5,120—total, £19,677.

Ayr.—The Tramways Committee invite tenders for Section 2, overhead work: Part 1, poles, centre and side brackets, section boxes, etc.; Part 2, complete overhead electrical equipment; Section 3—underground work: supply of feeders, distributors, telephone cables, conduits, trenching, etc. Tenders by Dec. 14. Details in our advertisement columns.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Alteerig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berenteen, British Vice-Consul, Stavanger.

Winwick (near Warrington, Lancs.)—The Committee of Visitors for the County Asylum invite tenders for (Contract No. 3) wiring, etc., including ring main and feeders, sub-main, lamp circuits, switchboards, distribution boards, fittings, etc. The drawings, etc., can be inspected at Winwick Hall, and also at the offices of the architects, Messrs. Crisp and Oatley and W. S. Skinner, Edinburgh-chambers, Baldwin-street, Bristol. Tenders by Dec. 29.

RESULTS OF TENDERS.

Colchester.—Two coolers, etc., have been ordered, at a cost of £386 each, from Messrs. Klein, Limited.

Gillingham.—The Electric Lighting Committee have arranged with the electric lighting company to supply the nine arc lights in the High-street at a cost of £18 each per annum.

Beetle.—The Committee have accepted the tender of the Electric Construction Company, at £2,263, for a Belliss triple-expansion engine and E.C.C. dynamo. Sixty-five tenders were received.

London County Council.—The Council have accepted the tenders of the Dermatine Company, Limited, for the supply of indiarubber goods; and Messrs. Middleton Bros., for oils and lubricants.

Rhyl.—The tender of Messrs. W. Thornton and Sons, 38 Wellington-road, Toxteth Park, Liverpool, has been accepted at £6,225, for the erection of refuse destructor and electric light station buildings, together with a chimney 120ft. high.

Metropolitan and District Railways.—The Directors of the Metropolitan District Railway and the Metropolitan Railway Companies have received numerous tenders for supplying electricity on the portions of the underground railway selected for this purpose. These were opened on Tuesday, but no decision was arrived at.

Keighley.—The following tenders have been accepted; Chamberlain and Hookham, Birmingham, 140 electricity meters, £551; Lancashire and Cheshire Opalite Tile Company, Limited, Manchester, tiling engine-room walls, £390; Gardner, Sons, and Co., Limited, Bristol, wrought-iron window frames, £80. 2s.; Edmondson Bros., Keighley, plasterers' work, etc., £129. 1s. 10d.

Aberdeen.—The Electric Lighting Committee have accepted the following tenders: Mavor and Coulson, Limited, 47, King-street, Mile End, Glasgow, two 200-kw. direct-coupled continuous-current generators and one 120-kw. balancing set; Johnson-Lundell Electric Traction Company, Limited, 16A, Soho-square, London, W., one 420-kw. direct-coupled continuous-current generator.

Pacific Cable. The Pacific Cable Committee have accepted, on behalf of her Majesty's Government and of the Governments of New South Wales, Victoria, Queensland, New Zealand, and Canada, the tender of the Telegraph Construction and Maintenance Company for the manufacture and laying of the projected Pacific cable. The amount of the tender is £1,795,000, and the work is to be completed by the end of 1902.

Mexborough.—The Council have accepted the following tenders: Tinkers, Limited, Hyde, Lancashire boiler, £532; Mavor and Coulson, Limited, Glasgow, steam dynamos, balancer, booster, feed heater, and pump, £1,786. 14s.; B. Thomas, Manchester, switchboard and connections £355, battery connections 3s. 7d. per yard; Aehmore, Benson, Pease, and Co., Stockton, storage battery, £1,050; Callender's Cable Company, Limited, mains, £5,585; Chatteris Engineering Company, Chatteris, five-ton crane, £127. 10s.

Leeds.—The City Council have accepted the following tenders, amounting to a total of £72,943. 13s., for the extension of the electric lighting station on the Britannia Mills site: P. Rhodes, excavator, mason, and bricklayer, £42,977. 17s.; J. Moulson and Son, carpenters and joiners, £4,000; Phœnix Foundry Company, ironfounders, £17,975; J. Atkinson and Son, slaters, £330; G. Thompson, plumber and glazier, £3,359; T. Cordinglay and Sons, plasterers, £527; A. and S. Wheater, concreters, £3,296; J. W. Walton, painter, £478. 16s.

Cardiff.—The Tramways Committee have received the following tenders for cables for tramway purposes: British Insulated Wire Company, £22,166 (accepted); Callender's Cable Company, £23,614; W. T. Glover, £23,468; Henley's Telegraph Company, £23,628; Johnson and Phillips, £24,007; St. Helens Cable Company, £24,065; Siemens, Limited, £22 656; Telegraph Manufacturing Company £23,702; Union Cable Company, £24,762; Western Electric Company, £22,667. For a tramway crane, Joseph Booth, of Leeds, at £865, was accepted. Bruce Peebles and Co.'s tenders of £1 041 for a motor-generator, and £1,260. 10s. for a Tudor storage battery, have been accepted.

BUSINESS NOTES.

TRACTION.

Southend.—The new tramways were started on Monday.

Birkdale.—The introduction of trams into this district is being urged.

Willesden.—A poll will be taken early in January with reference to the tramways scheme.

Kingston.—It has been decided that the poll on the tramways scheme should take place.

Irthlingborough.—Stoney Stanton granite and Mountsorrel paving setts are to be used for the new tramway route.

Worthing.—The Town Council are considering an electric tramways scheme, estimated to cost from £80,000 to £100,000.

Aberdeen.—It has been decided to at once double a number of lines. We understand that an American contract for rails has been accepted.

Birkenhead.—Mr. Arthur R. Fearnley, manager of the Bradford Tramways Company, has been appointed tramway manager at a salary of £300 a year.

Wandsworth.—From the last proceedings of the Council it appears that the London County Council's Tramway Bill will meet with considerable opposition.

West Ham.—The Town Council have now definitely resolved that granite pitching be used on all the lines of tramways, subject to the resolution already passed as to wood paving in front of buildings used for public meetings.

Digitized by Google

West Bromwich.—It is believed that the South Staffordshire Tramway Company are now prepared to negotiate with the Corporation as to the sale of their lines.

Beetle.—Colonel Trotter inspected the Derby-road and Rimrose-road tramway last week and approved same. This route consists of 1½ miles of double track, with span wire.

Gravesend.—The promoters of the local tramways have decided to register a company and to obtain final understanding whether or not the Corporation would furnish the current.

Manchester.—With regard to the change in tramways from horse to electric traction now in progress, we learn that the new permanent way is being laid at the rate of a mile per week.

King's Norton.—A meeting of ratepayers have agreed that consent should be given to promote a Bill enabling the Council to construct tramways within the urban district and any adjoining districts.

Leamington.—It is reported that difficulties have arisen between the Leamington Corporation and the tramway company with regard to the agreement to equip the present tramways on the overhead electric trolley system.

Torquay.—The Electric Lighting Committee have appointed Messrs. Kerswill, Ball, Beavis, Taylor, R. Smerdon, Bowden, and Person to consider the electric tram question. Refuse destructor complaints have been received.

Wortley.—The Tramways Committee of the Leeds Corporation have decided to proceed with the work of laying the lines for electric traction as soon as possible, the new line forming a junction with the existing line at the Crown Inn.

Levenshulme.—The District Council are calling the attention of the Manchester Corporation to the Council's request to be informed of the negotiations which had taken place in regard to the purchase of the tramway lines in the district.

Stoke-on-Trent.—The notice of the Potteries Electric Traction Company of application to the Light Railway Commissioners for an order authorising the construction and working of light railways in the borough has been referred to a committee.

Halifax.—It is proposed to rescind a former decision of the Council to amalgamate the duties of the Electricity and Tramways Committees, and instead thereof to amalgamate the duties of the Electricity and Gasworks Committees as heretofore.

Darwen.—The Town Council have advanced the salary of the electrical engineer by £50 per year, and also granted him an honorarium of £50 for services rendered in connection with the conversion of the tramways from steam to electric traction.

Barrow.—The Board of Trade have sanctioned the use of steam power on the tramways till February only. It is proposed to substitute electric traction, but the terms between the Corporation and the British Electric Traction Company have not yet been agreed upon.

Nottingham.—It is now stated that everything in connection with the new tramways system has been completed except the cars. The bodies of the cars are in the shed, but the equipment is not complete. As soon as the cars have been completed they will be set running.

Dover.—The petition by drivers and conductors for increases of pay, reduced hours, annual holiday, superannuation fund, and other matters has been settled by the acceptance of a report by the general manager recommending that there be no addition to present cost of staff.

Cumberland.—We notice that an extensive scheme of electric tramway and tramroad on the west coast of Cumberland, extending over 30 miles, has been deposited in Parliament. Messrs. Bennett and Ward Thomas, of Manchester, and Mr. A. M. Fowler, M.I.C.E., of Westminster, are the engineers.

Bristol.—The extension of the electrical system of the Bristol Tramways Company is now practically completed. No date has yet been fixed for the inspection of the permanent way by the Board of Trade official but the inspection of the power station and the various electrical appliances has been made.

Cycle and Motorcar Exhibition.—In consequence of the great success of the National Cycle and Motorcar Exhibition at the Crystal Palace, recently completed, we understand that the directors of the show have already arranged with the directors of the Palace to hold their tenth annual exhibition in November, 1901.

Dundee.—The provisional order for tramway extension and street improvements, application for which is about to be made by the Town Council to the Secretary for Scotland, is noteworthy, inasmuch as it is, if not the first, one of the first of such applications that have been made in terms of the Private Legislation Procedure (Scotland) Act, 1899.

Walker.—The District Council will not discuss the question of the proposed new electric tram service until next month, as they are at present negotiating with the Newcastle Corporation upon a similar subject. The promoters of the scheme propose to institute two quick services of electric trams, one running along the high road and the other by the riverside to Shields.

Blackburn.—The new electric cars purchased by the Corporation continue to arrive at the depôt in Simmons-street During the week several of the new cars have been on the Darwen and Blackburn tram routes, and the journeys have been successful. Ere long the Blackburn public will have the whole of the cars at their service, and a thorough system will be in operation.

North Wirral.—One outcome of the complaints made by the Hoylake and West Kirby District Council recently about the railway service to and from Liverpool, and the assertions of several councillors that any opposition would receive large support, has been the projection of a scheme for connecting the Deeside district with Seacombe and Birkenhead by a system of electric tramways.

Water Power at Snowdon.—A scheme has been deposited in Parliament for utilising the water power near the foot of Snowdon to work an electric light railway to Port Madoc to open out the mineral district, and also to facilitate the excursionists and pleasure seekers in the season. Messrs. Bennett and Ward Thomas, of Manchester, and Mr. A. M. Fowler, M.I.C.E., of Westminster, are responsible for the work.

Darlington.—With regard to the Town Council's wish to purchase the present tramways in certain contingencies, and lay down an electric system, the General Purposes Committee now recommend that professional advice be called in to ascertain the approximate value of the present tramways, which are owned by the Imperial Tramways Company, and also to report on the cost of constructing electric tramways and the probable receipts from the same.

Hampstead, Euston, and Charing Cross Railway.—The proposed extension of this electric railway to Hendon and Finchley by tunnelling under a portion of Hampstead Heath is likely to meet with great opposition at Hampstead. The railway is not objected to *per se* but the threatened interference with Hampstead Heath is, especially as there seems to be no reason why the line should not go under the public roadways instead of under the Heath.

Burnley.—Representatives of the Padiham Urban District Council are about to confer with the Corporation Tramways Committee respecting the reconstruction of the tramway in the Padiham district. The Standing Sub-Committee were authorised to meet the Padiham representatives. The borough surveyor is about to advertise for tenders for electric cars, and the Electricity Committee will now take steps to enable them to supply electrical energy for the tramways.

Wigan.—A conference will be held to-day between representatives of the Ince and Hindley Urban District Councils and the Corporation to discuss the question of the purchase by them from the Corporation of so much of the tramways as are situate in their respective districts. The following have been appointed as engineers-in-charge on the terms of a recent advertisement: Messrs. S. Lees, Bradford; W. Abraham, London; H. Lamb, Preston; and A. Granger, Morecambe.

Chester-le-Street.—The Highway Committee of the District Council have recommended that consent be given to an application by the United Kingdom Tramway and Light Railway Electrical Syndicate, Limited, for the consent and support of the committee for the promotion of a provisional order under the Tramways Act, 1870, for the construction of tramways on the overhead electric trolley system from Penshaw Bridge through Washington and New Washington, along the Washington New-road, being a continuation of the Easington, Houghton, and Sunderland scheme.

Chester.—The Town Council have passed the requisite statutory resolution as to tramways as follows: "That application be made to Parliament in the ensuing session for a Bill to confer powers on the Corporation of Chester to reconstruct the existing tramways in the city of Chester, to construct additional tramways in and adjacent to the city, to work tramways, and for other purposes, and that the costs and expenses attending the promotion of such Bill be charged on the borough fund." A meeting of ratepayers on the 4th inst. approved of the promotion of the proposed Bill.

Liverpool.—The new regulations of the Liverpool Tramways Committee with respect to penny stages came into operation on Saturday, and, generally speaking, afforded considerable satisfaction to the travelling public, although in several districts grumbling is yet heard as to the inequality of the intermediate stages. It is expected that on Sunday next the extension to Seaforth will be available for traffic, and by another week Mr. Bellamy, the manager, hopes to have the belt line encircling the whole city open for the car service, so that then the entire system will be practically completed.

Lowestoft.—The Corporation have passed a resolution to promote their Tramways Bill, which includes the confirmation of any agreement made with the National Electric Traction Company, Limited, with reference to the leasing of the proposed tramways, also power to make further provision in regard to the tramway undertaking, and to enact provisions incidental to the funds; and further provision in regard to the electric lighting undertaking of the Corporation, and, amongst other things, to empower them to supply electricity in bulk beyond the borough, and to supply electrical fittings.

Warrington.—The British Electric Traction Company, Limited, have submitted to the Tramways Committee proposals for leasing the Warrington tramways, the consideration of which has been postponed. A proposal having been made by the promoters of the Warrington and Northwich light railway that the Corporation should join in the application for the order, the Corporation have resolved that it was inadvisable for them to join in the proposed application for the light railway order; and that in order to preserve the entire control of the tramways within the borough, no running powers over them be granted to any company.

Newcastle.—The Tramways Committee have just made an official inspection of the work in progress. The committee determined that the work in the heart of the city should be stopped during the winter months until spring-time, immediately after the junction at the foot of Northumberland-street and in Grainger-street was completed. The contractor, however, was authorised

Digitized by Google

to go on with the work in outlying districts in the meantime. Much satisfaction was expressed at the work done by the contractor as to material and workmanship, and more particularly were the committee pleased with the sections by the Town Moor and around St. George's Church and Osborne-road.

Gosport.—The District Council and the Provincial Tramways Company have come to a sort of deadlock. In accordance with a recent resolution of the District Council, Mr. Palmer, the clerk, attended at the London office of the company, and tendered the notice that the Council meant to take possession of the tramways under the Act of 1870. The secretary, however, declined to accept the notice as valid, upon the ground that the meeting at which the Council's decision was arrived at had not been called in accordance with the terms of the Act. A long and costly litigation is now threatened, and the points in dispute being questions of law, the case may be carried to the Court of Appeal and the House of Lords.

Southport.—Another section in the tramway system of the Corporation has been opened for use, this being the line from the markets to Ash-street, thus completing what is called the inner circle, a distance of nearly three miles, for which the fare is one penny. A 12 minutes' service will be run each way, with supplementary cars to the infirmary and Kew Gardens when that section is completed. Preliminary arrangements are in progress for the construction of an electric line of railway, which is to be laid on a plateau near the edge of the line of sandhills, thus connecting Formby-by-the-Sea with Birkdale and Southport. A new motor engine is being put down at the electricity works at Blowick to complete the three which were originally ordered for motive purposes. It is expected to be ready for working at Christmas.

Bournemouth.—Mr. Peers, in his report on the lighting of the workhouse, pointed out that the supply could be provided by an engine and dynamo of 13 b.h.p. or 14 b.h.p., but the engines and dynamos in his scheme were of 27 b.h.p. One of these engines and dynamos would form a spare set in case of a breakdown. As, however, he understood the Guardians contemplated extending their laundry, he would recommend them to fix a boiler, say 18ft. long by 5ft. 6in. in diameter, instead of the smaller 10ft. boiler in his schemes. Such a boiler would give ample margin for the laundry requirements, and would only add £70 or £80 to his estimate; but if the larger boiler were adopted it would be necessary to rebuild the existing chimney stack, and make it 60ft. or 70ft. high. The report is to be discussed at the next meeting of the Guardians.

Little Lever.—The District Council have approved the minutes of committees stating that a letter had been sent to the Farnworth and Radcliffe Urban District Councils asking whether those authorities would agree to certain terms as to the leasing of the lines and the payments in respect thereto in the event of the Little Lever Council obtaining a provisional order enabling them to construct a line in their own district connecting the systems of the Farnworth and Radcliffe Councils. Deputations from those authorities attended the meeting and made counter proposals, which were left over for consideration by the General Purposes Committee of the Little Lever Council. In answer to an application by the Lancashire Electric Power Company, the committee expressed their willingness to grant an easement at a rental of 5s. per annum, subject to the company bearing the costs of an agreement for protecting the Council's interests for the laying of a water-main along Hall lane and Tong road.

Wimbledon.—At a meeting of the Urban District Council last week the Tramways Committee presented a report dealing with the scheme for the construction of two miles of local tramways, which the Council at their last meeting decided to include in their Improvement Bill. The report referred to the fact that the principle of the scheme had received the sanction of the London County Council, the Croydon Rural District Council, and the Mitcham and Merton local authorities, and a letter was read from Mr. J. Clifton Robinson, managing director of the London United Tramways, Limited, asking to be allowed to compete for the leasing of the lines when powers had been obtained. The sum of £32 000 was given as the estimate for the cost of the lines in the event of their being constructed by the Council and afterwards leased to a company, and £57,000 in the event of the Council deciding to construct and work the lines themselves. Another £20,000 would be required for street widenings. A motion to proceed with the scheme was rejected by one vote.

Walsall.—At the meeting of the Town Council on Monday next the General Purposes Committee will recommend that the common seal of the Council be affixed to the conveyance from the South Staffordshire Tramways Company to the Corporation of the tramways undertaking in the borough, and to an assignment of the Birchills tramways depôt; also to a lease of the tramway lines to the South Staffordshire Tramways (Lessee) Company, Limited, in accordance with the terms of the agreement with the company and the provisions of the Walsall Corporation Act. The same committee will recommend that the duty of repairing and maintaining the tramways be added to the borough surveyor's department, and that the necessary plant and material be purchased, at an estimated cost of £1,000; also that the following tramways be laid down and equipped by the Council: along Lichfield-road to Walsall Wood; in High-street and Stafford-road, Bloxwich, as far as Little Bloxwich-lane; along Bridge-street, Ablewell street, and Birmingham-road for a length of one mile from Lichfield-street; from Park-street along Wolverhampton-street and Wolverhampton-road as far as Willenhall. It is proposed that the borough surveyor and electrical engineer prepare the necessary specifications, estimates of cost, etc.

Middlesbrough.—At a meeting of the Streets Committee of the Corporation on Friday, a report was read from Lieut.-Colonel Von Donop, R.E., who was appointed by the Board of Trade to inspect the uncompleted portions of the tramways. It stated that with regard to the uncompleted Zetland-road section, and the end of the Linthorpe line, he was of opinion that the inconvenience caused the public was not sufficient to justify the Board of Trade in pressing the company to carry them out. With reference to the Zetland-road section however, this decision only applies to the existing state of affairs; if the projected extensions beyond Nos. 5 and 6 tramways are carried out, the question of the completion of the Zetland road section should then be reconsidered. It was stated that Sir Courtenay Boyle had ordered the Tramway Committee to proceed with the line from the ferry to the exchange, and said that if it were not done the consequence would be serious. Sir Courtenay intimated that the company must at once prepare the line from the ferry, and that they would be given another six months to complete it. A long discussion arose, during which it was urged that the Corporation should insist upon the penalty per day for the non-completion of the lines. Ultimately it was left with the committee to draw up a letter to the Board of Trade.

New Issue.—The South Lancashire Electric Traction and Power Company, Limited, which has been formed with a share capital of £850 000, divided into £600,000 in 6 per cent. cumulative preference and £250,000 in ordinary shares of £1 each, together with £750,000 in 4½ per cent. first mortgage debenture stock, are now making an issue of the whole of the debenture stock and £400,000 of the preference shares at par. The company propose to acquire and develop as parts of a single system the concessions and rights obtained by the South Lancashire Tramways Company and the Lancashire Light Railways Company, taking over the whole of the issued shares in both undertakings and thus obtaining exclusive control. Thus a complete system of electric traction in South Lancashire will be rendered possible, with cars running at frequent intervals between Liverpool and Manchester through Prescot, St. Helens, Newton, Earlestown, Leigh, and Eccles, and with branch connections from the main line to Wigan, Bolton, and other important centres. The purchase price has been fixed at £350,000, payable as to £50,000 in cash, £50,000 in preference shares, and the balance in ordinary shares. The South Lancashire Tramways Company was formed by the South Lancashire Tramways Act, 1900, which authorised the construction of electric tramways between St. Helens and the Manchester district by two main trunk lines, one from Haydock, passing through Ashton-in-Makerfield, Abram, Hindley, Westhoughton, Little Hulton, and Walkden, to Swindon, where it meets the tramways leased to the Salford Corporation; and the other from St. Helens, through Earlestown, Newton-in-Makerfield, Lowton, Leigh, Atherton, Tyldesley, Boothstown, and Worsley, to the boundary of the borough of Eccles, where it also meets the tramways leased to the Corporation of Salford; branch lines also connect Lowton with Golborne and Abram, Hindley with Atherton and Tyldesley, Worsley with Swinton, and the borough of Bolton with both Westhoughton and Atherton. Powers will be sought next session for the Liverpool and Prescot light railway extensions. Order was granted in 1898 to the Lancashire Light Railway Company, Limited, the whole of whose shares will be held by this company. The line, nearly 3½ miles in length, will commence at the end of the St. Helens tramway system at Prescot and terminate at the city boundary of Liverpool at Knotty Ash, to which point it is expected that the Liverpool Corporation's electric tramways will shortly be completed. The application had the support of all the local authorities of the districts through which it passes, but its special importance lies in the fact that it must form the connecting link between the two tramway systems of Liverpool and St. Helens, and through the latter with the South Lancashire systems to Manchester and district. Although granted under the Light Railway Act, it is for all practical purposes a tramway, and its construction will be the same as that of the South Lancashire tramways. The St. Helens tramways, which are leased to the New St. Helens and District Tramways Company, Limited, lie between the Liverpool and Prescot light railway and the South Lancashire tramways, and connect the two. A continuous route will thus be available from the tramway system of Liverpool to that of Manchester, and to the whole of the places served by and in connection with the South Lancashire Tramway Company's system. The St. Helens Company has undertaken to grant facilities for an interchange of traffic Every class of goods will be carried on the tramways and light railway. The South Lancashire Tramways Company is empowered by its Act to supply electric energy to local authorities for all purposes, and arrangements will be made accordingly.

LIGHTING AND GENERAL.

Croydon.—Application is to be made for a loan of £5,000 for free wiring.

Newcastle.—The better lighting of Grey-street is being considered by the Town Council.

Hull.—The new street between Monument Bridge and Prospect-street is to be lighted by electricity.

Warrington.—Mr. William H. Grimsdale has been appointed electrical engineer to the Corporation.

Grimsby.—The question of the Corporation taking over the telephone system has been postponed for a time at least.

Aberystwyth.—Mr. Preece is being consulted with reference to the proposed new agreement with the electric lighting company.

Digitized by Google

Criccieth.—The report of the Electric Lighting Committee on electric lighting is being discussed in committee by the Council.

Saltburn.—The electric lighting company have declined the Urban District Council's offer of £8,000 for the purchase of their plant.

Edinburgh.—The advisableness of extending the electric light along Albert-street from Easter road to Leith-walk is being considered.

Commercial Cable Co.—The directors have declared a quarterly dividend of 1¾ per cent. and a bonus of 1 per cent. on the capital stock, payable 2nd prox.

Cardiff.—Owing to the appointment of Mr. Appelbee to Ashton, the Council are reopening the question of combining the lighting and tramway departments.

Hanley.—Sanction has been received for the borrowing of £5,000 for electric lighting purposes and £9,500 for the erection of a refuse destructor at Sandyfield.

Helensburgh.—The proposal to obtain a provisional order for the introduction of electric lighting into the burgh has been abandoned by the Commissioners.

Ilkley.—A deputation of the District Council is to confer with Mr. Gibbings and others who are applying for a provisional order to light the district with electricity.

St. Helens Cable Co.—The Company having declared a dividend of 6 per cent. on their share capital, now notify that the transfer books will be closed until the 10th inst.

Wrexham.—Mr. Sillery, the newly-appointed electrical engineer, will commence duties on Jan. 1. The Town Council have obtained a loan of £5,000 for electric lighting.

Pemberton.—We note that the Urban District Council are inviting offers of a loan of £20,000 on the security of the general district rate and the electric lighting undertaking.

Doncaster.—The Town Council's electricity works are making very satisfactory progress. The committee have applications for 8,300 lamps, and the price is to be only 5d. per unit.

Bournemouth.—The County Borough Council are about to consult an expert with regard to the application of the Bournemouth and Poole Electricity Supply Company, Limited.

East Ham.—Lieut.-Colonel A. C. Smith has held an enquiry into the application of the Urban District Council for sanction to the borrowing of £2,640 for purposes of electric lighting.

Bedford.—The mains for private lighting are to be extended along Goldington-avenue, Kempston-road, Woburn-road, The Avenue, Ampthill-road, and Victoria-road at an estimated cost of £1,150.

Burnley.—The Rural District Council have decided to receive a deputation from the Reedley Hallows Parish Council with regard to obtaining a provisional order to forward electric lighting powers at Reedley, east of the canal.

Derby.—The Electric Lighting Committee have ordered plans and specifications of a new chimney, etc., at the electric light station, to be prepared by Mr. A. Eaton, architect, who was employed as architect for the recent extensions.

Water-Softening Plant.—We note that an order for the "Archbutt-Deeley" water-softening plant has been placed with Messrs Mather and Platt, Limited, by the Electrical Power Distribution Company for their works at Sutton.

Stock Exchange Settlements.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the London United Tramways, Limited, 4 per cent. first mortgage debenture stock.

Worthing.—It appears that over 100 applications were received for the post of resident engineer of the new Worthing Corporation electric lighting works. Mr. G. Porter, of the Westminster Electric Supply Corporation, has been recommended by the Town Council for the appointment.

Fife.—At a recent meeting of the Fife or Turriff Committee applications by the National Telephone Company for permission to erect poles were granted, subject to the provision that the poles could only be erected within the burgh of Turriff with the approval of the Commissioners.

Colchester.—The Town Council have fixed the price of current at 2½d. per unit for motor purposes. A report from Mr. Sillar, the electrical engineer, recommending various alterations of and additions to the plant has been adopted, and application is to be made for a loan of £12,000.

Wombwell.—A letter from the South Yorkshire Electric Lighting Company giving notice of intention to apply for power to erect an electric lighting plant at Wombwell, and to supply the district with electricity, is being considered by the Gas Committee of the Urban District Council.

Keighley.—The Town Council have appointed a deputation to wait upon the management of the National Telephone Company at Bradford for the purpose of urging upon the company the desirability of a modification of the charges in connection with their telephone system in this borough and district.

Sheffield.—It appears that on Friday quite a succession of faults occurred in the cables in the neighbourhood of Broomhill and Glossop road, and customers were for three, four, or five hours plunged in darkness. Gangs of men were out all Saturday night, and again on Sunday, and nearly all the customers were reconnected.

Eastbourne.—The Chamber of Commerce have passed a resolution in favour of the establishment of a municipal telephone exchange for the borough. Plans for the new electric light station have been approved, and the borough engineer has been instructed to prepare the specification and bill of quantities and invite tenders for the same.

St. Pancras.—The Electrical Engineer reported at the meeting last week that by Christmas he anticipated they would have reached the maximum load they could deal with through the existing mains, and he produced a scheme for increasing the capacity of the feeders and extensions at an estimated cost of £29,390. The matter was referred to the Finance Committee.

Inverness.—At a recent meeting of the Town Council, it was agreed to settle the account of Mr. Craven, Edinburgh, the engineer for the abandoned electric lighting scheme, by a payment of 2½ per cent. on £27,000, the estimated cost of the scheme. Letters from two private companies offering to purchase the right of providing electric light for the town were remitted to a special committee.

St. Marylebone.—At a meeting of the Council last night a letter was read from the Metropolitan Electric Supply Company calling the Council's attention to the arrangement made with the Vestry in 1896 for the experimental lighting by electricity of the upper part of Regent-street, and stating that they are prepared to enter into an agreement for an adequate scheme of public lighting in the borough.

York Minster.—The electric light installation for the choir and lady chapel of York Minster has now been completed, and was used for the first time last Sunday. There are 170 lights, extending in rows along the whole length of the choir and lady chapel, and clusters of lamps are suspended from the triforium; the latter are 32 c.p. each. The south choir transept is also lighted by electricity, and the crypt will shortly be wired.

Aberdeen.—On Wednesday Councillor Kemp, convener of the Gas and Electric Lighting Committee of Aberdeen Town Council, attended at the Corporation electric station and formally turned steam on to the new 420-kw. Westinghouse generator, with Willans engine. The new generator, which is the largest installation that has yet been placed in the works at Aberdeen, is of 700 h.p., and has a capacity for lighting 20,000 lamps.

Appointments Vacant.—The Corporation of Lancaster invite applications for the appointment of an electrical engineer.—The Corporation of Grimsby invite applications for the post of assistant engineer in their electricity department.—A mains superintendent and a cable jointer are required by the City of York.—The Corporation of Perth require a resident electrical engineer. Particulars of these vacancies appear in our advertisement columns.

Cardiff.—Mr. Arthur Ellis, of Newcastle, whose appointment we announced some time ago as an electrical engineer and tramway manager, has now been elected by the joint committee of the Electric Lighting and New Tramways Committee sole engineer to the Electrical Committee, as well as electrical manager of the New Tramways Committee of the Corporation of Cardiff, at a salary of £750 per annum, to be increased £50 annually for five years.

Smoke Nuisance.—The Lambeth Council are again prosecuting the South London Electric Light Company for alleged smoke nuisance. As far as we can gather, there appears to be a decided conflict between the evidence of the Council's inspector and that adduced on behalf of the company. The case being still *sub judice*, we, of course, refrain from making any comments, and reserve ourselves to do so after the adjourned hearing on Wednesday next.

Share Market.—On Friday last electrics did not move, and very little was done except in debentures of all sorts. Tractions kept steady. Shares were steady on Saturday without change, and debentures were all in strong demand at the beginning of the week. Shares were unchanged, but fairly active. The feature in tractions was the demand for all Belgrano issues on the good traffics of late. Prices seemed inclined to harden on the following day, but there was little doing, and no particular changes have taken place since.

Monmouthshire.—At the adjourned conference of delegates of councils of the Monmouthshire Western Valleys, held at Abercarn on Monday, to consider the electric lighting scheme only Abercarn and Risca were represented. Letters were read stating that the Abertillery Council had decided not to share in the expense of an expert, and that Nantyglo and Blaina Council would take no action in the matter. It was agreed to recommend the Abercarn and Risca Councils to obtain expert evidence upon the desirability of providing a joint electrical installation.

Stoke-on-Trent.—Plans of the proposed new laundry and boiler-house at the workhouse have been approved. A loan of £14,900 had been applied for in respect of the erection of these buildings and of the proposed electric lighting installation. The Local Government Board, however, considered that of the sum in question £5,000 only might properly be repaid in 30 years, and that the remaining £9,900 should be repaid in a period not exceeding 15 years. It has now been decided to urge the Local Government Board to authorise the borrowing of the £9,900 for a period of 20 years.

Proposed New Bills.—The following is the concluded list of notices of intention to apply for Bills that have appeared in the *London Gazette*: Electric tramways and railways: Glossop (U.D.C.), Colchester (Corporation), Northampton (Corporation), Ashton-under-Lyne (Corporation), Denton (U.D.C.). Electric lighting: Lewisham and Penge (company), New Hunstanton (U.D.C.), Aspull (U.D.C.), Ashton-in-Makerfield (U.D.C.), Mountain Ash (U.D.C.), Briton Ferry (U.D.C.), Skipton (U.D.C.), Birstall (U.D.C.), Chesham (U.D.C.), Macclesfield (Corporation), Stratford-on-Avon (Corporation).

Digitized by Google

Selby.—The new workhouse was formally opened on Dec. 4. If it had not been for some delay in the electrical works the building could have been opened two months ago. The electric light is now completed, and the whole place is well lighted, the station is duplicated, and the accumulators are sufficient to avoid all chance of a breakdown.

At Last!—The Common Council have finally been moved to do a little to mitigate the nuisance caused by the uprooting of the London streets in order to lay telephone and telegraph wires. They have now decided that in future all work entailing interference with the public ways of the City should be carried on continuously day and night.

Harrow.—At the meeting of the Urban District Council last week the point of making good paths broken up by the electric light company was raised. The Chairman read a letter from the company, stating that they were willing to come to some arrangement as to reinstating the footpaths. It was agreed to refer the matter to the Surveyor's Committee.

Barry.—In addition to making application to Parliament for a provisional order of the Board of Trade for the establishment of electric lighting plant and supply in the town, the Barry Urban District Council are negotiating for the purchase of the railway siding at the rear of Thompson-street, Barry Dock, which they desire to utilise for the purposes of the electric station.

Sligo.—The Town Council appear to be favourably impressed with Mr. Enwright's proposal to apply to the Board of Trade for a provisional order for the public and private lighting by electricity of the town of Sligo. Mr. Enwright's intention is, with the consent of the Corporation, to get a company to carry out the work, and to make it a condition that the price should not exceed 6d. per unit for private lighting, and 4½d. for public lighting.

Sunbury.—At the last meeting of the District Council a letter was read from Edmundson's Electricity Corporation, whose application for a provisional order to supply electric light in the district the Council had decided to oppose, stating that as they had been unable to obtain the consent of other district councils in the neighbourhood they did not intend to proceed with their application for electric lighting powers this session. In the meantime they proposed to take steps for the construction of electric lighting works at Twickenham.

Hampstead.—The Borough Council have confirmed a resolution passed by the late Vestry to charge the electric lighting account with the sum of £12,500 in respect of the use of the whole of the existing stoneyard for the purposes of that department, and to appropriate such amount towards the cost of providing a new stoneyard. Statutory notices are to be given to the Hampstead Electric Supply Company, Limited, and the Electric Laundry Company, Limited, in respect of alleged infringements of the requirements of the Public Health (London) Act, 1891, as to smoke consumption.

Ilford.—The charge for all current supplied for motive power or heating purposes, through a separate meter, has been fixed at 8d. per unit for one hour's use per diem of the maximum demand, with a charge of 1d. per unit for all units used in excess of that number. The price of electrical energy supplied to places of worship is to be at the uniform rate of 5d. per unit, and the following charges will be made for the hire of meters, including the maximum demand indicator: 1s. per quarter up to 15 lights, 16 c.p.; 1s. 6d. 25 lights, 16 c.p; 2s. 50 lights, 16 c.p.; 2s. 6d. all above, or the equivalent.

Eccles.—Sanction has now been obtained to a loan of £5,306 to cover overspent capital on the electric lighting scheme. The borough electrical engineer is about to prepare a scheme for the extension of the electric light undertaking, with the view of the supply of electrical current for tramway purposes and the supply of the whole of the lamps in the borough. The Council will also apply for sanction to the borrowing of £515 for the provision and laying of additional cable for electric lighting purposes. The electrical engineer has been authorised to obtain the necessary gear for adjusting the speed of the engines, at a cost of £20 each engine.

Kensington.—The Guardians some time ago appointed a special committee to consider whether the workhouse, infirmary, and other premises should be lighted by electricity, and, if so, whether current should be taken from the public supply mains or generated at home. Acting on expert advice obtained from Prof. Robinson, the committee recommended a self-contained installation estimated to cost £12,500. This recommendation came up for discussion at the last meeting of the Guardians, but it was decided that the first thing to do was to supply each member with a copy of the professor's report. The committee's recommendation was accordingly postponed to allow time for the report to be circulated.

Dudley.—We understand that the business of Messrs. Whittaker Bros. has been transformed into a limited liability company under the style of Whittaker Bros., Limited This firm has obtained the contract from the Corporation for free wiring and fitting premises of the Corporation's customers. Free wiring must be giving the scheme great impetus seeing that Whittaker Bros., Limited, have fixed or are fixing about 10,000 lamps in shops, works, offices, residences, churches, and theatres, including the municipal buildings and the free library and science and art schools at Dudley and Kidderminster. They have also wired the new Temperance Institute, Mr. E. C. Theedam supplying the fittings.

Forthcoming Exhibition.—The Managing Committee of the International Exhibition of Fire-Extinguishing and Life-Saving Apparatus, to be held in Berlin during 1900, are able to publish a very satisfactory preliminary report, from which it appears a large number of home and foreign firms have already promised to contribute exhibits. The principal railway companies concerned are also giving their support by undertaking to return, carriage free, all exhibits which may remain unsold, while the Norddeutsche-Lloyd and the Hamburg-American lines, besides many other large steamship companies, offer to carry exhibits both to and from the exhibition free of charge. Further information may be obtained on application to the committee's offices, 41, Lindenstrasse, Berlin, S.W.

Russia. — The *Financial News* correspondent wires from St. Petersburg: "The results of the public tenders invited for the taking over of the telephone services in the cities of St. Petersburg, Moscow, Warsaw, Odessa, and Riga, where the concession of the Bell Company is shortly to expire, have just been made public, but are still awaiting the sanction of the Minister of the Interior. In St. Petersburg the municipality scored with an offer to fix the annual subscribers' fee at 55 roubles; at Moscow, the Swedish-Russian Telephone Company, with a subscription fee of 79 roubles; and at Warsaw another Swedish concern (the Sverddergren Company), with 69 roubles. At Odessa a Mr. Raffalovitsch proposed a price of 48 roubles, and at Riga the lowest tender was 57 roubles, offered by Messrs. Rukkert and Co."

Transvaal.—We have been favoured with a copy of the following proclamation which has just appeared in the *Johannesburg Gazette*: "V.R.—Imperial Government Municipality—Municipal Notice—Town Engineer's Department—Notice to Architects, Contractors, and others.—Notice is hereby given that the town engineer (Mr. Chas. Aburrow, M.I.C.E.) has returned to his duties, and can be seen by the public at office No. 14 of the Imperial Government Municipality, *Standard and Diggers' News* Buildings. The laws relating to buildings, etc., of the late Town Council remain in force, and special attention is hereby drawn to hoardings, fences, etc., on and adjoining public streets, which must be maintained in good order in accordance with the regulations.—W. A. J. O'Meara (Major), acting burgomaster, Johannesburg, Nov. 5, 1900."

Durham Power Scheme.—At the last meeting of the Tees Conservancy it was mentioned that an application was intended to be made in the ensuing session of Parliament for leave to bring in a Bill by the company to be known as the Cleveland and Durham Counties Electric Power Company. Amongst various purposes the company seek power to acquire compulsorily or by agreement easements or rights in or under the bed, foreshore, and channel of the River Tees, and also power to lay down and maintain under the bed, foreshore, and channel of the river electric cables. It is also intended to acquire a parcel of reclaimed land at Haverton Hill. The company is being incorporated for the purpose of establishing and carrying on electric works and for generating, producing, and supplying electric energy. The matter was referred to the Parliamentary Committee of the Conservancy.

Stepney.—At the last meeting of the Borough Council, a report by the Local Committee for Whitechapel was agreed to, which recommended that all the electric lamps in the Whitechapel area be kept alight all night for the advantage of the public; that a representation be made by the metropolitan borough of Stepney to the London County Council for the loan of £20,000 for Whitechapel electric lighting purposes, such loan having already been applied for from the London County Council by the late White chapel District Board of Works upon terms agreed upon, and such having already been taken by the London County Council with the view of making such allowance; that authority be given to the Whitechapel Electric Lighting Committee to expend by resolution for any one purpose a sum not exceeding £50; that authority be given to the Whitechapel General Purposes Committee to expend by resolution for any one purpose a sum not exceeding £50.

Swansea.—The electric lighting works are almost completed and ready for a start. Some time ago it was agreed to allow the wiring to be done by the National Free Wiring Company. The agreement was, however, a short time ago withdrawn, and at last week's meeting of the Electric Lighting Committee the Chairman advised that a new contract be entered into with the company. The company had asked 1s. 4d. per lamp per annum, while the Corporation held out for 1s., and as the company were now willing to accept the Corporation's offer he thought, in the interests of the station as well as of the possible consumers who could not afford or did not care to find the initial outlay, it was desirable that the agreement should be carried out. During the discussion it was pointed out that the company would be the landlords in perpetuity, and that it would be paid back the prime cost over and over again. When a customer had paid off the net value of the plant laid down, he should be entirely free in that respect. The Chairman said if the Corporation did the work it would probably decide on the adoption of similar terms to those of the company, but eventually it was decided to ask the company for terms more favourable to the consumers.

Montrose.—The Edmundson's Electricity Company, Limited, have given notice (in accordance with the provisions of the transfer deed of Montrose Electric Lighting Order, 1898, granted by the Board of Trade for the establishment of the electricity supply undertaking for the burgh) of their intention to lay down main cables and the boxes for connecting up same for supply to a number of thoroughfares named. The feeder mains would run from the works to the centres of the town, and were of a section large enough to allow of 5,000 lamps being supplied at once, and the distributing mains would also be of a capacity to supply that number of lamps. The cables would be laid direct in the ground,

Digitized by Google

no conduits of any sort being used; a tarred wood board or row of bricks would be laid above each as an indication of the presence of the cable, which would be laid under the footpath at an average depth of 10in., and under a roadway from 18in. to 24in. The work would be carried through very expeditiously, the special class of cables allowing this to be done, so as to avoid interfering with the convenience of the householders along the routes of work as little as possible. The feeder boxes to be put in at the points where the feeder cables joined the distributors would be cast iron pillar boxes set in the footways, and the boxes at the other points where the distributors met cast-iron boxes would be placed under the pavement in suitable pits with covers filled in with cement to match the pavement. The matter is now in the hands of the Streets and Roads Committee.

Southampton.—We notice that the Electricity Committee have received a number of claims with respect to accidents. Amongst these Mr. Joseph Morris claimed £25 in respect of alleged injuries sustained through an escape of electricity from one of the standards belonging to the Corporation in the High street, opposite the Capital and Counties Bank. The electrical engineer has reported that it was an impossibility for the column referred to to have been the cause of the alleged physical injuries. The committee decided to decline to admit any liability in the matter on the part of the Council. Mr. Howat, at present filling the position of third engineer, has been promoted to be second engineer, and Mr. H. A. Pearson has been appointed third engineer. The electrical engineer in his report last week stated that some trouble had lately been experienced with the joints in the high-tension cables, and the lighting in the upper part of the town had been affected thereby; that he had taken the matter up with Messrs. Glovers, who had remade the faulty joints at their own expense, although their guarantee had expired some time ago. The electrical engineer also reported that on two occasions the alternating current had been off for about 30 seconds owing to the breakdown of coils in the armature of the alternators; that the continuous-current plant was overloaded nightly, making it necessary to run about two volts below pressure for about three hours every evening; that this state of things could not be remedied until the new set was at work, and the delay in the erection of the plant was due to the non-delivery of the dynamo. The committee, in consequence, resolved to instruct the town clerk to inform the contractors, S. Z. de Ferranti, Limited, that the penalty clause of their contract would be strictly enforced. An enquiry is to be held with regard to the loan of £12,000.

New Issue.—Edmundson's Electricity Corporation are making an issue of 6 per cent. cumulative preference shares at ¼ premium. These shares will be preferential as to capital as well. The revenue of the company has steadily increased since its formation in 1897, and the last balance-sheet shows a profit of £17,260. To pay the dividend on the proposed issue will only require £6,000, so there is ample margin. This company retains an interest in the following local lighting companies as mentioned below, for whom central stations have been erected, and where work has been done to the following extent:

		8-c.p. lamp equivalents installed.		
	Works opened.	Jan. 1, 1899.	Nov. 1, 1899.	Nov. 1, 1900
Winchester	June, 1898	3,815	8,669	13,764
Folkestone	July, 1898	10,089	16,361	22,944
Salisbury	July, 1898	2,169	4,778	9,313
High Wycombe	Sept., 1898	1,730	6,461	15,550
Bromley, Kent	Dec., 1898	2,308	6,089	11,627
Chislehurst	Mar., 1899	—	3,327	4,412
Newmarket	Mar., 1899	—	4,010	6,278
Woolwich (reconstructed)	Mar., 1899	—	8,587	18,905
Ventnor	April, 1899	—	2,513	6,388
Alderley Edge	Aug. 1899	—	810	2,112
Guernsey	April, 1900	—	—	6,173

The net profits of the company, after payment of debenture interest, have been as follows: for the year ended March 31, 1898, £5,145; March 31, 1899, £11,268; March 31, 1900, £17,260. The income derived from electricity supply investments alone has been as follows: for the year ended March 31, 1898, nil; March 31, 1899, nil; March 31, 1900, £4,438; for the year ending March 31, 1901, the directors consider, from a careful calculation, that the income from this source alone will be not less than £8,500, while the sum required for payment of debenture interest and preference dividend during the same period will amount to about £6,900.

Finchley.—The Urban District Council on Monday discussed the electric lighting question. The Council have obtained a provisional order. Effect must be given to that order before 1902. The work is estimated to cost £30,000, but nothing can be decided until Alderman Swinburn's report has been received. The following letters were received and referred to the Highways Committee: (1) From the North Metropolitan Electrical Power Distribution Company: "With reference to your letter of the 7th and our reply of the 9th, as we have no desire to act otherwise than in friendly co operation with your Council in the matter of the electric supply, we will take no further action with the application for a provisional order in the coming session. We have no doubt whatever that our proposals, if carried out, would be in the interest of your district, and trust that a little later on you will afford us the opportunity of resuming negotiations. Owing to flaws which have developed in some small accessories used in the lamp columns, the arc lighting at Barnet has been unsatisfactory, but this is now being remedied, and soon after Christmas we trust it will be convenient for the members of your Council to visit the works there." (2) From Mr. W. M. Woods, director of the Finchley Electric Lighting Company, Limited: "I have gathered from the Press that the subject of the electric lighting at Finchley is to be under discussion to-night. In view of any statement which you may be making to the Council, I beg to remind you of the proposals that I laid before your committee in the early part of this year. The generating station then referred to is approaching completion, and I am directed to inform you that this company is prepared to enter into negotiations with the District Council for providing a more extended system of lighting, either (*a*) on the basis of the Council providing and laying mains, and the company supplying and distributing the electric energy; or (*b*) on the basis of the company taking over either in part or wholly the powers obtained by the District Council under their provisional order. Probably some arrangements might be made to hand over to the Council for the benefit of the ratepayers a certain proportion of the net profits after providing a fair dividend on the capital invested. In the event of any terms being arranged, this company is prepared forthwith to put down plant capable of dealing with any demand that may arise and to provide further extensions as and when necessary. I shall be glad to attend before the Council if desired, and give any further information that may be required."

Fulham.—At Wednesday's meeting the Consulting Engineer submitted the following report: "Since the date of my last report to you, I have not much to say with regard to progress of work. Messrs. the General Electric Company have been pushing forward far more expeditiously than recently with the pipework, and I am glad to be able to report to you that this is now very nearly all completed. The Horsfall Destructor Company have now delivered the two remaining 6in. junction valves for the boilers, and this will enable the General Electric Company to complete the main steam ring in the boiler house. I hope to make the requisite tests of the whole of the pipework this week, and to have steam on some of the engines towards the end of the week, or the beginning of next. The switchboard connections in the station are not yet completed, and there are other minor matters that the General Electric Company have still to attend to. The work on the mains is not progressing fast enough. The Horsfall Company have, as above reported, delivered the two remaining valves for the boilers, but, with this exception, have made little progress with the work covered by their contract since the date of my last report to you. Their contract however, is, with few exceptions, practically complete. I am of opinion that work on the boundary walls and the gateways at the entrances to the site should be proceeded with expeditiously now. This work has, I understand, been placed in Mr. Botterill's hands, together with the roadways on the site." The Resident Engineer reported that since the last meeting of the committee applications equivalent to 263 8 c.p. lamps had been received, bringing the total applications (88 in number) to the equivalent of 8,933 8-c.p. lamps. The resident engineer has been authorised to expend a sum not exceeding £10 in purchasing necessary materials to commence the trial running of the engines, and he has been asked to report as to the cost of introducing the system of electric motor traction for the cartage of dust and trade refuse, and to prepare plans and specification for wiring the central library for electric light with a view to tenders for the work being obtained. A sub-committee of the Council recently had a conference with the committee of the Guardians, and placed before them the advantages which must accrue to the parish at large by the Guardians taking the electric current required from the Council's mains instead of erecting their own installation. It was suggested to charge the Guardians 3½d. per unit—*i.e.*, 25 per cent. discount—for 50,000 units per annum, subject to a proper agreement being entered into.

Heywood.—Mr. E. A. Sandford Fawcett held an enquiry last week into the application of the Town Council for sanction to borrow £17,000 for electric light purposes, and £5,438 for the erection of a refuse destructor. From the evidence given we gather that the canvass of the district resulted as follows: circulars sent out, 125; replies received, 93; number in affirmative, 58; number in negative, 23; number undecided, 12; number requiring power, 7; number of 8-c.p. lamps required, 106; number of 16 c.p. lamps required, 966—equal to 2,037 8-c.p. lights; power, 30¾ b.h.p.; affirmative replies which state no particulars, 10. Mr. W. P. Adams, the consulting electrical engineer, stated that it is proposed to lay the mains along all the compulsory area, and also along Manchester-road, to include Hopwood, on the three-wire, low-tension, continuous-current system with 400 volts between the outers. Consumers would be supplied at 200 volts. The total length of mains proposed to be laid was about 5,000 yards. From the results of the canvass, adding 20 per cent. to the replies received which was what could be expected judging by experience, he estimated that during the first year the consumption would be 2,844 8-c.p. lights and 37 b.h.p. in motors. The income from this source would be £912. 9s.; from the sale of current for motors, £289. 1s. 3d.; and for meter rents, etc., £50; a total of £1,251. 10s. 3d. The estimated expenditure amounted to £778. 11s. 10d., leaving a balance of £472. 18s. 5d. Interest at 3 per cent. on £15,000 would absorb £450, and there would be a surplus of £22. 18s. 5d. This surplus was small, and it was desirable that the Board should sanction the deferment of payments on sinking funds until the fourth year, as had been done in other towns. Dealing with the plant, Mr. Adams said that two steam generators, two boilers capable of evaporating 3,000lb. of water per hour each, and two batteries of 115 cells each would be required. The distributing mains would be laid on the solid system. The boiler-house plant was estimated to cost £2,728. 8s. 6d.; engine-room plant, £2,074; battery-room plant, £869; switchboard

Digitized by Google

and connections, £762; station lighting, £116; feeders and mains, £1,597. 16s. 9d.; meters, £242. 10s.; laying cables conduits, house connections, etc., £1,342 10s.—a total of £9,732. 5s. 1d. The amount of the buildings was £4,557. 12s. 7d.; contingencies and engineering expenses, £691. 0s. 3d—a total of £14 980. 17s. 11d. The sum of £2 000 was to be borrowed to defray the cost of wiring consumers' premises. This would be done on the deferred payment system, carrying the repayments over five years. The Inspector was afraid that this was hardly subject for a loan; still, it was a matter for the Board. Mr. J. Ainsworth Settle, the borough engineer, stated that the works in progress commenced in July under three contracts—one for the electrical works proper, amounting to £3,002. 6s. 1d.; a second one for the roof, amounting to £130; and a third for the chimney, amounting to £692. 10s. Other expenses, amounting to £67 6s. 6d., had been incurred on another site in Hind Hill-street, which was first fixed upon as the site of the works, but was found to be unsuitable. With regard to the refuse destructor, it was stated that the Council received sanction to erect a destructor and authority to borrow £3,000 in 1893, but the destructor had not been erected before now, partly on account of difficulties connected with the site. The borough engineer said it was now proposed to erect a two-cell destructor on Meldrum's principle It would destroy from 25 to 30 tons per day.

PROVISIONAL PATENTS, 1900.

NOVEMBER 26.

21336. An improved illuminated advertising device for attachment to incandescent electric lamps and the like. Leo Connor, 34, Castle-street, Liverpool.

21366. An improved method of and means for joining the ends of lengths of telegraph wires and other wires. Richard James Fawcett, 322, High Holborn, London.

21374. Improvements relating to electric incandescent lamps. Henry Harris Lake, 45 Southampton-buildings, Chancery-lane, London. (The firm Electrische Glühlampen-Fabrik "Watt" Scharf und Co., Austria.)

21390. Improvements in variable resistance electric contacts. Francis Greenwich Sharp, 24, Southampton-buildings, Chancery lane, London.

NOVEMBER 27.

21409. Improvements in conduits for electrical conductors. Sydney Bryan Donkin, 5, St. Loo mansions, Chelsea, London.

21429. Improvements in or relating to dynamometers Karl Leverkus, 21, Pestalozzistrasse, Charlottenburg, Germany.

21447. Improvements in electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Granville T. Woods, United States.) (Complete specification.)

21448. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States) (Complete specification.)

21449. Improvements in interrupting devices for electric circuits. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States) (Complete specification.)

21450. Improvements in methods of transforming alternating electric currents. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Jonathan E. Woodbridge, United States.) (Complete specification)

21457. Improvements in telephony and telegraphy. Sidney George Brown, 9, Putney-hill, Putney, London.

21459. Improvements in safety cut-outs for electric circuits. Joseph Sachs, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21469. Improvements in lightning arresters for safety cut outs for electric circuits. Joseph Sachs, 23, Southampton-buildings, Chancery-lane, London (Complete specification.)

21478. Improvements in or relating to electric meters. John Henry Barker and James Alfred Ewing, 111, Hatton-garden, London.

21486. An improved appliance suitable for removing screw-threaded clamping rings from electric incandescent lampholders. Herbert Frank Cotton, Arthur Tennent Cotton, and Alfred Henry Reddell, 46, Lincoln's-inn-fields, London. (Complete specification.)

21490 Improvements relating to switches for use in electric circuits. Rudolf Lehnhoff 27, Chancery-lane, London.

NOVEMBER 28.

21497. Improvements relating to an electrolytic process and apparatus for the treatment of metalliferous ores and substances for the extraction of precious metals therefrom. George Harrison, of the firm of D. Young and Co., 11, Southampton buildings, Chancery-lane, London. (Alfred Charles Lorenz, United States.)

21501. Improvements in electrical switches. Alfred Watson, 180, Hockley-street, Birmingham.

21517. Improvements in electric belts. Otto Reinicke, 160, Friedrichstrasse, Berlin.

21533. Improvements in electrolytical apparatus. Joseph Matthews and William Davies, 77, Colmore row, Birmingham.

21538. Improvements in or relating to plates for electric batteries or the like. Alfred Julius Boult, 111, Hatton-garden, London. (William James Jackson, United States.) (Complete specification.)

21540. Improvements in or relating to overhead trolley wires or conductors for electric traction, overhead electric cables, or the like. Augustus Wyvill Hancock, John Leighton, and Robert Hacking, 111, Hatton-garden, London.

21566 Improvements in accumulators or secondary batteries. Carl Auer von Welsbach, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

21575 Improvements in electric telegraphs. Alexander Muirhead, 323, High Holborn, London.

NOVEMBER 29.

21578. Enclosed switch and cut-out combined. Walter John Fryer, 42, Sloane-square, London.

21615. Improvements in the socket joints of metallic telegraph and like poles. Edward Haward Chambers, 7, Staple-inn, London.

21617. Improvements in electrical fuse distribution or switch-boards. Conrad Edward Zimdars, 52, Chancery-lane, London.

21629. Improvements in and connected with means for the conversion of electrical energy derived from a source of direct current into varying or alternating currents. William Du Bois Duddell, 1, Queen Victoria-street, London.

21642. Improvements relating to electric fuses. John Charles Augustus Ward, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21644 Improvements in systems of electrical distribution. Henry Russell Kent, Westinghouse-buildings, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 1, 1900, being date of application in United States.)

21645. Improvements in and relating to electric switches. Clarke, Chapman, and Co., Limited and Alfred Lindsay Forster, 46, Lincoln's-inn-fields, London. (Complete specification.)

NOVEMBER 30.

21669. An improved reflector for electric or other lights. Samuel Hall, 4, St. Ann's-square, Manchester.

21674. Improvements in the method of supporting electric motors directly connected to the axles of cars or locomotives for electric railways or tramways. James Campbell, Arthur Hird, and Alexander Bewicke Blackburn, 17, Haymarket, Sheffield.

21700. Improvements in telephony. Louis Sterne, Donington House, Norfolk-street, Strand, London. (Samuel B. Fowler, United States.) (Complete specification.)

21701. Improvements in telephony. Louis Sterne, Donington House, Norfolk-street, Strand, London. (Samuel B. Fowler, United States.) (Complete specification.)

21702. Improvements in operating dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (William Le R. Emmet, United States.) (Complete specification.)

21703. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Richard Fleming, United States.) (Complete specification.)

21704. Improvements in systems of electrical distribution. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Ernst J. Berg, United States.) (Complete specification.)

21716. Improvements in and in the arrangement and construction of arc lamps. Charles Oliver, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

21722. Improvements in or relating to trolley wire and other conductors for electric traction. George Edward Heyldia, 6, Lord-street, Liverpool.

21732. Method of automatically cutting out main conductors of powerful electrical currents. Siemens Bros. and Co., Limited, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktiengesellschaft, Germany.) (Complete specification.)

21736. Improvements in apparatus for electrically lighting railway trains. Arthur Bernard Gill, 77, Chancery-lane, London.

21749 Improvements in dynamo-electric machines. Walter Langdon-Davies and Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

DECEMBER 1.

21759. An improved process for the electro-deposition of metals. Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

21804. Improvements in the manufacture of electrical insulating materials. Ernest Alexander Claremont, 4, Bloomsbury-square, London.

Digitized by Google

21306. Improvements in or relating to trolleys, switches, and crossings used in connection with overhead wires for electric traction Phelan McCulloch, 6, Lord-street, Liverpool.

21312. Improvements in and relating to electric arc lamps. Louis Warren Emerick, 77, Chancery-lane, London. (Complete specification.)

21315. Improvements in and relating to armatures and inductors. Victor Isodore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) Complete specification.)

21327. Improvements relating to electric incandescent lamps and the like. Societa Edison per la Fabricazione delle Lampade Eng. C. Clerici ed Co., 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 16, 1900, being date of application in Italy.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Dec. 22.

1899.

19539. Automatic electric circuit breakers for automatically closing the circuit after breaking. Hopkinson and Talbot.

23734. Electric lighting or heating apparatus. Bouillet.

24049. Intercommunication telephone systems. Wilson.

24053. Means for carrying off the gases generated in electrolytic apparatus. Bein.

25396. Electrically-propelled vehicles and permanent way therefor. Burnaby.

25417. Electromagnets. Delaveau

25421. Alternating-current generators Lamme. (Date applied for under International Convention, May 24, 1899.)

25439. Electrical contact apparatus for automatic signalling. Cadet and Chevallier.

25622. Method of fitting the covers of electric light fittings to their base parts. Lundberg and Lundberg.

1900.

1756. Suspension devices for arc lamps and the like. Wehrmann and Bastians.

2231. Telephone ear instrument holders. Stamp.

14054. Indicators for electric bells and the like. Julius Sax and Co. Limited, and Aird.

14798. Attachment to ceiling roses for raising and lowering central hole weights or fixing electrical fittings. Braham.

16248. Electric wall or floor coupling sockets. Davies, Kent, and Stewart.

17663. Method of and apparatus for signalling between stations having no electrical or mechanical connection. Silkman, Selden, and Day.

18347. Switch apparatus for electrically-propelled vehicles. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

18718. Magneto-electric ignition devices for explosion engines Seck.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Dec. 1	602	496	+ 104	18,707	16,050
Birmingham Trams.	,, 1	4,283	4,440	- 157	210 226	200,088
Blackburn Corp'rat'n	Nov. 30	405	390	+ 15	19,183	21 492
Blackpool Corporatn.	,, 29	185	149	+ 36	27,372	20,171
Blackpool-Fleetwood	Dec. 1	136	161	- 25	19,712	19,737
Bolton Corporation..	Oct. 28	1,254	-	—	42,293	—
Bradford City Trams	Dec 2	687	356	+ 331	19,091	13,888
Bristol Tramways Co.	Nov. 30	2,987	2 696	+ 291	—	—
Carlisle Tr'mw'ys Co	Dec. 1	118	118	—	4 012*f*	—
Central London Ry.	,, 1	5,766	—	—	93,687*e*	—
City & South London	,, 2	1,904	1,053	+ 851	35,860	21.561
Cork E. T. and L. Co.	Nov. 29	327	359	- 32	19,647*c*	18,216
Dover Tramways ...	Dec. 1	157	154	+ 3	9,920	9,462
Dublin & Lucan E.R	Oct. 6	98	77	+ 21	1 590	—
Dublin U.T., elec. cars	Nov. 30	3,265	2,754	—	—	—
Dublin S.D. Electric	,, 30	651	665	—	—	—
Glasgow Corporation	Dec. 1	8,999	8 892	+ 107	—	—
Halifax Corporation	,, 1	672	576	+ 46	—	—
Hull Corporat'n E.S.	,, 1	1.332	656	+ 676	45,656*a*	—
Liverpool Corporat'n	Nov. 24	7,962	6,902	+1,060	372 495	324,115
Liverpool Overhead	Dec. 2	1,569	1,747	- 178	36 643	36,023
St. Helens Tramways.	Nov. 28	—	—	+ 174	—	—
Sheffield Corporation	Dec. 2	2,653	—	—	—	—
Southampton Trams	Nov. 29	639	291	+ 348	—	—
Southport Corporat'n	,, *24	328	—	—	—	—
Swansea Tramways..	Oct. 5	447	263	+ 184	7,093	4,462

a Since April 1. *c* Since Jan. 1. *e* From July 30. *f* From June 30.
* Fortnightly returns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Tuesday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 –	¾-⅞
British Insulated Wire, Ord., 1-40,000	5 –	10-11
—— 40,001-70,000	5 –	10 13/16-11 1/16
—— 6 per cent. Cum. Pref., 1-40,000	5 ..	6¾-6¾
—— 5 per cent. Mortgage Debentures	100 –	100-102
British Electric Works, Ordinary, 50,001-95,000	1 ..	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1 –	⅛-¼
—— 4½ per cent. First Mortgage Debentures	100 –	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 –	4¾-5 xd
Brush Electrical Engineering, Ordinary	2 –	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	1 –	¾-⅞
—— 4½ per cent. Debenture Stock	100 ..	106-111
—— 4½ per cent. 2nd Debenture Stock	100 –	108-108
Callender's Cable, Debentures	100 –	110-114
—— Ordinary	5 –	13½-13¾
—— 5 per cent. Pref.	5 –	4¾-4¾
Crompton and Co.	3 –	2¾-3
—— 5 per cent. Debentures	— –	99-102
Edison and Swan United, Ordinary	3 –	1⅝-1¾
—— 5 per cent. Debentures	5 –	3¾-4¼
—— 6 per cent. Deb. Stock, Red.	100 –	100-103
—— 5 per cent. Second Deb. Stk., Prov. Certs.	70 –	66-100
Electric Construction	2 –	2-2½
—— 7 per cent. Cumulative Pref.	2 –	2¾-3
—— 6 per cent. Perp. 1st Mort. Deb.	100 –	103-105
W. T. Henley's Telegraph Works, Ordinary	5 –	13½-13¾
—— 4½ per cent. Preference	5 –	4¾-4¾
—— 4½ per cent. Debentures	100 –	108 113
India Rubber, Gutta Percha, and Telegraph Works	10 –	12-13
—— 5 per cent. Debentures	100 –	100-104
Telegraph Construction and Maintenance	12 –	12-13
—— 5 per cent. Bonds	100 –	101 104
Telegraph Manufacturing, Ordinary	5 –	10-11 xd
—— 5 per cent. Cum. Pref.	5 –	4¾-5¼
Willans and Robinson, Ordinary, 1-80,000	5 ..	10¾-11¼
—— 6 per cent. Cum. Pref., 80,001-90,000	5 –	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	103-105 xd
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅞-1
Bournemouth and Poole, Ordinary	10 ..	13½-13¾
—— 4½ per cent. Cum. Pref.	10 ..	10-11
—— Debenture Stock, Red.	100 ..	103-106
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 –	5¾-6¼
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 –	6¼-6¾
Charing Cross and Strand	5 ..	9¾-10¼
—— 4½ per cent. Cum. Pref.	5 –	5¾-6
Chelsea Electricity Supply	5 –	6¾-7
—— 4½ per cent. Debentures	100 –	110-113
City of London, Ordinary	10 ..	9-10
—— 6 per cent. Cumulative Pref.	10 –	13-14
—— 5 per cent. Debenture Stock	100 –	120-130
County of London and Brush Provincial, Ordinary	10 –	8¾-9¼
—— 6 per cent. Cum. Pref.	10 –	11-12
—— 4½ per cents Debentures Prov. Certs. All pd. Ed.	— –	108 112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 –	4¾-5
—— 4½ per cent. First Mort. Deb.	100 –	101-104
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5 ..	4¾-5
Hove Electric Lighting, Limited, Ord., 1-11,000	5 ..	7¾-8¼
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 –	9¾-10¼
London Electric, Ordinary	3 –	1¾-2
—— 6 per cent. Pref.	5 –	4¾-5¼
—— 6 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-103
Metropolitan, Ordinary	10 –	13¾-13¾
—— 4½ per cent. First Mortgage Debenture Stock	100 –	113-115
—— 3½ per cent. Mortgage Debenture, Red	100 –	97-100
Notting Hill Electric Lighting	10 –	14¾-15¼
Oriental, 1879	1 –	1¾-1¾
—— £5 Shares	5 –	7-7¼
—— £4½ Shares, New	4½ –	6¾-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,210	5 –	6¾-6¾
River Plate Electric Light and Traction, Deb.	100 –	70-80
Royal Electrical Company of Montreal	$100 ..	170-180
—— 4½ per cent. First Shares Mortgage Debentures	$100 ..	103-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 –	2-2½
—— 6 per cent. Debenture Stock	100 ..	95-98
South London, Ordinary	3 –	2¾-3¼
St. James's and Pall Mall, Ordinary, 101-20,060	5 –	13-14
—— 7 per cent. Pref.	5 –	8-9
—— 3½ per cent. Deb.	100 ..	100-105
Westminster, Ordinary	5 –	12-13
—— 80,001-100,457	5 –	11½-12½
Electric Railways.—		
Central London, Ordinary	10 ..	9¾-9¾
—— Pref. Half-Shares	5 –	4¾-5
—— ,, ,, deferred	5 –	4¾-5
City and South London, Consolidated Ordinary	100 –	93-96
—— Ordinary	10 –	4¾-5¼
—— 4 per cent. Debenture Stock	100 –	113-115
—— 5 per cent. Pref. Stock '91	100 –	138-143
—— ,, ,, '96	100 –	130-135
Liverpool Overhead, 5 per cent. Pref.	— –	12-12½
Waterloo and City, Ordinary	100 –	93 96
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 –	14-16
Brisbane Tramway	100 ..	104-108
British Columbia Electric Railway Co., 5 per cent. Pref.	10 ..	9¾-10¼
British Electric Traction, Ordinary	10 ..	14-15
—— 6 per cent. Cm. Pf. 30,001-60,000	10 –	13-13
—— 5 per cent. Perpetual Debenture Stock	100 –	130-133
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 –	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4¾-5
—— 5 per cent. Deb. Stock, Red.	100 ..	104-107
—— Prov. Cert., all paid	— ..	96-99
Kidderminster and District Lighting and Traction, Pref.	10 –	9¾-10¼
New General Traction, Ordinary	5 –	3¾-4
—— 6 per cent. Cum. Pref.	5 –	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	16-17½
—— 5 per cent. Cum. Pref.	10 ..	10¾-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10 –	10¾-11¼
—— 5 per cent. Cum. Pref., 1-20,000	10 –	10-11
—— 4½ per cent. Debenture Stock	100 –	103-105
Telephones.—		
National Telephone, Ordinary	5 –	4¾-4¾
—— 6 per cent. Cum. First Pref.	10 –	13-14
—— 6 per cent. Cum Second Pref.	10 –	12-14
—— 5 per cent. Non. Cum. Third Pref.	5 –	5-5¼
—— 4 per cent. Deb. Stock, Red.	100 ..	101-104
—— 2½ per cent. Deb. Stock, Red.	100 –	66-69
Oriental Telephone and Electric Company	1 –	3-3¼

Digitized by Google

NOTES.

Wireless Telegraphy.—Colonel Hozier, on behalf of Lloyd's Committee, on Saturday last notified Glasgow shipowners that it had been decided to establish experimentally the reporting of vessels by ætheric signalling at Inishtrahull, North of Ireland. It is expected that the installation will be ready by the middle of January. Arrangements are also being made for night signalling, as well as day, at Kildonan, Arran, Scotland.

Telephone Insulators. — According to the *Amur Gazette*, an extraordinary telephone line has been built by the Amur Goldworks Company at their place on the Seja River, to another establishment on the River Aldan. Instead of insulators, which are difficult to obtain in Siberia, empty bottles have been used on which to support the line. Anyone who is conversant with the characteristics of the Russians can quite believe that there was an ample supply of empty bottles in the district.

The Haab Electromagnet.—At a recent meeting of the Liverpool Medical Institution the electromagnet designed by Prof. Haab, of Zürich, for removing small fragments of iron and steel from the eye was described. Various speakers gave instances of the success of this magnet, which we have referred to previously in our columns. It requires about 1½ kw. to energise it, and is capable of lifting about half a ton. One can hardly wonder therefore that it has been successful in removing a great number of splinters of iron and steel from the interiors of patients' eyes.

Branch Line Service.—In view of the remarks of Prof. Carus-Wilson at the Institution of Electrical Engineers last week, in which he advocated increased service of lighter trains on branch lines of railways, it will be of interest to note that in Italy the Adriatic Railway Company is experimenting with a new and special type of automobile designed for use on rails. Each vehicle can carry 12 persons, and they will be used for conveying passengers in districts containing a number of towns at no great distance apart. By this means it is hoped to provide a fast service in districts where it would not pay to increase the number of heavy trains.

Railway Carriage Lighting.—Dr. Andrew Wilson, in the *Daily Chronicle* science columns, deals with the lighting of railway carriages by acetylene, which is stated to be so successful in Germany. Referring to the progress made in the United Kingdom, he has a good word to say for electric lighting in this connection. Thus he states that even in the North of Ireland he has found railway carriages with an electric lamp in each corner of each compartment, such as you can switch off and on as you will. There are very few lines now in England which have not adopted electricity as the illuminating agent in their new rolling-stock, and we are pleased because electric lamps are to be noticed in even the suburban trains on several London railways.

Cables to the West Indies.—In view of the fact that the contract between the West Indian Colonies and the Pacific Telegraph Company expires at the end of next year, a movement is on foot which it is hoped will result in the securing of improved connection between these colonies and Great Britain. The Governor of British Guiana is taking the move in the question, and has written to the governors of all the other colonies on the subject. It is urged that united action should be taken towards inducing the Imperial Government to organise an all-British cable out to the West Indies. Unfortunately, the colonies in question are by no means in the most prosperous condition owing to the depreciation of the sugar plantations, but we trust that something may be done in the direction indicated.

Metropolitan Railway Ventilation. — Mr. J. Galloway Weir, M.P., has been concerning himself over the ventilation of the Metropolitan and the District underground railways, and has secured copies of the correspondence on the matter between the companies and the Board of Trade. The letters show that the introduction of the ventilating outlets recommended by the Parliamentary Committee is being postponed, due to the proposed adoption of electric traction. We presume that the authorised expense of constructing these ventilators will eventually be saved. It may be of interest to our readers to know that the member of Parliament above mentioned takes much interest in many things. It was of him that a colleague wrote :

> The weary Weir with questions drear
> The notice paper crams,
> Surely there never was a weir
> That caused so many dams.

The Glasgow Exhibition.—While the Glasgow Exhibition may only serve as an additional attraction, the fact remains that the city of Glasgow is selected as the meeting place of a great number of engineering institutions during the next year. Thus the Institution of Civil Engineers are holding a congress in the city; the annual meeting of the Municipal Electrical Association is also to be held there; and we now learn that the Automobile Club have so arranged their long-distance trials for 1901 that seven days will be spent at the Glasgow Exhibition. The route selected for the next year's trials will comprise 1,200 miles. This long journey will be commenced on Aug. 12, and the cars are due at Glasgow on Aug. 19. The cars will be on view in the exhibition for the next five days, and the return journey commenced on the 26th. We understand that the buildings of the exhibition are now almost completed, and that good support is being obtained from all the leading engineering firms in the country.

The Proposed Mont Blanc Railway.—The special correspondent, as a rule, is lacking in humour, and the special correspondent at Geneva of the *Daily Mail* is no exception. This gentleman states that "the construction of a railway to the summit of Mont Blanc, similar in all respects to the Jungfrau line, is under consideration. The route which presents the least obstacles, and which is likely to be chosen, is on the Savoy side, departing from the village of Houches. There will be 12 stations, which will be specially built to resist the climatic conditions, and will be supplied with every convenience for travellers. The length of the mountain railway is estimated at 11 miles. The hydraulic power, which will be electricity, will be obtained from the River Arve and the Mer de Glace. The author of the scheme, a French engineer named Fabre, has laid the plans of the new railway before the French Minister of the Interior." If the line is not to be similar in all respects to the Jungfrau Railway, it might be an advantage to make the hydraulic power of gold instead of electricity.

The Central London Vibrations.—The numerous letters which have been written to the daily papers respecting the annoyance caused by the Central London Railway to householders along the line of route should be received with caution. It is exceedingly easy to write to the papers, and it is also easy to make the most of inconvenience, however slight. It will be noticed, however, that the Central London Company has not denied that their trains may be heard and a certain amount of vibration produced along certain parts of the line, and it will

Digitized by Google

be exceedingly interesting to hear the result of an expert examination about the point in question. What we should like to see would be a comparison made between the vibrations caused by the trains in the Central London Railway and by the traffic in the public streets. Another ill effect of the twopenny tube is exploited by the *Daily Mail*, and if sufficiently boomed will do much to increase the financial prosperity of the company. It is seriously stated by a passenger on the line that a journey on it produced on him the effect of intoxication. He had, in fact, after going out into the fresh air, to support himself by holding on to railings for 20 minutes. We think this gentleman had a remarkably cheap experience for his money.

Standard Time.—From the first of the new century we understand that the official standard time in Spain will be obtained from Greenwich, so that there will be absolute uniformity in time between Great Britain and Spain. Owing to the geographical position of the two countries, the error introduced between the official standard time and the local mean time for any part of Spain will not be very great, and there will be considerable advantage from the adoption of the Greenwich standard. This move raises the question as to whether it would not be advantageous for all nations to have a standard time. As far as those firms which have business over the submarine cables are concerned there would be considerable benefit derived, and it would also greatly help the numerous newspaper editors in preparing their foreign news. These advantages, we are afraid, will not be apparent to the great bulk of the people in the country, and the workman who has been used to dine at 12 noon would seriously object to an alteration which he would presume to have been made in his routine. We do not suppose that the official adoption of a standard time would produce riots similar to those known as the ten-day riots, but we are quite sure that no official standard would become common in the various countries, owing to the extremely radical changes which would have to be made.

Patents for Details.—We have several times had to refer to the patents which the two or three large manufacturing firms of the United States have taken out in this country for the details of their apparatus. These patents are, as a rule, for such trivial points in the device of the machinery as would be devised by the ordinary draughtsman, and which do not require any inventive skill. We have said before now that in our opinion these patents for details would not stand the test of the law courts. We are pleased to see that in the United States an action has recently been tried on this very point, and that our opinion has been upheld by the Court. The action in question was between the Thomson-Houston Electric Company and the Walker Company. The patent alleged to have been infringed by the defendants was for a brush-holder of the block form, in which a spring keeps the brush against the commutator. The brush moves in the slot or socket of the brush-holder. Another patent for an exceedingly common form of brush-holder was alleged to have been infringed, but the Court held that in each case the device which was patented was wholly wanting in novelty. We trust, therefore, that electrical engineers in England will not be frightened by the exceedingly numerous patents which these firms have taken out for details.

Electric Lighting in Bombay.—After years of consideration, a committee of the Bombay Corporation has at last recommended that an electric lighting concession should be granted. It is not convenient at this distance from the town to take up the question as to whether the supply could be most economically given by the Corporation or by a company. The only evidence we have is that the Corporation has refrained up to the present from taking any steps towards supplying electric light from a municipal station. On the other hand, the company to whom it is proposed by the Electric Lighting Committee to give the concession, have taken active steps in other parts of India for providing electric lighting for towns. As this company are the agents for Messrs. Crompton and Co., one can well believe that a certain amount of the energy of Lieutenant-Colonel Crompton has been infused into them. We therefore hope that there will no great delay over the granting of the concession, and that Messrs. Kilburn and Co. will carry out the work with their usual promptitude. As an example of what this company has done elsewhere, we may mention that the Calcutta Electric Supply Corporation have already declared a dividend, it being at the rate of 3 per cent. per annum for the half-year ending June 30. In view of the supply having only been given for a short time in Calcutta, this result is most satisfactory.

Smoke Nuisance.—An interesting case illustrating the law with respect to smoke nuisance was recently tried in the Lancashire Chancery Court. A new section of the line for the Midland Railway Company was, in the spring, being constructed at Heaton Mersey, and the plaintiff objected to the smoke issuing from the locomotives, etc., of the railway contractor. He urged that this smoke was greatly to his annoyance, and that it damaged the plants and shrubs in his garden. He particularly urged that orchids valued at £10,000 were liable to serious damage. The Vice-Chancellor ruled that a casual or temporary nuisance would not be interfered with, but that the Court would move in the matter if it were proved that substantial injury would be caused unless the nuisance complained of was stopped. The orchids, however, were not to be considered in the case, but only the effect of the smoke on ordinary garden plants. The decision of the Vice-Chancellor was that the smoke nuisance caused would have done damage to the garden, and that in consequence the verdict would be for the plaintiff, who would have the right to apply for an injunction if the nuisance were repeated. It seems to us to be rather a hard condition to lay down that contractors who have to work with temporary plant should be obliged to adopt smoke-consuming devices. Of course the actual damage done should be compensated for, but too much obstruction should not be placed in the way of conducting new transport facilities.

Institution of Electrical Engineers.—At the ordinary meeting of this Institution to be held on Thursday, the 20th inst., Lieut.-Colonel Crompton, E.R.E., will read a paper on the Electrical Engineers (Royal Engineers) Volunteers in South Africa. It is hoped that the lecture will be accompanied by lantern views illustrating the life of these volunteers at the front. We expect there will be a very large gathering to hear Lieut.-Colonel Crompton's experiences. It is obviously no sinecure to be the commanding officer of a corps of Electrical Engineers, and especially of a detachment just returned from the front. As an example of this we would instance the number of engagements at which Lieut.-Colonel Crompton has to speak within the next week. These commence with the dinner which is to be given at the Trocadero Restaurant on Saturday next by the members of the corps to the South African detachment. On Monday, the 17th, there will be another dinner to the detachment, at which again the commanding officer will have to speak, as will also be the case at the reception on Tuesday, the 18th, in the Covent Garden

Digitized by Google

Theatre. The lecture on Thursday should be practically the last straw, and we trust that Lieut.-Colonel Crompton will then have a rest till after the Christmas holidays. We understand that the applications for tickets for Covent Garden on the 18th are exceedingly numerous, and that great interest is being displayed in it by the ladies indirectly connected with the Institution.

Insulating Observatories.—The *Financial News* last week had a caustic leader on the question of the interference with magnetic observatories by stray currents from electric tramways. As far as the financial element in the leader is concerned, one cannot but agree with the remarks of the writer. It is a question of the ultimate good of the largest number, and we do not think that even a magnetic observatory should be allowed to interfere with improvements in facilities for rapid communication in large towns. We know that there has been a continuous record of magnetic observations carried out at the Kew Observatory for a large number of years, and that the sequence of these records will be broken if the observatory has to be moved elsewhere. It is, therefore, only to be expected that the physicists of the country should make strenuous efforts to protect the observatory. We believe that the electrical engineers responsible for the equipment of the lines near Kew have also undertaken to use special precautions against interfering with the instruments in the observatory. The decision as to whether these precautions are sufficient lies with the Board of Trade, and this decision is being held back unduly—in fact, the London United Tramways Company have practically everything ready for working, and yet the decision of the Board of Trade as to whether their system is to be allowed has not been given. Reverting to the leader in the *Financial News*, one finds that the writer has gone wrong in his scientific observations when he assumes that it is possible to insulate the instruments themselves against disturbances from stray currents from the tramways. Unfortunately, anything which would insulate these instruments from the magnetic lines of force from these stray currents would also insulate them from the field of the earth's magnetism.

High Vacua Testing.—A patent has recently been granted in the U.S.A. to Mr. John Waring for a method of gauging or measuring the degree of tension of a confined body of gas, and with especial reference to obtaining an equal vacuum in the exhaustion of electric lamps. The fundamental principle underlying the method is that the regular transmission of heat in a rarefied gaseous medium depends upon the density of that medium. In applying the invention a known resistance is taken as a standard, and with this is compared a resistance enclosed in a suitable chamber connected to the lamp bulbs or other chambers undergoing exhaustion. This comparison can best be made by using for the standard resistance one or more standard incandescent lamps and comparing therewith one or more similar lamps whose bulbs are in connection with the exhaust pipe to which the lamps are connected for exhaustion, a galvanometer being used to show the proper degree of vacuum. The theory of operation is that the deflection of the galvanometer is proportional to the change in resistance of the filament, which in turn is proportional to the change in temperature, and this in turn is proportional to the number of molecules impinging upon the filament, which number of molecules is proportional to the degree of vacuum; consequently, the deflection of the galvanometer is proportional to the vacuum. In other words, the method consists in electrically heating a conductor in a vacuum and measuring the electrical resistance of such conductor while heated. In carrying out the method a Wheatstone bridge arrangement is employed. We are indebted for the above to the *Electrical World*.

The Glasgow Section.—The section of the Institution of Electrical Engineers at Glasgow is infusing considerable vigour into its debates, and is also organising them on what we consider to be good lines. As an example of this, we may mention that on Wednesday last the discussion on the paper by Mr. W. E. Langdon on "The Supersession of the Steam by the Electric Locomotive" took place. The full debate will be reported in our next issue, and our readers will then see that the matter was taken up most thoroughly. This is due to one or two of the local members arranging for a sub-division of the various points raised, and selecting the most capable engineer in the district for each special point. As a contrast to this, the debate last week at the parent Institution is most striking. While certain speakers kept to the issues of the subject under discussion and added their practical experiences, there were others who simply wasted the time of the meeting. Without mentioning names, one is tempted to ask what value can possibly arise out of a *résumé* of the progress of telegraphy and the fight between electric lighting and gaslighting in a paper on the electrical equipment of our main lines of railway. Or, again, is it of interest to the members to know that the subject is an extremely old one, and that the speaker has looked into the matter for various authorities and Governments, if that speaker refrains from giving in a concise manner the conclusions which he came to from his investigations. In our opinion, it would be well to enforce a rule that no member should be allowed to continue speaking if he wastes three minutes over introductory remarks which do not concern the paper.

Electrical Work at Cardiff.—The question has now been decided at Cardiff as to what should be done with respect to the vacancy created by Mr. Appelbee leaving to take up a more responsible position at Ashton-under-Lyne. It will be remembered that the Tramway Committee have had for some months now the services of an expert electrical engineer, and that it is proposed to erect a separate generating station for the tramway system. It has now been decided by the Council that this gentleman (Mr. A. Ellis) shall also be responsible for the electric lighting of Cardiff. In our opinion there is much to be gained by the combination of the two posts, always provided that the work of the engineer selected is not hampered by conflicts between the two committees. In spite of what has been written by what may be termed interested engineers, there is practically very little advantage in isolating the tramway generating works from those wholly used for electric lighting. In the present instance the fact has to be considered that at Cardiff alternating currents are used for lighting, whereas, of course, the tramway machinery is likely to be of continuous current. There is no reason why the much needed extensions in the electric lighting system should not be carried out on the direct-current system, and in that case plant could well be placed in the same building as the tramway plant. If this is done, there will be a saving in the stand-by plant required, and also in the cost of labour. The only thing which seems likely to act against a combined scheme is the character which the councillors at Cardiff have for interfering with the under-officials of their departments. As, however, the Electric Lighting Committee have agreed to accept the electrical engineer of the Tramway Committee as quite capable of managing their electric lighting station, mains, and particularly the staff, they will, we hope, work smoothly with the Traction Committee. In view of the history of the Cardiff undertaking for the last three years, it is evident that the organisation of a staff interfered

Digitized by Google

with and mismanaged by the individual members of the committee has been a very heavy task for the engineer who is now leaving Cardiff. We congratulate Mr. Ellis on his appointment, and wish him every success in the heavy work he has in hand in equipping the tramways, etc.

The Government and Telephonic Facilities.—On Friday last an influential deputation waited upon the Marquis of Londonderry at the General Post Office to protest against the suggestion of the Post Office to cut off their special wires to Glasgow. It appears that some large firms arranged with the National Telephone Company to have special wires communicating with the telephone exchange in Glasgow, as there were too many delays by going on the public trunk wires. The Government took over the trunk from the National Telephone Company in 1896, and the Government contend that by the agreement with the National Telephone Company all the business should come on the trunk lines. The deputation pointed out that their agreements with the Telephone Company were made prior to the trunk wires being acquired by the Government; that the facilities given on the trunk lines were not such as would meet the demands of their business; and that the royalty paid by the deputation to the National Telephone Company would equal, if not exceed, any charges payable to the Government for the use of the trunk wires. The Marquis of Londonderry promised to consider the matter, and see whether any possible arrangement could be made to meet the difficulty. The real point at issue seems to be as to whether firms carrying on business at considerable distances from the large industrial centres are to be compelled to use the trunk wires, or whether the Government will not erect and maintain for them independent private lines. We do not think that it is so much the question of expense that these firms consider as the saving in time, and also the convenience of being able to at once call up the central exchange without the intervention of a local exchange. From what we remember of the Newcastle-on-Tyne Post Office telephone system some eight or ten years ago, its great advantage over the company's exchange was that most of the large collieries and ironworks in Northumberland as well as the large shipbuilding yards and dry docks were connected direct with this exchange. In consequence, one could quickly get through communication, involving only one switching operation. We trust, therefore, that the Marquis of Londonderry will not allow red-tape to prevent the establishment of long private lines in connection with telephone systems, whether they are managed by municipal authorities or by the National Telephone Company.

Railway Traction.—In a leading article the *Elektrotechnische Zeitschrift* comments on the increasing practicability of equipping standard-gauge railways for electric traction. Since considerable distances are involved by railway work, the transmission of energy by means of high-tension multiphase currents is a fundamental basis for such projects, opines the authority in question. But the transformation of the energy prior to its final conveyance to the propelling motors of the trains may be accomplished in various ways. As a matter of fact, three systems have already been tried. One of these consists in the conversion of the high-pressure multiphase currents into continuous currents of moderate pressure by means of fixed transformers and rotary converters placed in sub-stations. In this case the arrangements are similar to those prevailing for ordinary tramways, except that they are on a correspondingly larger scale. A second system consists in converting the high-pressure multiphase currents into multiphase currents of moderate pressure, and conveying the same to the trains through three separate conductors. In this case at least two special conductors are requisite, while the rails may constitute the third, and the trains would, of course, be equipped with multiphase motors. The third system consists in conducting the high-pressure multiphase currents by means of three overhead wires direct to the train, which is equipped with transformers and multiphase motors. As regards the relative values of the three systems, expert opinions differ. Each has its particular advantages and disadvantages. To the first-mentioned system belongs the merit of having the least number of untried combinations, besides that of being already extensively adopted. But as a set off against the great advantage of securing complete control of the speed and of obtaining high efficiency at all speeds when continuous-current motors are employed, the disadvantage of having to take fairly large currents from the working line must be taken into account. The same disadvantage holds for the second system, which does not, however, combine the easy regulation and high efficiency of the motors as a compensation, for which reason it has been adopted only where fairly constant speed can be maintained. The third system combines the great advantage of easy transmission, and, therefore, permits the use of heavy trains designed for high speeds, by virtue of which its application for standard-gauge railways gives great promise of success. Experiments in Lichterfelde have proved the practical possibility of this system, and a trial on a larger scale is to be made on the military railway to Zossen.

Road Traction.—Prof. Hele-Shaw's paper on "Road Traction" attracted a good attendance at the Society of Arts on the Wednesday of last week. The author's zeal in all that pertains to the improvement of road surface and to the perfection of automobiles is well known. In the paper in question a strong contrast was drawn between the ease with which resistance to motion in water can be ascertained and predetermined, as compared with the difficulty in arriving at any reliable average figures for road traction. Thus figures were quoted by the author to show that the maximum tractive effort on a good road may vary in the ratio of 1 to 3, according to the state of the weather. One most interesting point which was discussed in the paper is the wear of the road due to heavy automobiles passing over them. Figures are quoted from experimental trials in France to show that such heavy motors may increase the cost of upkeep of a road by as much as £50 per mile per annum. It does not, however, follow from this that these heavy motorcars should not be used, because, even considering the extra cost of upkeep of road, they may be considerably cheaper transport agents than horse-drawn vehicles or local railways. Prof. Hele-Shaw, however, hoped that the designers of carriages would so proportion the size of their tyres as to reduce the wear of the roads as much as possible. The instruments were described with which the committee appointed by the British Association are investigating the various causes of resistance to self-controlled vehicles on the common roads, and it was pointed out by the author that up to the present the frictional resistance of traction has not been separated out from the resistance due to vibrations of the vehicles. Another point requiring investigation was the influence in the power required, if any, of driving the car by the front or rear wheels respectively. In the discussion which followed, Lieut.-Colonel R. E. B. Crompton gave some interesting information as to the use of traction engines over the veldt in South Africa. In the months of July, August, and September the resistance to traction on the

Digitized by Google

surface of the veldt was less than occurred on the best English roads at this time of the year. In South Africa they had used for the first time very broad wheels, in absolute opposition to the time-honoured custom of the Boers, who employed only narrow wheels. The result of using the broader wheels was that the very thin crust of the veldt was not broken up, and that much greater traffic could be taken over a given route without destroying the surface. Mr. A. R. Sennet also spoke, and gave some curious figures with respect to the advantage of driving the front wheels of a carriage. These were not in the form in which they can be referred to as percentages, but of two exactly similar cabs, with the exception that one had the front wheels driven and the other the rear; the first-named was able to run for several hours more on the one charge of the accumulator. It is not easy to see why there should be any great difference between front and rear driving.

Incandescent Lamp Development.—Mr. Edwin W. Hammer is contributing to the *Electrical World* a series of articles on incandescent lamp development up to the year 1880. Those who are interested in historical lamps will find these articles of great value, in that illustrations are given as well as descriptions of most of the earlier forms of incandescent lamps. The author is chiefly indebted to the Patent Office records for some of his earlier information, and it is obvious, as he pointed out, that some of the earlier lamps could never have been successfully made by their inventors. For instance, the Starr-King lamp, which was patented in 1845 by an American, J. W. Starr, is one of these. It is generally believed that Mr. Starr resided in England. In this lamp two alternative forms were proposed. In one, wires of platinum or other metals were to be raised to incandescence, and in the other the inventor proposed to employ pieces of carbon. With respect to the carbon lamp, he states that the "form of carbon found on the interior of coal-gas retorts which have long been used is well suited for this purpose, and may be worked into the form of either small pencils or thin plates by the aid of the saw and file." The carbon plates or pencils are to be enclosed in a Torricellian vacuum produced in a glass tube similar to those used for barometers, except that the upper end is enlarged into a cylindrical bulb, with a stout platinum wire sealed in at the top. The length of the tube, exclusive of the bulb, was to be about 30in.; the tube is filled with mercury in the same manner as a barometer, and then stood upright with its open end in a basin of mercury, the column of mercury in the tube falling until it is balanced by atmospheric pressure, leaving a vacuum above it. The carbon rod produced by mechanical means was, of course, of very low resistance, and hence required a considerable current to heat it. It is curious to note that the other inventors, such as M. J. Roberts in 1852, Changz in 1853, Dr. Isaac Adams in 1865, Lodyguine in 1873, and Konn in 1875 all proposed to use this short thick bar of carbon of low resistance. It is due to this that the Edison-Swan combination were able to uphold as long as they did the patents for their incandescent lamps employing carbon filaments of high resistance. One of the most interesting lamps described in the first of Mr. Hammer's articles is the Konn lamp. In this there were a number of short rods of carbon, which were so arranged in connection with a falling switch that as soon as the first one had burnt out the next one came into circuit. Some extensive experiments carried out by this lamp showed that while the first carbon lasted somewhat more than a quarter of an hour, its average duration being 21 minutes, the succeeding carbons lasted on an average for two hours. It seemed from this that the vacuum employed was far from perfect, and that the small traces of oxygen remaining in the bulb were consumed by the burning up of the first filament.

Gloucestershire Engineering Society.—The first general meeting of the new session of the members of the Gloucestershire Engineering Society was held last week. There was a large attendance of members, the chair being taken by the recently-elected president, Mr. Hamilton Kilgour, A.M.I.C.E., M.I.E.E., electrical engineer for the borough of Cheltenham. In delivering his presidential address, Mr. Kilgour referred to the important industries which depended upon the application of electricity—namely: telegraphy—with and without wires, overland and sea and submarine, in peace and in war, simple, duplex, quadruplex, and multiplex, signalling, printing, and writing; telephony — urban and inter-urban; electric lighting—indoor and outdoor, mine lighting, searchlights in peace and in war; power transmission—to towns from a source of cheap power, to factories and in factories, electric tramways, electric railways; electro-chemistry—alkali and bleach manufacture, calcium carbide, typing, and sewage purification; and applications to medicine and surgery—galvanic treatment, cautery, and radiography. The revenue derived from these industries, and from those depending on the manufacture of machinery and apparatus for them, amounted to several millions per annum, and the total capital expenditure was expressed in hundreds of millions. These figures might enable them to realise the enormous part now played by electricity in contributing to the welfare of mankind, and might stimulate their interest in the labours of the pioneers of electrical science. There were at the present time, roughly speaking, 764,000 miles of telegraph lines, and a total mileage of conductors of 2,584,000 overhead. There were 85,000 miles of underground conductors, making a total of 2,669,000 miles of land conductors. Of the submarine cables, 20,357 miles belonged to various governments and 157,632 belonged to companies, making a total of 177,989 miles of submarine cables. There were 42 large cable ships kept for the repair of these cables. Turning to electric supply in Great Britain, there had been a total of £11,445,000 of capital expended by companies and £11,834,000 by municipalities, and at the same time revenues obtained from electric supply by companies of £1,053,000, and by municipalities of £988,000, or about £2,000,000 a year altogether. Those figures related simply to the United Kingdom. The number of lamps connected at the end of last year were 3,608,000 by companies and 4,052,000 by municipalities. With regard to telegraphs the number of messages sent last year amounted to 90,415,000. As to telephones, the National Telephone Company, the largest telephone company in the kingdom, had expended £6,827,000, and had paid a royalty to the Government in 1899 of £123,000. Those figures gave a fair idea of the enormous applications of electricity to the uses of their civilised life. Continuing, Mr. Kilgour dealt with some electrical discoveries that had been made in preceding centuries, and also with the progress in the science within the last 100 years. He said it was true that up till 1750 experiments were made, but it was practically only in the reign of the present Queen that English philosophers had made experiments which led to the discovery of electromagnetism. Nearly every great work that had been done had been effected in the reigns of the three Queens of England. Thus in Elizabeth's reign Gilbert made important discoveries in magnetism, and did some work in electricity. This was continued in Anne's reign by Haukabee, and in the present reign by such scientists as Faraday, Kelvin, Maxwell, and others.

Digitized by Google

THE ARRANGEMENT OF THE DISTRIBUTING NETWORK.

BY CHAS. A. GILLIN.

(Continued from page 799.)

Pursuing the method of dividing the network into sections, we can further facilitate the locating of faults by dividing each section into a number of sub-sections; and having traced the fault to a certain section, its sub-sections can be transferred one at a time to the main network without interrupting the supply in any way, and the section tested, as before, for the fault, each time a transfer takes place, the sub-section bearing the fault being thus easily found. In the same manner the streets forming the sub-section can be transferred to the main network one by one (as before without interrupting the supply) until the fault is located to a single length of cable, when the work of location is finished as far as the arrangement of the network is concerned.

In locating the fault in a section of the network as described above, the ingenious instrument devised by Mr. R. C. Quin, chief electrical engineer to the Corporation of Blackpool, which he calls a leakage ammeter, might be used with great advantage, as its employment would effect a considerable saving of time. Most of the time expended in the localisation of faults, however, is necessarily taken up in disconnecting and connecting up cables, etc., and before closing this article a few words may be said about the disconnecting boxes and their positions.

The Board of Trade regulations lay down the maximum number of consumers who may be affected by a breakdown as 80, and this implies that disconnecting boxes should be placed at a maximum distance of about a quarter of a mile apart in the streets of a town. This is a very convenient distance to place the boxes apart if there are no other long or important streets branching off the one in question, for, of course, boxes must be placed at all the principal street junctions, and, in fact, at almost every street where there is any prospect of a demand for electric energy. There is no necessity for fixing the disconnecting boxes until the time arrives for extending the mains down the streets referred to above, but provision for them should be made when laying the cables in such a manner that sufficient slack can be obtained for inserting the boxes without having to lengthen the cables.

Some illustrations are given to show the different types of disconnecting boxes in use at the present time in some of the larger supply undertakings. It will be noticed that to obtain access into most of these boxes, a number of screws have to be drawn, which operation takes up a good deal of time when a large number of boxes are being dealt with.

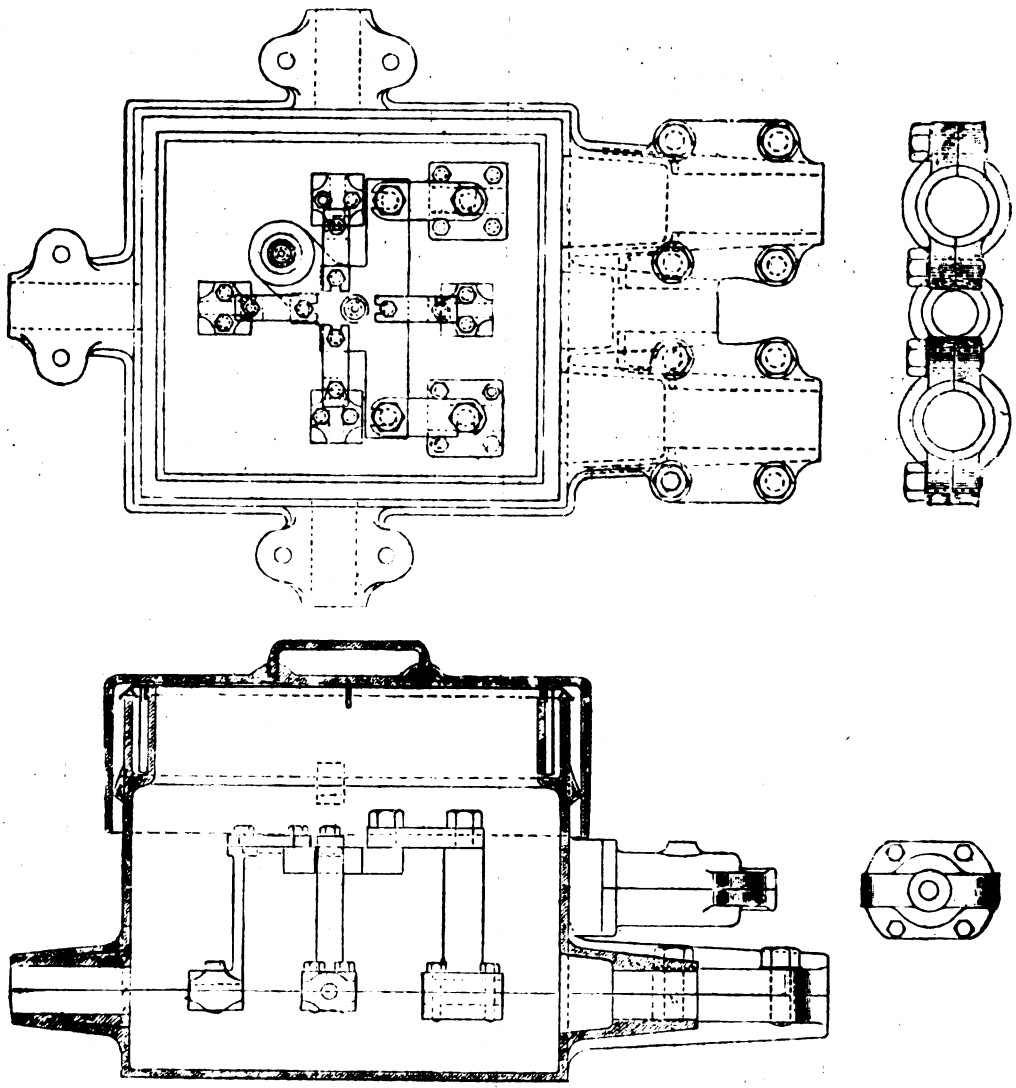


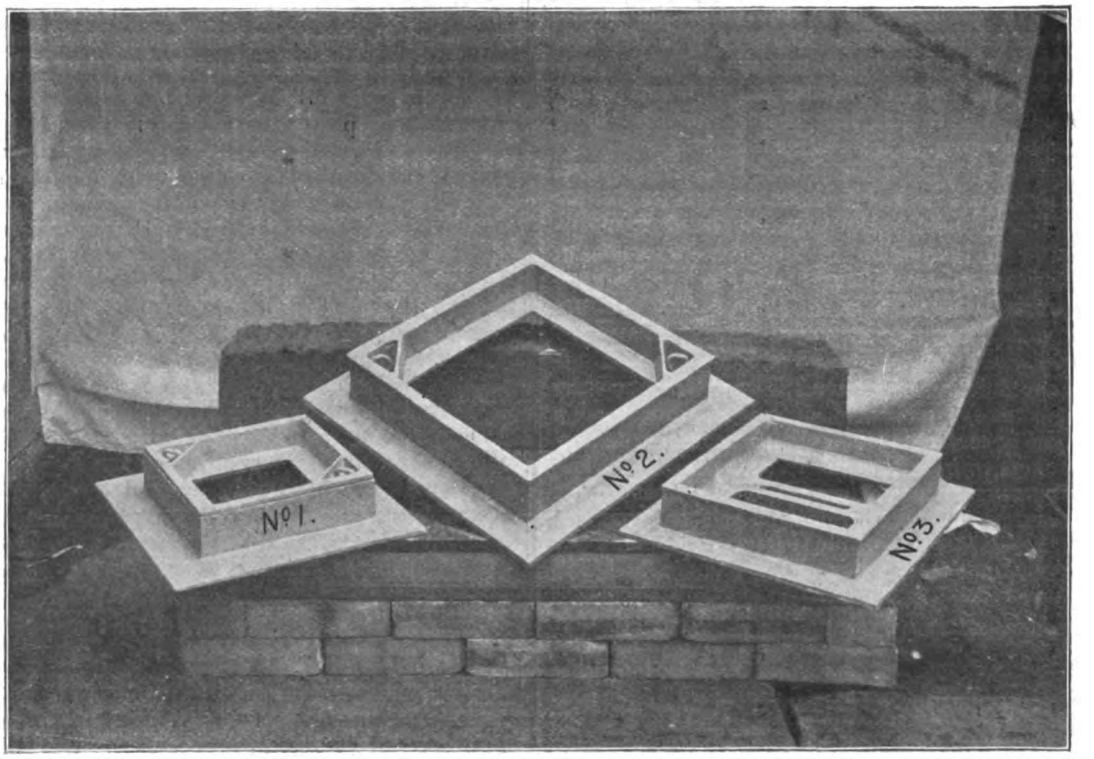
FIG. 6.

Most street boxes are rendered waterproof and air tight by means of indiarubber bands or rings inserted between the lid and the box—a most unsatisfactory method, as indiarubber perishes, sticks, and gives a lot of trouble generally. The arrangement of box cover shown in Figs. 6 and 7 was invented and patented in 1893 by Mr. S. W. Baynes, the present chief electrical engineer to the Vestry of St. Pancras, and it deserves particular notice in connection with the subject matter of this article as a great saver of time and labour, inasmuch as it takes less than one minute to open the box, disconnect, and close the box again, whereas in most other boxes the same cannot be done in 10 times that amount of time. It will be seen that there are no screws to unfasten, access being gained to the interior of the box by merely lifting off the covers. In designing the box cover so as to render the admission of water into the box impossible under any circumstances, the principle of the corollary to Boyle's law

Digitized by Google

was followed—*i.e.*, that the pressure of a given quantity of gas varies inversely as its volume. As shown in Fig. 6, the outer lid projects loosely over the outside of the box, and another lid made of copper fits into a trough containing oil, thus making the box air-tight. If water rises around the box and endeavours to force its way between the outer cover and the box, the enclosed air is compressed until its pressure balances the pressure of the water outside, and thus effectively prevents its ingress into the box. The depth of the cover can be increased so as to easily resist any depth of water, and the box may be filled with an insulating compound in the usual way, thus preventing any water finding its way in through the joints between the upper and lower parts of the box. Fig. 8 illustrates a box used by the Western Electric Company.

A few words may also be said here for the disconnecting fittings as a valuable factor in saving time. Complicated arrangements to save space and reduce the size of the disconnecting boxes should be rigorously avoided, as they tend not only to create confusion and loss of time, but often to cause disastrous results through taking off the wrong link, etc. Simplicity commends itself, and the



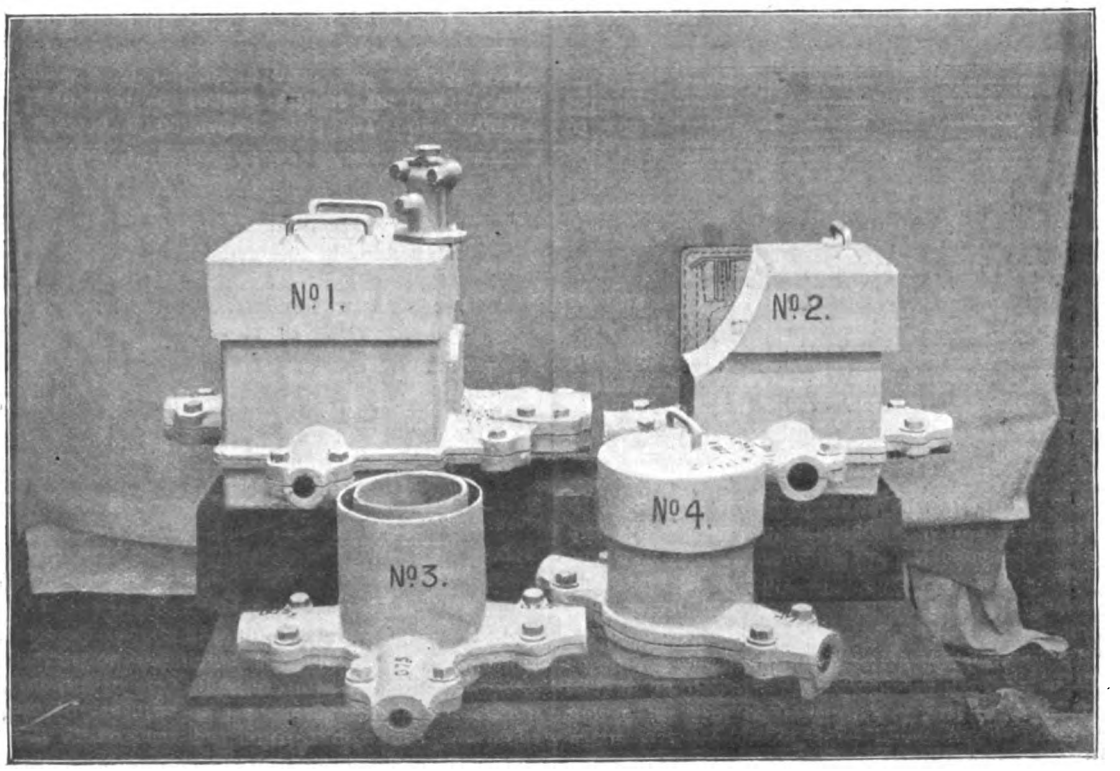


FIG. 7.

arrangement of disconnecting fittings in Fig. 6 may be pointed out as being exceedingly simple and reliable. This box was designed by the writer to serve the purpose of a feeding-box, provision being made for thickening up the feeders in the future. Four distributing cables leave the box to convey the current in four different directions, and the links for disconnecting them point respectively in the same direction as the distributors they disconnect, it

Digitized by Google

being quite unnecessary, therefore, to perform a feat of memory or make a trial disconnection before being able to cut off any desired cable. The same remarks apply to the feeder links.

In this article the writer has had no intention of criticising any existing systems of distribution, but he has endeavoured to indicate on broad lines a *system* of building up a distributing network from the commencement of the undertaking, so that all extensions of mains, however small, may be made subservient to the systematisation of the complete network. I have to thank Messrs. G. Clark and Sons, Shipley, the makers of the street boxes mentioned, and sole makers of Mr. Baynes's patent boxes, for

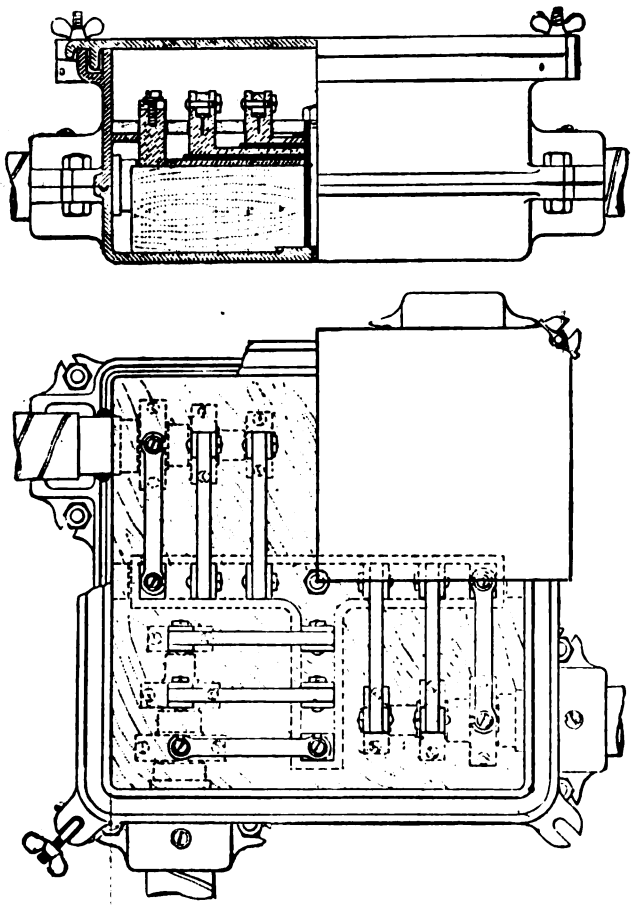


FIG. 8.

kindly lending me some of the illustrations used in this article, and taken from their catalogue.

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Continued from page 764.)

THE MAGNETIC CIRCUIT.

If a coil of wire be wound in a helix so as to form a solenoid, the number of lines of force flowing through it will depend upon the magnetising force, or number of ampere-turns. Since in the C.G.S. system if H equal the magnetising force and $a\ t$ the number of ampere-turns, $H = \frac{4\pi}{10} \times \frac{a\ t}{e} = 1{\cdot}257$ times the ampere-turns per centimetre of length, the number of lines of force will be increased in the same proportion as is the magnetising force. If, however, a steel or iron core be inserted in the solenoid, we have seen that the number of lines of force now flowing through the core will be enormously increased, but they will be no longer increased proportionately with the increase in the number of the ampere-turns, although this will be the case when the magnetising force is weak, but as the number of ampere-turns is increased, they will have less effect in producing additional lines of force. We know that the reason why the number of lines of force is increased by the insertion of the iron core is because the iron offers them an easier path than air does, or, as it is usually termed, the permeability of iron is greater than that of air; and if we represent the induction or total number of lines of force flowing through unit cross-sectional area of the iron by B, for any given value of H, then $B = \mu H$, where μ is called the coefficient of permeability of the piece of iron. And it will be found that as B increases in value μ will decrease; or, in other words, as the iron becomes saturated its permeability becomes less.

Since $H = 1{\cdot}257 \times a\ t$, it is easy to measure the value of the magnetising force, and it is also not difficult to obtain values for B, although the method of doing so is outside the scope of these notes. If, then, a known number of turns of wire be wound round a given length of iron bent in the form of a closed ring, and the magnetising current be increased by uniform small amounts, and the different values of B and H marked on a chart—the former as ordinates and the latter as abscissæ—and the various points so obtained be joined together, we shall get the curve O A, shown in Fig. 28. If, now, the magnetising force be gradually withdrawn, the induction will decrease in value, but not as rapidly as it increased, and we shall obtain a curve, A B, where O A represents the amount of magnetism retained by the iron after all the magnetising force has been withdrawn. This value is called the residual magnetism of the iron. If, now, the direction of the current be reversed through the coil, the lines of force will flow in the opposite direction, and we shall obtain the curve B C, and it will be noticed that the curve crosses the axis H H at some little distance to the left of the axis B B showing that it requires a certain magnetising force in the opposite direction to get rid of the residual magnetism. If, finally, the magnetising force be again withdrawn, the induction will decrease, and we shall obtain the curve C D; and if the magnetising force be again applied, we shall get the curve D A, and additional cycles will approximately trace out the same curve.

This curve, D A B C, shown in Fig. 28, is of great value to all dynamo designers, and more especially the simple curve O A, or rather D A'. It will be noticed that a complete cycle gives a closed curve enclosing an area, and as the area enclosed by an engine indicator diagram shows the amount of work done by the engine in one cycle, so the area enclosed by this curve of magnetisation shows the amount of work done in magnetising a piece of iron first in one direction and then in another, and is of great assistance in calculating the watts lost in the armature, where in a bipolar dynamo the core undergoes this full cycle once every revolution.

Considering now the curve D A, we note that a small increase in the value of H causes a large increase in the value of B when H is only of small dimensions, but as H increases B does not increase so rapidly as at first, until at length the curve D A becomes almost a straight line, and the iron is said to be saturated.

We have seen from our fundamental equation that $E = \frac{\phi \times N \times C_a}{10^8 \times 60}$, and that both N and C_a are usually only of small dimensions, whilst ϕ is a number of large magnitude. There are two ways of securing a high value of ϕ: one is to make B of only moderate value, and the cross-sectional area of the yoke magnets and pole-pieces large; or to make B large and the sectional area smaller. Apart from other considerations, it will be found cheaper to make B of high value, for although a greater magnetising force, and consequently more copper wire, will be required in the field coils, yet the saving in iron will more than compensate for this.

There is, however, a much stronger reason why the value of B should be great. We have seen from Fig. 8 that the flow of the current through the armature, and the forward position of the brushes, creates, as it were, two bands of armature coils; one tending to give rise to the cross induction and the other to the back induction. These two sets of bands may be considered only as component parts of the magnetising force of the armature, and their resultant will lie in the line joining the two brushes, having its north and

Digitized by Google

south poles opposing the magnetising forces of the leading horns of the magnet poles. So that the resultant north pole of the armature will be opposite to the leading horn of the north field-magnet pole, and the south armature pole opposed to the leading horn of the south field-magnet pole. If B be of small value, the magnetic density per unit cross-sectional area of the field magnets and their pole-pieces will be low, and consequently the magnetic force in the leading horns will be small, or, as it is termed, the field is weak. Now we have already seen that if two like poles are brought opposite each other, they each try to induce a pole of the opposite polarity in the other, and if one is considerably stronger than the other, it will not only demagnetise, but may even reverse the polarity of the other. This is what will happen if the resultant poles of the armature are stronger than those of the leading horns. It has been shown that, in order to obtain sparkless commutation, the short-circuited coils must be under the influence of the field into which they are about to enter, and for this reason a forward lead is given to the brushes, and the short-circuited coils are brought almost under the tips of the leading horns; if, however, these have been demagnetised, the coils will not now be in the position for sparkless commutation, and an increased lead must be given to the brushes. Considering again the two bands of armature inductors separately, this increased lead will throw more coils into the band producing the back induction, and the field will be still further reduced and the number of active coils will be considerably reduced, so that the E.M.F. generated will not be nearly as great as it would were the lead of the brushes not so much. So that in order to try and obtain a position of sparkless commutation for the brushes with a weak field, the efficiency of the dynamo will be sacrificed, whilst at the same time the desired result will not be obtained, and it will be found that it is absolutely impossible to obtain a position of sparkless commutation for the brushes in any dynamo in which the field is weak.

If the brushes were given a negative lead or lag, and, as shown in Fig. 29, brought under the tips of the trailing horns, violent sparking would, as we have already seen, at once ensue, for the short-circuited coils would be under the influence of the field they were leaving, and not under that of the field they were entering, so that the induced short-circuited currents would be in the same direction as that of the *a* series of coils which would be opposed by the main *b* current, and we should have disastrous sparking and rapid wearing away of the commutator, which would be positive to the brush. Upon analysing the two bands of armature coils, we should find that the coils lying between the lines A B C D are now carrying the current in the opposite direction so as to induce a north armature pole, opposite the south pole of the field magnets, and a south armature pole opposite a north field pole, or, in other words, the induction would no longer be opposing the field flux, but aiding it, and would hence be a forward induction. It must be thoroughly understood that there is no peculiar virtue in commutating the current when the short-circuited coils are under the influence of field from the leading horn, except that with ordinary windings this is the only position where sparkless commutation can be secured, and that the condition for sparkless commutation is, as has already been stated, that the short-circuited coil when it passes from under the influence of the brush must carry a current similar in value and direction to that of the series of coils into which it is thrown.

In May, 1893, Mr. W. B. Sayers read a paper before the Institution of Electrical Engineers, in which he claimed that by means of a winding which he had patented sparkless commutation could be obtained with a lag of the brushes, and that thus advantage could be taken of the forward induction of the armature. It has been mentioned that, owing to the back induction, when a forward lead is given to the brushes the field flux is weakened proportionately to the output of the dynamo, and that to overcome this weakening of the forward induction, the series or compounding coils must be added to the field coils if a constant E.M.F. is required with uniform speed at all loads. Now if the armature back induction be converted into a forward induction, not only will no compounding coils be required, but also the magnetising force of the shunt coils need not be so great, as the armature will to a large extent create its own field. That this is so is not only evident from theory, but is borne out in practice by the fact that with a lag of the brushes a motor will run without any field coils, although the speed will probably be enormous, owing to the induced field being very weak and the value of ϕ small.

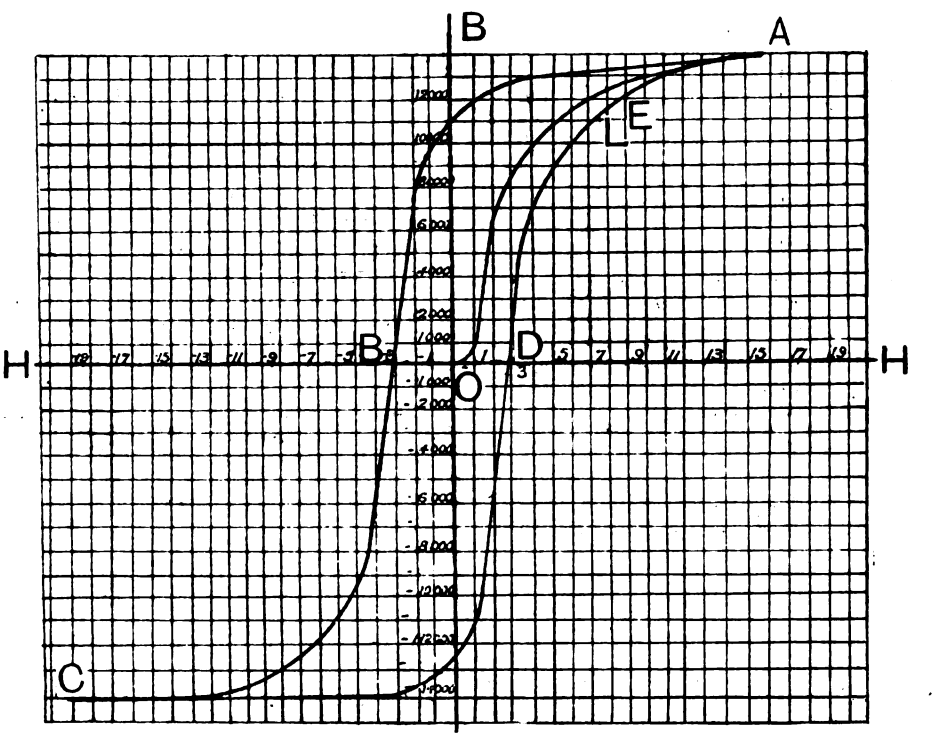


FIG. 28.

Fig. 30 gives a diagrammatic view of the arrangement of this winding, which is shown for a Gramme armature for the sake of clearness, although adaptable for either a Gramme or drum. There is first of all an ordinary closed two-circuit winding, and then interposed between each coil and its commutator section is a second coil, called by Mr. Sayers a commutator coil, wound behind the main coil. This coil is wound with the others, but in the diagram is shown below in order to avoid any complication of the coils. It is evident, as the short-circuited coils

Digitized by Google

have not yet reached the neutral plane, but are still under the influence of the trailing horns, that the coils to the right will be cutting a larger number of lines of force per unit time than those to the left, and hence will generate a higher E.M.F., and the resistances of the coils being the same, a larger current will flow round them. The object of this winding is to cause the short-circuited current produced in one set of coils to oppose the short-circuited current produced in the other to such an extent that the coil *d*, which is receding from the brush, may at the moment it passes from under the influence of the brush carry the normal current of the *b* series into which it is passing in the proper direction. In this, as in all other discussions on the theory of commutation, it must be remembered that if currents oppose each other along the same path, the resultant flow will only be the difference in their values.

Taking the output of the dynamo as 240 amperes, 120 will be due to the *a* series of coils, and 120 to the *b* series; and assuming that the two main coils, *d* and *e*, and the three commutator coils, *k*, *l*, *m*, generate short-circuited currents having the following values—viz., $d=60$, $e=120$, $k=120$, $l=240$, $m=420$—the currents which would tend to flow through the three lugs, *x*, *y*, and *z*, might be tabulated as follows:

In a forward direction to the commutator:

		y	*x*
Current due to *a*	60	40	20=120
,, *b*	20	40	60=120
,, *e*	—	80	40=120
,, *d*	—	—	60= 60
,, *k*	—	—	120=120
,, *l*	—	240	— —
,, *m*	420	—	— —
	500	400	300

In a backward direction from the commutator:

	z	*y*	*x*
Current due to *e*	80	—	40=120
,, *d*	20	40	— = 60
,, *k*	120	—	120=240
,, *l*	40	80	— =120
,, *m*	—	280	140=420
	280	400	300

Subtracting one from the other, it will be found that the currents through lugs *y* and *x* exactly balance each other, and that at the moment when *x* passes from under the brush no current is flowing through its lug, but that the whole of the current has been transferred to the heel of the brush—the condition necessary for sparkless commutation.

Reverting again to the question of the magnetic circuit, it is seen that unless by means of this winding, when a lag can be given to the brushes and the field of the active horns strengthened, sparkless commutation is impossible with a weak field; and it has also been shown that if the field is very strong, and the neck of the pole-piece is made of a small sectional area, an unsymmetrical field will be obtained, owing to the action of the cross-induction in distorting the field unequally. It is necessary, then, for the designer to choose a proper magnetic density for his magnetic circuit, and this will be found when the induction of the iron is equal to that which obtains when the curve of the sample piece has just passed the sharp bend marked E in Fig. 28. If the designer works at this point, he will find that the small changes in the magnetising force, which must occur in practice with the running of the machine, will make little difference in the E.M.F. induced.

At this point the permeability of the iron is still greatly in excess of that of air, and in order to obtain the best results the air-gaps must be kept as short as is possible, otherwise there will be a large expenditure of power in forcing the induction across these gaps. All joints in the magnetic circuit must be avoided as far as possible, and where these are inevitable they must be well fitted together. Dr. Silvanus P. Thompson states, in his "Dynamo-Electric Machinery," that if the induction of a solid bar with a magnetising force of $H=70$ be $B=17,100$, if the bar be cut in eight, B will only equal 15,200, whereas if the bar be compressed so as to close the joints and $H=70$, and B for the solid bar equal 17,200 for the bar cut in eight and compressed, B will equal 15,700. These figures show not only the bad effects of joints across the path of the magnetic flow, but also the difference which exists between a poor and a well bedded junction of two pieces.

We noticed that the curve of the complete cycle for the magnetisation and reversal of magnetisation of iron enclosed an area, and that this area represented the work done on the iron during the process of the operation. This work is completely lost for all useful purposes; we start with a piece of iron, magnetise it, reverse the direction of magnetisation, and then magnetise it again. We are then exactly as we started, and have effected no useful

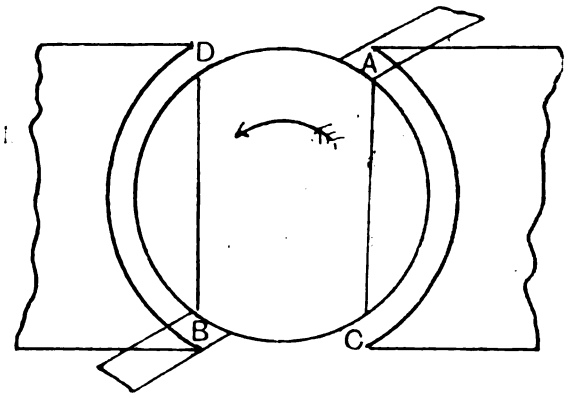


Fig. 29.

purpose, and yet have expended a certain amount of energy, and as energy cannot be destroyed, it will be found that it has been dissipated in a form we do not desire—viz., heat. It is evident that the size of the area, which is the measure of the work done, depends upon three things—the permeability of the iron, its retentiveness, and the strength to which it is magnetised.

What exactly occurs when a bar of iron is magnetised is not definitely known. Two theories have been advanced: that of Weber's is the one which is now almost universally adopted, and which is in accordance with all the known phenomena of magnetic induction. Weber proposes that

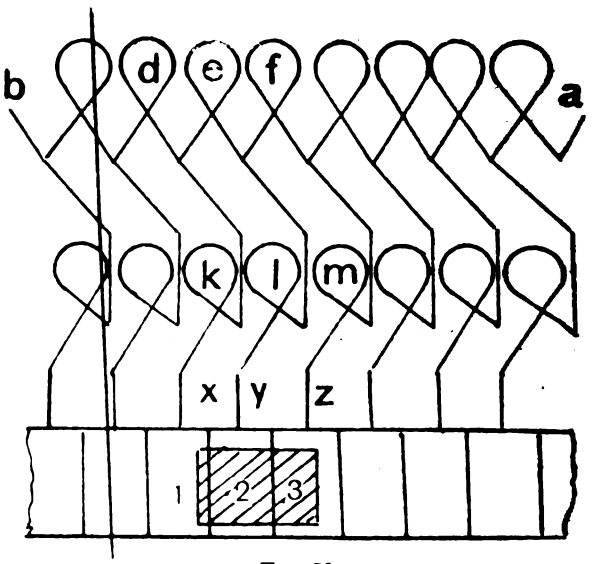


Fig. 30.

each molecule constitutes a small magnet, and that these magnets in an unmagnetised bar lie higgledy-piggledy, with their north and south poles pointing in any direction; or rather that they form closed magnetic circuits, so that there is no free magnetism. Upon the bar being magnetised these elementary magnets tend to set themselves in parallel lines, with all their north poles pointing in one direction and all their south poles in the other. It will be evident that if this is the case a very weak magnetising force will liberate a large number of these magnets from the closed circuits in which they are only loosely held, and cause them to take up the longitudinal direction. As the magnetising force is increased, more elementary magnets will be turned into the new direction, but as the number

Digitized by Google

to be turned is less, a smaller quantity will have their direction altered for an equal increment in the magnetising force. As the value of this force increases, fewer and fewer molecules will be diverted, until only those will be left which have become wedged into their primordial position, and if finally by the application of a very intense magnetising force these molecules are compelled to change into the required direction, no further increase will add to the strength of the induction in the iron, and the bar is said to be saturated. This it will be seen agrees fully with what does occur when a bar is magnetised, as shown by the curve in Fig. 28. Now, upon the magnetising force being removed, the molecules will take up their old positions, and again from closed magnetic circuits, and the bar will be demagnetised, or, rather, as a few molecules will become wedged in their new position the bar will still retain a little of its magnetism. This is what we find occurs in practice, and this magnetism is called, as we have seen, the residual magnetism. Again, if Weber's theory be correct, we should expect that it would be harder to magnetise a specimen in which the grain was close; the residual magnetism would be greater than in one where the grain was open, as not only more molecules would become wedged, but that also there would be more opposition to any of them moving. This also is found to be the case. A permanent magnet may be made of steel, but not of cast iron. Further, if during the process of magnetisation the bar be struck with a hammer the molecules will be moved, and will be freer to take up a new position, and so the effect of the magnetising force will be increased. This we find to be the case in practice, whilst the converse is also true, that a bar of iron at once loses much, if not all, its residual magnetism if sharply struck, which is what we should naturally expect if Weber's theory be true.

Accepting, then, this theory as correct, it is perfectly evident that if a piece of iron be not strongly magnetised—*i.e.*, if the molecules be not held in their position by means of a high magnetising force—small extraneous local magnetising forces will alter to a considerable extent the disposition of the molecules in their immediate neighbourhood, so that whilst we have seen that the hysteresis of an armature core varies as the induction, it is also evident that if the induction due to the field coils is not high, that due to the flow of current through the armature coils will greatly distort the resultant field, and also the self-induction of the short-circuited coils will be largely augmented, as the lines of force created by the stopping and starting of their currents will have a much easier path through the iron of the core than they would were the induction of the armature greater.

The designer is here met by a contradiction in his requirements. To minimise the loss due to hysteresis, the induction must be low, while to prevent trouble from the armature reactions the induction must be high, and one or the other must be sacrificed, or else a compromise must be made. Financial considerations must always have a great weight in determining any question of compromise, as for mere philosophical reasons it is not much good building a perfect machine if the cost is so great as to make the price prohibitive, and financial considerations are on the side of high induction and less weight of iron in the armature. The density of the lines of force is primarily governed by the heating, and loss of efficiency due to hysteresis and Foucault currents, both of which vary directly as the density and the number of revolutions per unit time; it also depends to a certain amount upon the special purpose for which the machine is required. If it is necessary to keep the magnetic flow constant with varying loads, the induction must be high in order to make the whole magnetic circuit insensitive to varitions in the magnetising force, for, as seen from Fig. 28, a large variation in H will make little or no difference to B if the induction be pushed far up the curve towards A. If, on the other hand, it is desirable that the E.M.F. should rise as the output in amperes is diminished—*e.g.*, a shunt-wound dynamo for charging cells—the induction should be much lower than in the former case. Consequently the induction permissible will vary between large limits according to the speed, and also that the purpose for which the dynamo is to be employed, and may be, according to Mr. A. E. Wiener, anything between 35,000 per square inch and 130,000 per square inch. In the introductory remarks it was stated that it was not sufficient when building a dynamo simply to copy the design of the first machine available, as the conditions under which the two machines had to work might be totally different, and then equal results would not be attained. The density of the lines of force in the armature core is a case in point, and should serve to show the student that each machine must be designed both from a knowledge of first principles and also in accordance with the modifications requisite for the special work it has to do.

The designer constantly finds, as in the case of the armature induction, that compromises have to be made and that the electrical or magnetic requirements are at variance with good mechanical practice (*e.g.*, the building up of the commutator), and throughout the whole design it is essential that he should not be slavishly bound to one side, as it were, and sacrifice all mechanical principles on the one hand, or all electrical or magnetic principles on the other; for the good designer is he who will keep the salient features of each and build a machine which, if not perfect, is in agreement with the fundamental principles of electrical and mechanical science.

(*To be continued.*)

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(*Continued from page 727.*)

2. *Cable Laying and Jointing.*

It will be best, perhaps, to commence this subject by reviewing the chief method of distribution, as regards class of conductor, material, and method of work, leaving jointing for the time to be treated later. The systems of distribution mostly in use are four in number, and can be classed as follows: drawn-in or conduit systems, solid laid systems, armoured cable systems, and bare copper systems.

Taking these systems in order as they stand, the conduit system, perhaps, appears better in theory than it works out in practice. For instance, we should like to use a conduit in our most busy streets, yet these are the very streets where we cannot find room for a conduit, as, above all, they are the streets which are most blocked by gas and water mains and their services, surface-water drains, cellar roofs, etc. It is very nice to think that in a particularly busy street, where it is almost impossible to open the ground on account of traffic, if we put in a conduit we shall, at the time of a fault occurring on a cable, be able to draw out the faulty cable and draw in a good one almost unknown to the general public using the footway. It seems hardly worth while to put in a conduit in a sparsely populated district, yet this is the district where we could best instal one.

If, however, conduits can be placed in our most busy streets, they will be found to answer very well in the case of an alternating supply, but not so very well in the case of a continuous-current supply, owing to electrolysis. It is quite unsafe to draw into a conduit lead-covered cables for use with continuous current, even if the conduit be made of earthenware; and if the cables are not lead-covered, there is great danger of the insulation and the protecting yarn or tape perishing before long owing to being continually wetted and dried as the weather changes. If it is intended to use a conduit for continuous-current work, cables insulated with vulcanised bitumen or rubber will probably give better results than others, as these materials have been found to stand fairly well in damp conduits, and they, moreover, are better suited to the strain of drawing in than cables covered with fibre or paper, this, of course, taking for granted that lead-covered cables will not be used. Whichever insulation is used, the insulating material must be well protected with braid, tape, or yarn, and in the writer's opinion ought to be so protected to at least twice the thickness usually employed; indeed, this protecting covering might well be made much heavier than it usually is on all cables that are not lead covered and for whatever system used, not speaking, of course, of house installations.

In cases where electrolysis has put in an appearance, it has

Digitized by Google

been found that the lead covering of the cable has been nearly of the same potential as earth—that is to say, a water or gas main—and that the potential of the surrounding ground has been anything up to five volts above that of earth, thus causing the destruction of all the metals at the lower or earth potential. This great difference of potential between the lead covering of a cable and the surrounding ground would obtain more often where the cable was lying in an iron pipe, and where the surrounding ground was of a sandy nature; so that it follows that no attempt to earth the lead of any continuous-current cables should be made, but an attempt rather to insulate them from earth.

Concentric or triple-concentric cables for use on an alternating supply can be made with a dielectric of any material liked, as they can be lead-covered with impunity; such lead covering is, however, better left without a serving of braid or yarn The insulating material for such cables will be found to answer well if made of fibre or paper, and, in the writer's experience, have answered better than rubber or bitumen when used in conduits.

Although perhaps not bearing directly on the question of conduits, it may be as well to state here that in a continuous-current supply the negative cable is the one that gives the most trouble, a positive earth being comparatively rare, so that if in the case of a three-wire network triple-concentric cables are used, the inner core should be made the negative pole, the intermediate being the positive and the outer the neutral and earthed conductor. The use of concentric cables would, of course, enable the size of the conduit to be materially decreased—that is to say, so great a number of pipes or ducts would not be required. If single-conductor cables are used, a rule which must never be broken is that no more than one cable must be in one pipe, however large the pipe. Even if two or more cables of comparatively small sectional area are used to make up the size necessary for one pole, yet each of these should be in a separate pipe, as if one goes wrong it could not be withdrawn without damage to its fellows if all the cables so used were in one pipe, owing to the fact that the cables when so drawn in would twist together. These remarks about single-conductor cables apply only to continuous-current supplies.

Some engineers lay down conduit systems in which they use the conduit for their feeder cables, laying down the distributors on some other method outside the conduit. This appears to be a wrong idea, because taking it for granted that we have laid our conduit in a busy street, and that as a rule it is the distributor that goes wrong and not the feeder, it is therefore the distributor that we shall most likely have to withdraw; and this can be so easily done with a distributor, even after it has been tapped in many places with service joints, as it can be cut up and pulled out in short lengths, a short length of new cable being pulled in to replace it. In this way very few consumers would have to be changed over in one day, as the composite, bad and good cable, would be charged at one end only, and that the good end, until it was good right through. The bad end could be supplied through a fuse inserted between the good and bad parts. All the succeeding good pieces can be easily joined together in a service box; this method of joining will be mentioned when speaking of jointing generally. When arranging for a conduit, care must be taken that enough ducts are allowed for, so that the ground has not to be opened again.

It will now be necessary to turn our attention to materials used and methods of using them. Conduits are constructed of glazed earthenware, sometimes in the form of single-collared pipes, and sometimes in short lengths, each length containing any number of ducts; of cast-iron socketed pipes; of zinc pipes; and sometimes of bitumenised paper tubes The single-collared earthenware pipes, the short lengths of multiple ducts, and the cast-iron pipes can be laid direct in the ground, the joints of the single iron and earthenware pipes being made after the pipes have been placed in position by neat cement being forced into the sockets in each case. The zinc and paper tubes are laid on a concrete bed and covered up with concrete. So that as the multiple duct earthenware conduit is made of very hard material, and can be laid direct in the ground, except for the necessary concrete round the joints, it will probably give the best result as to minimum amount of room required. If this class of conduit is used, or, for that matter, whatever class is used for distributors, care must be taken that sufficient room is left between one cable and the next cable or duct to allow the service joint-box to be fixed or a straight joint to be made. As it is almost impossible to make a good job when putting on a service to a cable in a conduit unless small brickwork boxes are provided, these will have to be built—the conduit being cut away as required—but can be built when and where circumstances require them. They need have no bottoms, and, indeed, are better without them, as any water which gets in from above immediately soaks away. If the conduit is laid low enough in the ground, the brick box can be covered with an ordinary rough flag, ground being filled in on the top to the necessary level for the paving flag. A glance at the accompanying sketch (Fig. 1) will show at once the arrangement meant. In

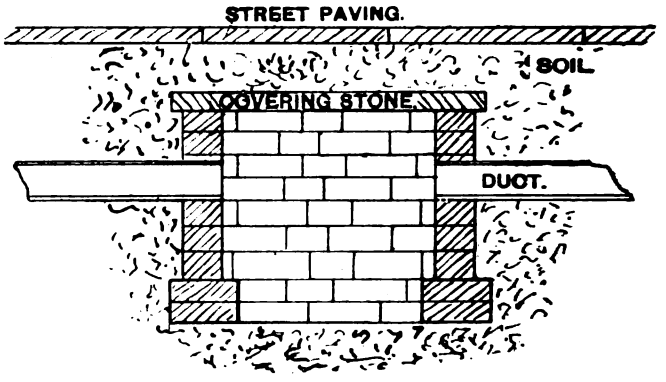


FIG. 1.—Brick Service Box.

some cases these brick boxes are built when the conduit is laid, and a box is usually placed opposite to every other party wall, thus making allowance for two services—one to each adjacent building If built at this time the boxes are usually brought up to the paving level and provided with a cast-iron frame and cover, the cover being filled in with a fine concrete made of granite chippings and cement, in the proportion of 3 of the former to 1 of the latter. Iron frames so placed must be earthed, preferably to the nearest water-main. The zinc and paper tube conduits have nothing to specially recommend them, the paper tube least of all, as if once a cable is drawn into such a tube and left there a few months, it needs a traction engine to draw it out again, because the cable sticks to the bitumen used with the paper; in fact, it is possible to pull a small cable in two and then not start it. The ducts in any conduit are best cylindrical in form.

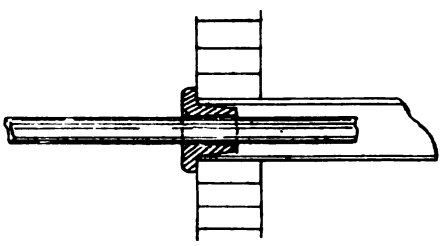


FIG. 2.—Plug for Duct.

The conduit, if constructed of earthenware, will need some protection on top, such a protection as will stand the blow of a pick, and also one that will warn the user of the pick that he must use care. A layer of concrete has been tried, but when the average navvy comes to a bit of concrete in making an opening he generally lets go all the harder until he has smashed through it. Iron, again, if cast, would fly in pieces when struck, and if wrought would soon rust away; moreover, both would be very expensive. In actual practice a board of pine or elm about 1¼in. thick, creosoted or boiled in Stockholm tar, has been found to give the best results, as when struck with a pick the pick usually sticks in, giving the user not a little trouble to get it out again, thus giving him plenty of warning that there is something unusual in the ground. If the conduit were constructed of thick cast-iron pipe this covering would not be needed, but cast iron cannot be recommended for conduits, as there seems always to be a more or less deleterious action going on between the cast iron

Digitized by Google

and the cable, whichever supply is used and whatever the class of cable employed.

Whichever class of cable or conduit is used, the ends of the ducts containing cables should be stopped with a solid rubber or wooden stopper. The stopper would necessarily be made in halves, the outside of the stopper tightly fitting the duct, a circular boring through the centre clasping the cable, as shown in Fig. 2. The use of such stoppers prevents corrosion of the cables, so often found at the ends of conduit ducts, probably caused by the deleterious action of the glaze on the stoneware; they also prevent the accumulation of gas in the ducts, and to this end any empty ducts should also be stopped.

When laying a conduit, a galvanised iron wire, say of No 10 B.W.G, should be threaded through each length as laid and left in; this wire can afterwards be used to draw in the drawing-in rope, and will save a lot of work in the end When drawing in cables, if the run of the conduit be fairly straight, a length of 200 yards is not too much to pull in at once, as it is always well not to flake the cable more than necessary. Of course, the heavier the cable, the more men will be required for drawing-in, and a man should be stationed at each intermediate box to direct the cable as it runs past him, and to keep it from rubbing by the application of some lubricant. A good lubricant can be made of pure tallow worked up with powdered blacklead. This should also be freely applied to the cable at the paying-in end.

The drawing-in rope must be securely fastened to the copper of the cable, and in the case of a concentric cable each conductor should be attached to the rope This fastening can best be made by providing an iron eye or

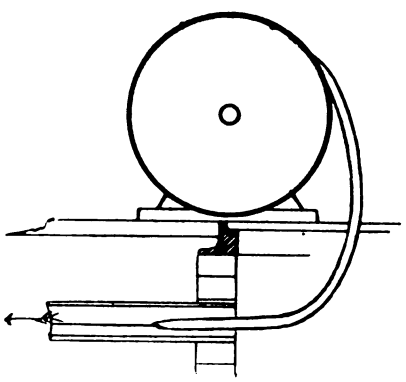


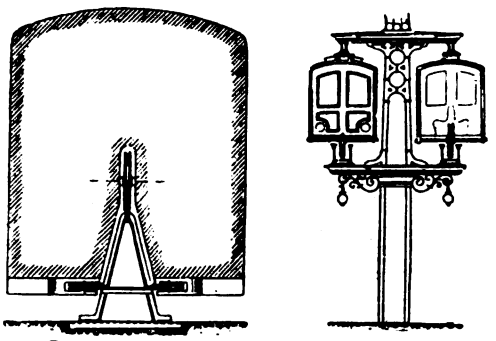
FIG. 3.—Drawing in.

thimble which should be wire spliced on to the end of the rope, a neat taper being made by the splice, which can then be whipped over with hard twine. The cable conductor or conductors are then halved, and each half passed through the eye in opposite directions and then bent backwards to the cable, being laid neatly down, and three or four copper binders fastened over and round all the strands. The whole cable end is then to be taped up and painted with waterproof compound to prevent any water which may be in the duct from getting into the cable. It will be found that 20 men will be sufficient for the whole work of drawing in, say, a 200-yard length of $^{37}/_{16}$ concentric lead-covered cable. This will allow four men to be stationed at the drum. The drum is best mounted about three yards away from the drawing-in box, and so mounted that the cable comes off underneath the drum, as this way there is less risk of damage to the cable, because the cable is more in line with the duct than it would be if it came off the top of the drum A very good way of mounting the drum is shown in the sketch (Fig. 3); in this case the cable does come off the top of the drum, but is still as much in line with the duct as it can be. As the cable is running in, it must be kept off the edge of the box on the paying-in side. The foreman in charge of the work should stand near the drum during the whole operation, except occasionally to look at the intermediate boxes to satisfy himself that the cable is running without undue rubbing. He should be provided with a shrill whistle. Before pulling in a cable a swab of spun yarn or waste should be attached to the wire which has been left in the duct, and pulled through in advance of the drawing-in rope; this will clear the duct of any dirty water which may be there.

(To be continued.)

THE BARMEN-VOHWINKEL SUSPENDED RAILWAY.

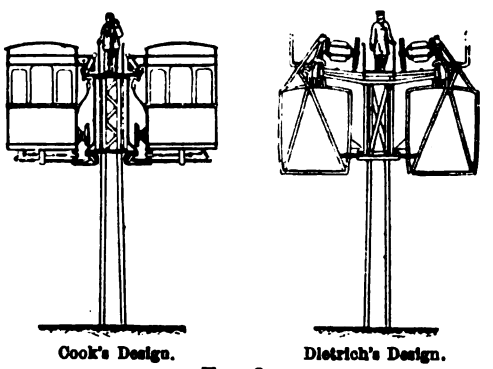
In the *Centralblatt der Bauverwaltung* there was commenced on Oct. 13 last a series of articles describing in detail the new suspended railway between Barmen and Vohwinkel. It will be remembered that a section of this railway was recently opened by the German Emperor. We venture to quote the following details of the railway from the above-mentioned source of information, to which we are also indebted for the drawings here reproduced.



Lartigue's Design. Beyer's Design.

FIG. 1.

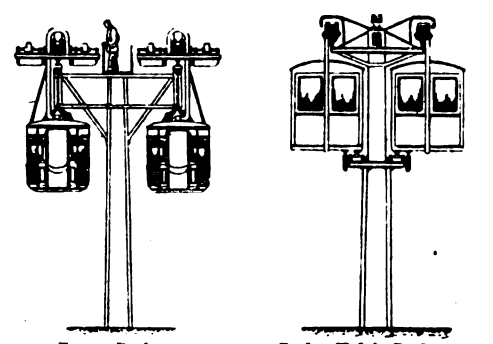
The Barmen-Vohwinkel Railway claims to be the first railway constructed for local passenger traffic in which the trains are supported directly under the track. That the idea of passenger conveyance by means of



Cook's Design. Dietrich's Design.

FIG. 2.

hanging or suspended cars, instead of by ordinary adhesion railways, contains much that is fascinating, is proved by the numerous proposals which have been made to construct such railways. These proposals must be looked upon as forerunners of the Barmen-Vohwinkel Railway, but their pros-



Enos's Design. Perley-Hale's Design.

FIG. 3.

pects of success were injured by the fact that in their design it was sought to embody the principle that all lateral movement of the cars should be as religiously avoided as in the case of ordinary surface railways. It is abundantly evident that to insist upon this condition would be to preclude the possibility of a mono-rail track. This circumstance has had a considerable influence upon the construction of such railways. The centrifugal force exerted round curves necessitated provisions of a similar nature to those for surface railways; to the perfecting of the rail track especial care had to be devoted; the points were complicated, and so on. Some inventors placed the centre of

Digitized by Google

gravity of the car above the rail, others on the same level, and yet others below the rail. The first method of construction is represented by the designs of Robinson and Palmer (1826), Fell, Haddam, Le Roy, Stone, Lartigue (Fig. 1), Decauville, Meigs, and Behr, who provided that the cars should straddle the bearing rail, as in Lartigue's design (Fig. 1). Below the bearing rail are provided guide rails, as shown, to take the thrust due to the lateral force acting upon the car. As regards the number of these guide rails, Behr has gone to the farthest extreme. Besides the bearing rail he provides four guide rails. A single car, which was employed upon an experimental railway of the Behr type at Brussels, possessed no less than 40 bearing wheels. The design by Beyer (Fig. 1) embodies an equivalent arrangement, the auxiliary rails being in this case supported by special girders fixed above the cars. To the second group of the suspended car types, in which the bearing rail is arranged to the side of the car's centre of gravity, belong the types designed by Cook (Fig. 2) and Dietrich (Fig. 2). The first-named inventor exhibited a small model at the Chicago Exhibition in 1893. Dietrich's design was evolved in 1895. To the third group belong, among many others, the types of construction proposed by Enos (Fig. 3) and Perlay-Hale (Fig. 3). Enos employed two slanting stay wheels arranged above the car body as shown, while Perlay provided guide wheels underneath the car. The structural and working disadvantages involved by thus staying the body of the suspended car are entirely absent in the Langen type of car. In this latter type all means of auxiliary support have been discarded, the car being left free to move laterally. By making this radical departure from previously conceived types of suspended railways, Herr Langen and his partner, Herr Feldmann (Government architect) have succeeded in endowing the new form of railway with a high standard of excellence. The railway having no precedent of its particular kind, the design, of course, embodies many originalities. Problems hitherto unknown to railway work had to be considered and practically solved—in what manner we shall see. Not only was there no existing example of a viaduct of suspended track required which could serve as a precedent, but details of the cars, of the railway itself, the points, cross-overs, and other arrangements, had also to be severally considered, and designs evolved to suit the unique conditions imposed.

Unfortunately, the inventor of the railway—Privy Councillor Eugen Langen—did not live to witness the completion of his pet scheme, nor, indeed, the commencement of its practical realisation. Death claimed him when he was in the midst of preliminary preparations for executing his novel scheme. At the beginning of 1893 he had entrusted Herr Feldmann with the elaboration of the proposed scheme. In the same year patents were applied for, and practical experiments on a limited scale made; also the preliminary plans for the Barmen-Vohwinkle suspended railway submitted.

The experimental railway—an O-shaped loop, consisting of two semi-circular end sections of 33ft. radius, connecting two straight rail sections 66ft. long, which formed the sides of the loop—had two bearing rails. The track had a gauge of 18in., while the experimental car was mounted upon two four-wheel bogies, which allowed it ample side play. Langen at first adhered strictly to the two-rail type of track, and was supported in this by expert advice. The success obtained with the experimental track also seemed to bear out his theory, and the original plans submitted for the Barmen-Elberfeld line therefore provided for a two-rail track. The scheme, however, was destined to meet with considerable opposition before its practical realisation in a modified form. Most of this opposition had its origin in that in the townships concerned the construction of electric tramways of the ordinary type by a local company was under consideration at the time. Also the opposition of the general public to a municipal undertaking of the description proposed made itself felt. However, the scheme was actively promoted, and eventually won on its merits. The greater security to life offered and the possibility of a higher speed being obtained, were points which told greatly in its favour. By an agreement entered into at the end of 1894 by the united municipalities of Barmen and Elberfeld, the requisite powers to construct the railway were conferred upon Messrs. Schuckert and Co., of Nürnberg. It was subsequently decided to continue the railway to Vohwinkel, but further delay occurred in making the final arrangements. Meanwhile,

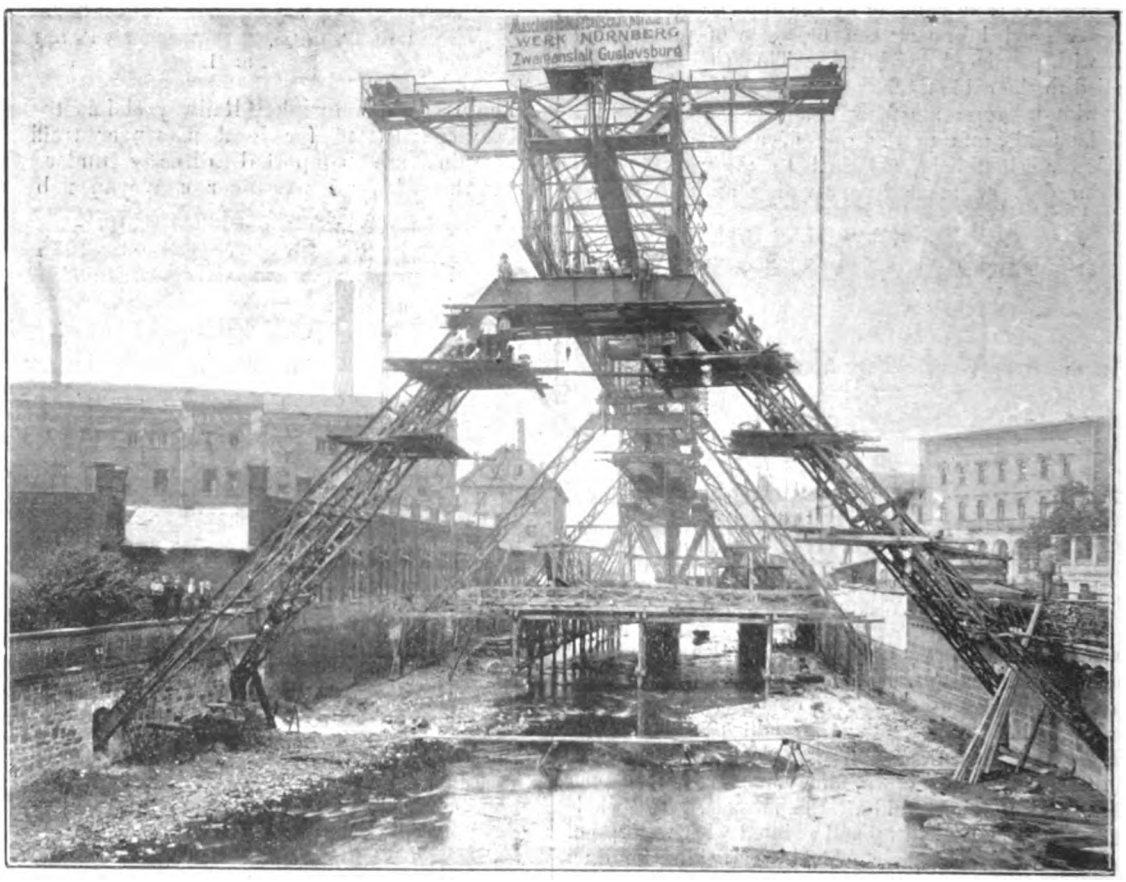


Fig. 4.—Wupper Section in course of Erection—Barmen-Vohwinkel Railway.

Digitized by Google

however, an experimental section of track constructed on the mono-rail principle was erected. So successful were the results obtained that even the town authorities urged the adoption of a mono-rail track, which course was eventually decided upon. The actual construction of the railway was commenced in 1898, and at the beginning of the following year a trial run was made over the first completed section of the line. A length of 2¾ miles is already open for traffic, and another 2¼ miles is expected to be ready shortly, though the Barmen section, which will be 3¾ miles long, is not likely to be completed before 1902.

For a distance of nearly 6½ miles the railway is suspended over the River Wupper, and follows the main road for another 1¾ miles to the railway station at Vohwinkel, where it joins a network of electric tramways communicating with Ohligs, Düsseldorf, Solingen, and Mettmann-Wülfrath. For the most part the course of the railway is of a winding nature, the sharpest curves being of 300ft. radius, except on the sidings, where curves of 26ft. radius are the rule. The line reaches its lowest level at Sonnborn, which lies about 105ft. lower than Ritterhausen, where the Wupper section commences. From Ritterhausen to Sonnborn, a distance of 6½ miles, the line, therefore, makes a gentle descent. But numerous rises and depressions occur *en route*. These, however, are so arranged that the trains proceed over the track at an uniform speed. From Sonnborn onward to Vohwinkel the track rises again about 130ft. On the whole the gradients are moderate, though at the Vohwinkel end of the line gradients up to 1 : 22 occur. There are 20 stations arranged at intervals of from 350 to 1,100 yards along the route, which gives a mean distance between stations of 760 yards. The superstructure of the railway is of a substantial character (as will be seen on referring to Figs. 4, 5, and 6), which show it in various stages of completion. The vertical girder supports are spaced at intervals of from 70ft. to 100ft., and straddle the

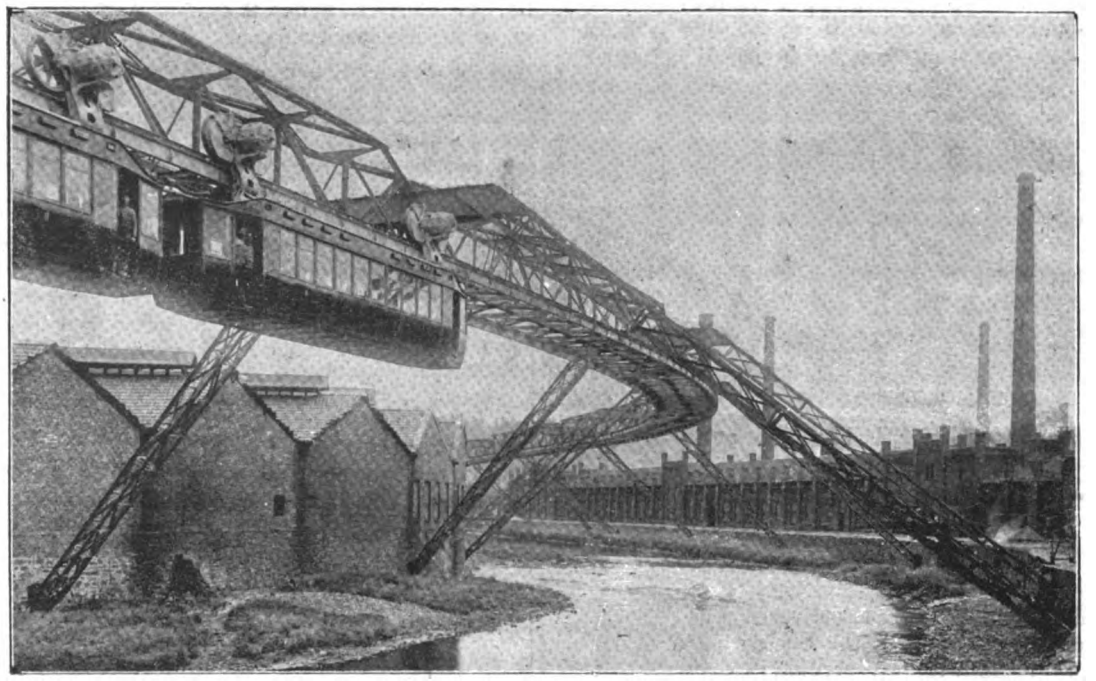


FIG. 5.—Wupper Section—Barmen-Vohwinkel Railway.

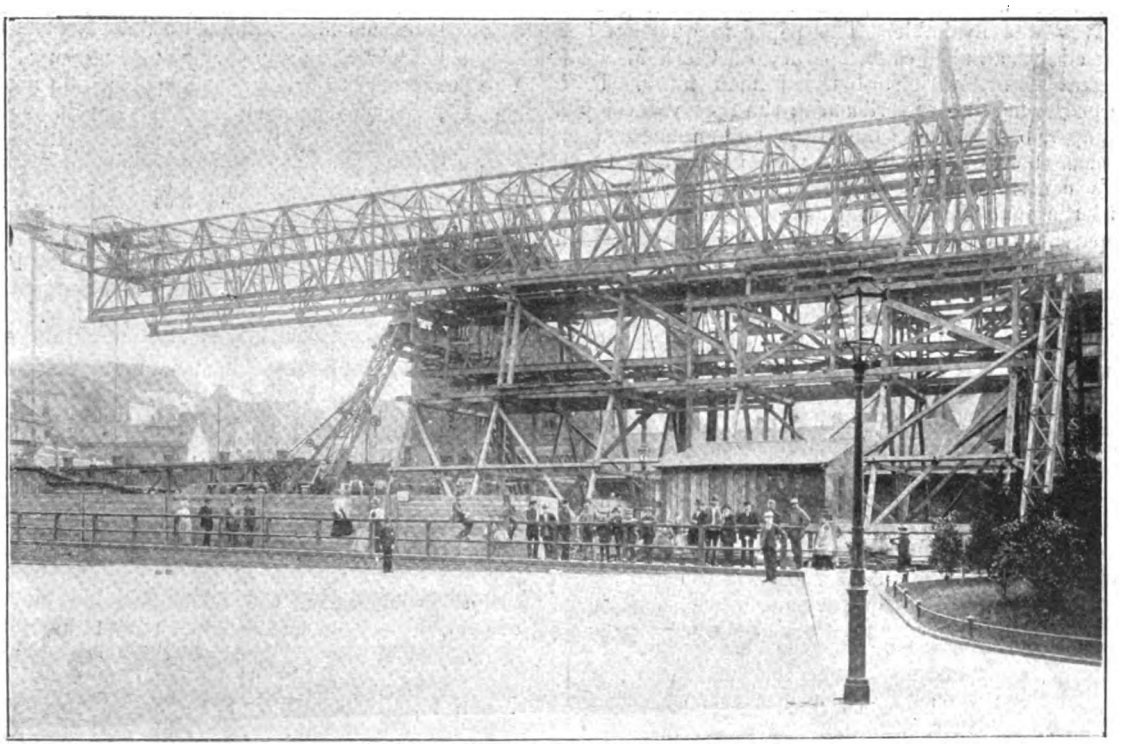


FIG. 6.—Superstructure in course of Erection—Barmen-Vohwinkel Railway.

Digitized by Google

river (as shown in Fig. 5), while square frames (Fig. 7) are employed over the roadway section of the line. At intervals of from 150ft. to 1,000ft. fixed groups of supporting yokes are placed, with an expansion joint half-way between them. The intermediate vertical supports are provided with ball and socket joints, and can therefore yield to temperature effects in either direction, whilst the fixed supports take up the longitudinal thrust of the superstructure due to the expansion. Since the supporting yokes of the several forms mentioned are subjected almost exclusively to direct pressure, and only in a very moderate

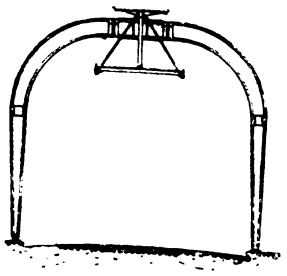


FIG. 7.—Portal Frame.

degree to a bending action, it has been possible to adopt the light braced girder type of construction shown.

ELECTRIC OSCILLATIONS.

The third Cantor lecture delivered by Prof. J. A. Fleming on Monday last at the Society of Arts did not deal quite so much with the oscillatory currents as those which preceded it. The lecture was devoted rather to the means of propagation of the electric waves through space. The lecturer explained that it was now generally accepted that all theories of action at a distance must be given up, and that phenomena connected with the action of distant bodies on each other required the presence of a transmitting medium. It was not until 1864, when Clerk Maxwell read his most interesting paper on the dynamic theory of the electromagnetic field, that any reliable explanation of what takes place in transmitting electrical waves was available. The paper in question had been classed by an able contemporary of Clerk Maxwell as the greatest production of the human mind. Prof. Fleming proceeded to give a *résumé* of the theory developed in this paper, but at the same time he reminded those present that there was much more than he gave in Clerk Maxwell's contribution to science. There were certain things in the investigation of this great scientist which were apparent, and there were other conclusions which could be deduced which were not at all clear. In fact, there were certain things in the investigation of this great scientist which were not at all clear, but which might be more understood as time went on. The author himself had said that his book was written with the idea of educating himself (Clerk Maxwell) and not for the public. But he intended afterwards to write two more volumes to explain the first. Unfortunately, however, his life was not spared to enable him to do so. Prof. Fleming went on to explain that there were two complete systems treated of in the paper by Maxwell—*i.e.*, the electric and magnetic systems. The various similarities of these two systems were gone through, as were also their circuit laws It was then shown that any displacement in space, caused, say, by an electric discharge, was propagated in waves, and that in these waves there were both electric and magnetic phenomena closely interlinked. An interesting diagram was then shown to illustrate that a displacement of an electric charge produces a magnetic force which tends to cause equal and opposite electrical displacements in the surrounding media. In this way the waves were propagated outwards much in the same way as the circular waves caused in a pond when a stone is thrown in. The next point to be determined by Maxwell was the velocity of the displacement. The lines on which the investigation proceeded were too long to give in a one-hour lecture, but the investigation could be simplified on the assumption that of the total energy of the wave half was potential energy and half kinetic energy. On this assumption, if E equals the maximum electric force, H equals the maximum magnetic force, K equals the dielectric constant, and μ equals the magnetic permeability, the following equation would be obtained:

$$\tfrac{1}{2} K \left(\frac{E^2}{2}\right) = \tfrac{1}{2} \mu \left(\frac{H^2}{2}\right).$$

But under the well-known laws of the electromagnetic circuit, $E = v\ B = v\ \mu\ H$. From the above equations $v = \frac{1}{\sqrt{K\mu}}$. The v in the equations represent the velocity of displacement which, when multiplied into the total flux, B, gives the E.M.F. in a unit length of the wave. The next point for consideration was that whereas K and μ for air are always assumed as unity, we had not a knowledge of their absolute value. In 1856, however, a method had been found to ascertain the product of K and μ, although neither of the quantities was known absolutely. The lecturer referred to the fact that v was the ratio between the absolute units of the electrostatic and the electromagnetic system. It was then found experimentally by Profs. Weber and Kolrausch that this velocity was practically the same as that of light, being equal to about $2{\cdot}99 \times 10^8$. Another step in the investigation was reached from the refraction of light as a ray enters a denser medium from the air. It was proved that the sine of the angle of incidence and refraction were proportional to the velocity of light in the media respectively. This velocity was proportional to the product of K and μ, and as μ was practically the same for the great majority of substances, this afforded a means of ascertaining the dielectric constants, as they should be equal to the square of the refractive index of the various substances. In Clerk Maxwell's time these properties had not been determined for a great many substances, and hence he was only able to apply this reasoning to a limited number, many of which gave discordant results. As an example of substances which agree with the above law, the following may be instanced:

	Dielectric constant.	(Refractive index)².
Sulphur	4·72	4·89
Paraffin	2·3	2
Petroleum	1·9	1·92
Petroleum oil	2·07	2·07

As an example of those substances which do not agree with this law, a very numerous list can be given, such as:

	Dielectric constant.	(Refractive index)².
Glass	6·57	2·37
Calcite	7 7	2·7
Mica	6·64	2·54

The next portion of the lecture was devoted to the description of a number of experiments made by Prof. Dewar and the lecturer on the dielectric constant of various substances which do not agree with the law. They found that the dielectric constant was largely influenced by temperature, and hence undertook an investigation of the properties of the various substances at exceedingly low temperatures, such as could be obtained with liquid air. In practically every case it was shown that as the temperature of the substance approached zero, the dielectric constant became very nearly equal to the square of the refractive index. Experiments were given with the apparatus used in these determinations. Particular interest centered round the use of liquid oxygen, because in this case μ was not unity. Careful experiments had shown that μ for liquid oxygen was equal to 1·0041, while K had been determined by the lecturer and Prof. Dewar to be 1·491. Another experimenter, Hasenochal, had also determined K and found the value of 1·465. If the mean of these two results were taken, one then got that K μ was for oxygen 1·484, whereas the square of the refractive index was 1 4837. As showing the influence of temperature on the dielectric constant the following figures were given:

	Dielectric constant. 15 deg. C.	Dielectric constant. -185 deg. C.	Refractive index².
Water	80	2 4	1 78
Castor oil	4 78	2·14	2·5
Glycerine	5·6	3·2	—
Olive oil	3·16	2·18	2·13

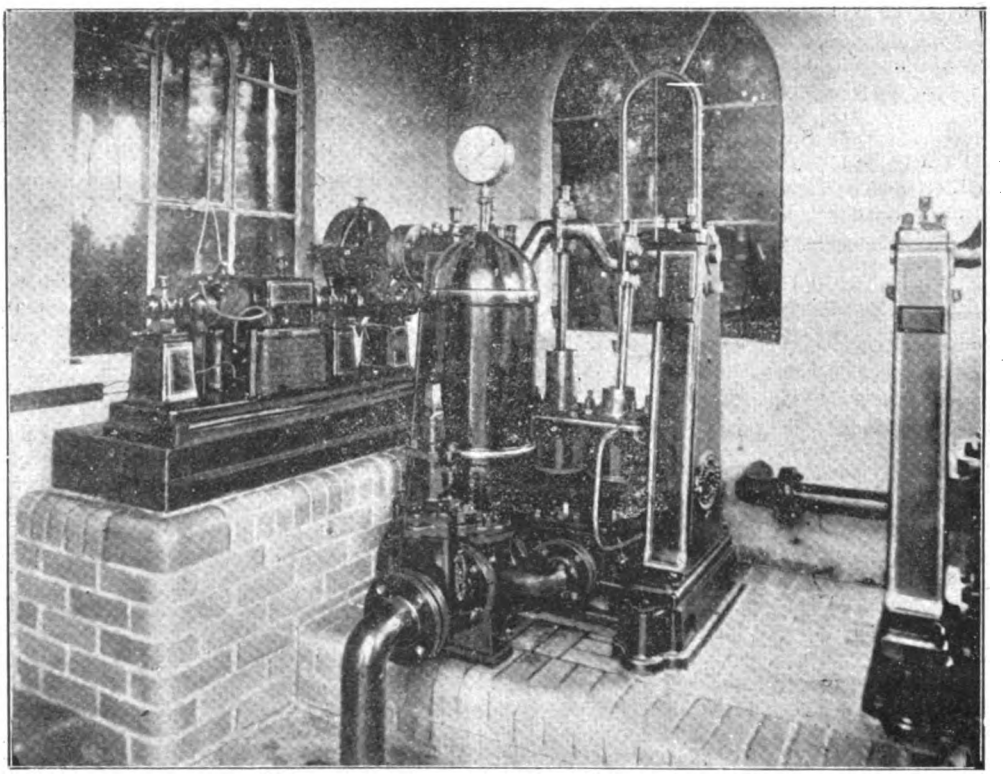
Digitized by Google

Attention was drawn to the fact that the similarity between the dielectric constant and the refractive index^2 occurred in substances whose composition was rather complex. The empirical law devised by Thwing was given for predetermining the value of K for these complex substances, and the lecturer stated that it gave fairly accurate results. In the course of the experiments it was also found that the frequency at which the condensers used in determining K were charged and discharged had an effect on this constant. Increase of frequency, like the lowering of temperature, tended to bring K more nearly equal to i^2. This led the lecturer on to a *résumé* of the various ether theories which have been in vogue during the century. These could be classed under three heads. By the first it was assumed that ether was a rare gas, but this had to be abandoned, as had also the theory that it was an elementary solid. The theories developed by Dr. Lamor, known as the rotating ether theory, was at present most favourable. He commended Dr. Lamor on the subject to those present in order that they might learn that scientist's view on the great ether question and on electrons, which he considered to be strains in the ether. One deduction from the theory was that electricity was atomic in character, and that matter generally was a solid form of electricity. There was much to be gained by the study of these various theories, even if they should be discarded in favour of others in the course of a few years. Theories helped us to search for new facts which would not be discovered but for theoretical predictions. At the same time they helped us to rearrange the facts already ascertained, and in this way forwarded general knowledge.

ELECTRICAL PUMPING OF SEWAGE.

The tiny village of Combs, Suffolk, would hardly suggest to the casual observer the existence of an up-to-date sewage scheme. Recently, however, in conjunction with the adjacent town of Stowmarket, a sewage scheme has been introduced, and a number of gentlemen were recently invited to inspect the pumps erected in the above village.

The machinery consists of two sets, each set comprising a three-throw pump driven by an electric motor through worm gearing. The bearings of the motor are lubricated automatically, the worm and wheel run in an oil bath, so that no attention would be required other than to start the motors and stop them when necessary; but even this labour has been dispensed with by the use of automatic switches controlled by the level of the sewage in the sump adjoining the pumping station. These switches can be easily altered so as to make either pump start in advance of the other, and a convenient arrangement is to allow one pump to deal with the ordinary flow of sewage, the second pump only starting if the sewage continues to rise when one pump is at work; and as it is easy to make either pump take the lead, they can be worked alternately week by week or month by month as desired, so that both sets of machinery are kept in good working order and do an equal amount of work. The power is derived from the electric light supply of Stowmarket, distant about three-quarters of a mile, and as it was desired that there should be no great fluctuation of current likely to affect the electric lights burning on this circuit, an ingenious arrangement of dashpot, with multiple-contact automatic switch, has been used, which gradually switches on the starting current over a period of from five to ten seconds.



Electrical Pumping Plant at Coombs, Suffolk.

The engineers who are responsible for this very pretty and useful installation are Messrs. Taylor, Sons, and Santo Crimp, while the contract has been carried out to their entire satisfaction by Mr. Napier Prentice, of the Anglian Engineering Company, Limited, of Stowmarket. The accompanying illustration is reproduced from a photograph taken of one of the pumping sets. It was difficult to get a good position for taking this picture, as, owing to the very small space required for this class of machinery, the building containing the two sets of pumps is under 15ft. square. The absence of steam, gas, or oil engines enables the pumping station to be kept scrupulously clean. The interior of the building presents a very pleasing appearance, the foundations for the machinery being faced with choice coloured glazed bricks set on a tiled floor, while the highly-finished machinery itself is painted black and carefully lined with gold.

CARDIFF.—Work in the direction of laying the new track for the electric tramway system which the Cardiff Corporation have decided to provide is to be commenced on Monday next.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	829	Institution of Civil Engineers	852
The Arrangement of the Distributing Network	834	Questions and Answers	853
The Philosophy of Dynamo Design	836	Light Railways	855
Practical Notes on Electric Mains	839	New Companies	855
The Barmen - Vohwinkel Suspended Railway	841	New Committees	855
Electric Oscillations	844	Legal Intelligence	856
Electrical Pumping of Sewage	845	Companies' Meetings and Reports	856
Electric Railways	846	Contracts for Electrical Supplies	858
eviews	847	Lighting Notes	859
Forthcoming Events	847	Traction Notes	861
Polyphase Electric Traction	848	Provisional Patents	863
Institution of Electrical Engineers	851	Specifications Accepted	864
		Traffic Returns	864
		Companies' Stock and Share List	864

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

ELECTRIC RAILWAYS.

The discussion on Mr. Langdon's paper at the Institution and its branches will, if it does nothing else, focus the opinions that are held upon the subject by competent men. It ought to do more—to plainly indicate the conditions under which electric traction on railways is commercially practical; by this we mean will be a paying introduction. Railways are of many kinds, because the necessities of modern civilisation are manifold. It may hence be preferable to restrict our remarks to one point, and to one point only, of this great problem. Those who have made themselves acquainted with the history of railways will know that the first railway in the modern acceptation of the term was that between Manchester and Liverpool, opened some seventy years ago, constructed under the genius of Stephenson. Here were two populous centres desirous of quicker means of intercommunication. Over two hundred years ago—in 1677—Sir W. Petty wrote these pregnant words: "There is much more to be gained by manufacture than husbandry, and by merchandise than manufacture." If any century has proved the truth of these words, it is the century just coming to an end. The necessities of manufacture and of merchandise have led to huge congeries of population upon suitable areas. The problem to be solved, or rather the one point to which we have alluded, is how to obtain free untrammelled means of communication between the various points in these congeries of population. Take Greater London as the worst case. We have ordinary street traffic, tramway traffic, underground and ordinary railways, yet the cry is, More facilities. Take any outlying populous district, such as West Ham or Greenwich and neighbourhood, with even the existing facilities an exasperating lapse of time is lost in getting to and from the City. If the attempt is made to go by train, the train has to stop at every station, and thus loses time to those whose destination is the terminal point. Under existing railway conditions it is almost impossible to decrease the time spent upon these journeys, and thus the question is raised, Is it commercially practicable—that is, payable—to directly connect two such centres by means of electrical traction or otherwise in order to avoid existing delays? We have more than once in recent years pointed out the seeming apathy of the great railway companies to the needs of suburban districts. They have hitherto seemed quite satisfied with developing to the greatest extent their lines as they exist, ignoring the increasing competition of trams and 'buses. Now, the railways have their freeholds. They can burrow under the existing lines in tunnels, or build above them on viaducts; they can adapt their stations to the delivery of passengers at the level of the ground, or above or below as they choose, with the one proviso insisted upon by the shareholders, that they make the change pay. They can adapt existing lines to a mixed traction system if that will help them, and this paper of Mr. Langdon's shows that the railway officials are not so unobservant as they were supposed to be. His figures may be incorrect, his

Digitized by Google

conclusions thereby imperfect, but that is merely a detail in the consideration of so vast a subject. It is not the first figures nor the first conclusions, but these modified after consideration by competent critics that concern us—the question is where, when, and how can electric traction be introduced so as to increase facilities for intercommunication. We might have pointed to the fact that a railway on the Behr system is suggested between the two populous centres, Liverpool and Manchester. Surely whatever arguments can be urged for its adoption, these are valid when considering the needs of Greater London. These needs are not met by the many projected deep-level lines as arranged at present, and which would do very little towards solving the problem before us. What is wanted is a number of express routes to distributing centres in the distant suburbs, and for such lines there is an ever-increasing prospect in the future.

REVIEWS.

The Technical, Industrial, Commercial Vocabulary, in English, French, and German. By M. HOSPITALIER. Published by *L'Industrie Electrique*, 9, Rue de Fleurus, Paris.

The author, in the volume now before us, has attempted something new in the arrangement of a technical dictionary, and one that enables a great economy to be effected in the space required. The principle followed by Mr. Hospitalier is to arrange in alphabetical order the technical words of all the three languages. These words are printed in Egyptian characters, and are, of course, in French, English, and German, mixed up indiscriminately. After each word, then, follows its equivalent in the other two languages. In order to distinguish between these, three distinct types are used. Thus, all the French equivalents to the words standing first in the line are printed in small capitals, the English words in italics, and the German words are in Roman characters. It hence follows that as soon as one is used to the distinctions, there can be no hesitation in using this vocabulary, because one has not first to search for the right section of the book, as is the case with most technical dictionaries, which to give the same results would be divided into six sections. In order to still further decrease the size of the book, the characteristic endings of a word only are given when the root is the same in each language; for instance, one line reads:

Collect- (EUR. *or.* or).

which means that the French word "collecteur" is equivalent to the English "collector," and also to the German word "collector." When a word has more than one general meaning, the translation of each of the meanings are given, but they are divided by the parallel sign (||) to indicate the different meanings. The author concludes his introduction by stating that the task of collecting these words has been no mean one, and that he looks for help from his readers in the improving of the book. As an inducement to such to send in to him corrections and additions, he offers to send free a copy of the next edition to all those who forward him 200 useful corrections or additions to the present issue. We have looked through the vocabulary very carefully, and have failed to find any very serious errors. In one place *exergue* is given as an English word. We do not remember to have met with it in practice. We propose to use this vocabulary regularly, and hope to be amongst those able to suggest the requisite number of improvements to entitle us to an issue of the next edition. This little volume, which consists of only some 320 pages, should find a place on the desks of all electrical engineers.

FORTHCOMING EVENTS.

FRIDAY, DEC. 14.

Institution of Mechanical Engineers.—At 8 p.m., ordinary general meeting, Sir Wm. H. White, F.R.S., in the chair. Discussion on Mr. Herbert A. Humphrey's paper on "Power-Gas and Large Gas-Engines for Central Stations."

Institution of Engineers and Shipbuilders.—General meeting in Newcastle-upon-Tyne.

Institution of Junior Engineers.—At 8 p.m., meeting, at Westminster Palace Hotel. Paper, "The Metallurgy of Tin," by Mr. J. H. Davy James.

Physical Society of London.—At 5 p.m., meeting, at Royal College of Science (by invitation of Prof. Rücker). The papers to be read are: "Electric Inertia" and "The Effect of Inertia on Electric Currents in a Rotating Sphere," by Prof. A. Schuster, F.R.S.; "Exhibition and Description of a Quartz-Thread Gravity Balance," by Prof. R. Threlfall, F.R.S.; "On the Theory of Magnetic Disturbances by Earth Currents," by Prof. A. W. Rücker, F.R.S.; "Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents," by Dr. R. T. Glazebrook, F.R.S.; "The New Physical Laboratories of the Royal College of Science," by Prof. A. W. Rücker, F.R.S.; and "Exhibition of a Set of Half-Seconds Pendulums," by Mr. W. Watson. Council meeting at 4 p.m.

Faradian Club.—At 8 p.m., club dinner, at Hotel Florence.

SATURDAY, DEC. 15.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "Technical Colleges in Germany," by Prof. A. MacLay, B.Sc.

North-East Coast Institution.—At 8 p.m., ordinary meeting at Newcastle-upon-Tyne.

Electrical Engineers Volunteers.—At 6.30 p.m., dinner to the South African contingent at the Trocadero Restaurant.

MONDAY, DEC. 17.

Society of Arts.—At 8 p.m., Cantor lecture on "Electric Oscillations and Electric Waves," by Prof. J. A. Fleming, F.R.S.

Electrical Engineers Volunteers.—Dinner to the South African contingent at the Prince's Restaurant, under the presidency of Prof. Perry.

TUESDAY, DEC. 18.

Electrical Engineers Volunteers.—Reception of the South African contingent by the Institution of Electrical Engineers at Covent Garden Opera House, at 8 p.m.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. The papers to be further discussed are "The Signalling on the Waterloo and City Railway" and "Note on the Signalling of Outlying Siding Connections," by Mr. Alfred W. Szlumper, and "Signalling on the Liverpool Overhead Railway," by Mr. Stephen B. Cottrell. Time permitting, the following papers will be read: "Glasgow Bridge," by Mr. B. H. Blyth; "Railway Bridge over the Fitzroy River at Rockhampton, Queensland," by Mr. W. J. Doak; and "The Niagara Falls and Clifton Steel Arch Bridge," by Mr. L. L. Buck.

WEDNESDAY, DEC. 19.

Royal Meteorological Society.—Ordinary meeting at the Institution of Civil Engineers at 7.30 p.m. Following papers will be read: "The Seasonal Rainfall of the British Isles," by Mr. Henry Mellish; and "A Review of Past Severe Winters in England, with Deductions therefrom," by Mr. Albert E. Watson.

THURSDAY, DEC. 20.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Lecture by Lieut.-Colonel Crompton, E.E. (R.E.), on "The Electrical Engineers (Royal Engineers) in South Africa."

Institution of Electrical Engineers (Dublin Section).—At 7.30 p.m., ordinary meeting in the University College, when a paper will be read by the Right Rev. Monsignor Molloy, D.D., D.Sc., on "Electric Currents of High Tension and Great Frequency, with Suggestions as to the Possible Electric Light of the Future."

FRIDAY, DEC. 21.

Institution of Civil Engineers.—At 8 p.m., students' meeting, Prof. Alex. B. W. Kennedy, F.R.S., in the chair. Paper on "The Use of Geometrical Methods in Investigating Mechanical Problems," by Mr. C. E. Inglis.

ROYAL INSTITUTION OF GREAT BRITAIN.

We have received a notice of the various meetings and lectures arranged by this institution for the first three months of the New Year. Weekly meetings are to be held on Friday evenings, beginning on Jan. 18, when Prof. Dewar will read a paper on "Gases at the Beginning and End of the Century." On Feb. 1 "Electric Waves," by the

Digitized by Google

Right Rev. Monsignor Molloy, will be discussed, while on the following Friday evening Prof. G. H. Bryan will bring forward a paper on "History and Progress of Aerial Locomotion." At the succeeding weekly meetings respectively up to March 1 the following papers will be read and discussed: "The Existence of Bodies Smaller than Atoms," by Prof. J. J. Thomson; "Metals as Fuels," by Sir W. Roberts-Austen, K.C.B.; "Enamels," by Mr. Henry H. Cunynghame, C.B.; and "Vitrified Quartz" (with experimental illustrations), by Mr. W. A. Shenstone. The lecture arrangements are well conceived, and include six at Christmas time by Sir Robert Ball "On Great Chapters from the Book of Nature." This course of lectures has been specially arranged to illustrate the bearing of modern astronomical discovery on Laplace's famous doctrine of the evolution of the sun and the moon, the earth and the planets. They will no doubt prove extremely interesting, and a large number of members of the institution and their friends are expected to attend. Among the other lectures to be given during the months of January, February, and March in the New Year are: "First Principles and Modern Illustrations," by Prof. J. A. Ewing; "The Cell as the Unit of Life," by Mr. Allan Macfadyen; "The Government and People of China," by Prof. R. K. Douglas; and "Sound and Vibrations," by the Right Hon. Lord Rayleigh.

POLYPHASE ELECTRIC TRACTION.*

BY PROF. C. A. CARUS-WILSON.

PART I.—THE POLYPHASE SYSTEM.

(Continued from page 808.)

Influence of the Starting Period.—From what has been said above, it might appear that the best results on a line such as that from Burgdorf to Thun would be obtained if the track were absolutely level, but this is not the case, since the motors have to be able to exert an abnormal effort in order to start the train, and this effort may be utilised in mounting a grade. Thus the maximum permissible grade depends upon the effort required to start. The ability of polyphase motors to accelerate, and their economy in so doing, are thus matters of importance, and the author has therefore made a number of tests on the Burgdorf Railway with a view to obtaining definite information on these points. An account of the tests is given later in this paper. Some of the results will be quoted here. Allowing 94 per cent. as the efficiency of the gearing at full load, the actual horizontal effort of the motorcars on the Burgdorf Railway, at 60 kw. input, is 3,500lb., from which has to be deducted the axle and track resistance of the motorcar itself; taking this at 15lb. per ton of load, for both motorcars and trailers we find that a single 32-ton motorcar will get up full speed, 24·2 miles per hour, in 26 seconds. The time observed in the tests was 30 seconds. The addition of one trailer will increase the time of getting up speed to 38 seconds. Two trailers should, by calculation, take 51 seconds—the test gave 57; three trailers should take 67 seconds—the test gave 71. Five trailers would take 106 seconds to get up speed. The discrepancy between calculation and test is probably due to the resistance to motion having been taken too small. In Table I. are given the number of trailers which can be drawn up different grades by one motorcar; also the corresponding acceleration with full load on a level, and the difference of time due to starting with maximum load as compared with the motorcar only. It will be seen that as the maximum grade is reduced the maximum possible load is increased, but at the expense of a considerable increase in the time lost in starting. Thus five trailers could be hauled up a grade of 1 in 100, but nine minutes would be lost in starting. This would probably be inadmissible, in view of the necessity of making connections with the main lines. If five minutes is fixed as the maximum permissible starting delay, a load

TABLE I.—Showing Time Lost in Starting (calculated).

Grade.	No. of 12-ton trailers.	Total maximum weight.	Acceleration, f. p. s. per second.	Time lost in starting. Difference between maximum and minimum load. 1 station.	14 stations.
		Tons.		Seconds.	Minutes.
1 in 40	1	44	0·92	6	1 5
1 in 62	3	68	0·52	20	4·5
1 in 100	5	92	0·33	40	9
1 in 200	8	128	0·17	87	20

FIG. 6.

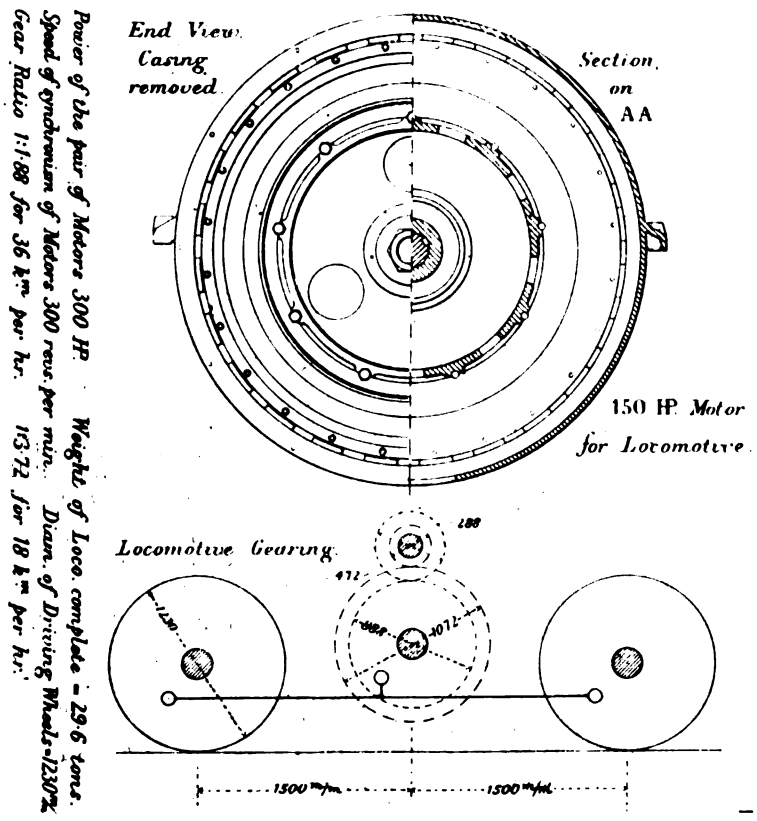
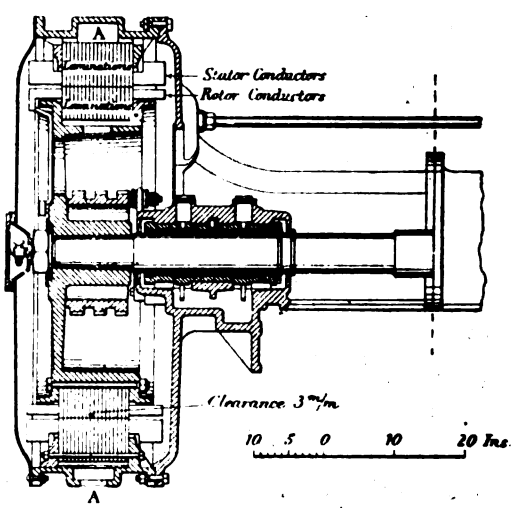


FIG. 9.

FIG. 7.



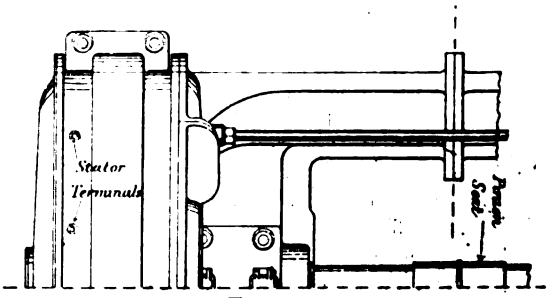


FIG. 8.

* Paper read before the Institution of Mechanical Engineers.

Digitized by Google

variation of three trailers could be dealt with, and this would mean a maximum grade of 1 in 62. In general, the maximum permissible starting delay should be fixed first; this determines the number of trailers, and this again the maximum grade. The fewer the stops, the larger will be the number of trailers, and the smaller will be the maximum grade. In considering the application of electricity to existing railroads, the grades and station intervals are of course fixed. The average station interval in this country is probably greater than that on the Burgdorf Railway, which is 1¾ miles, and the grades would not be so steep. If one assumed three miles as the average station interval, and 1 in 100 as the maximum grade on a line 25 miles long, a motorcar with an electrical equipment of 250 h.p. could haul a maximum of five trailers, or a total train weight of 92 tons, with a time difference of only five minutes between minimum and maximum load.

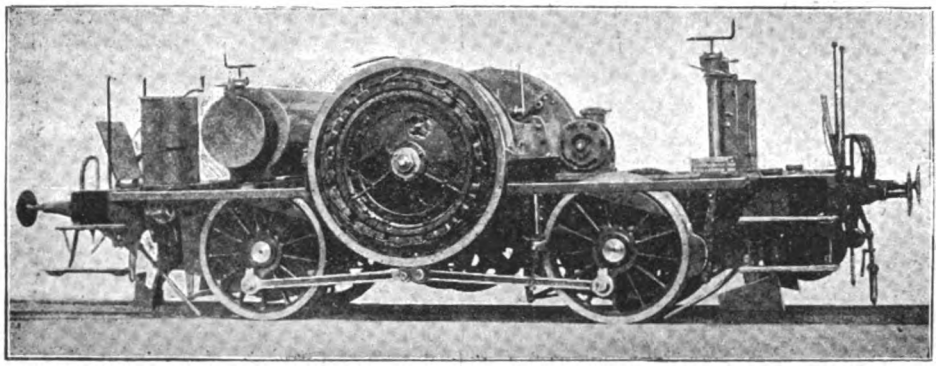


FIG. 10.—Locomotive with Cab Removed.

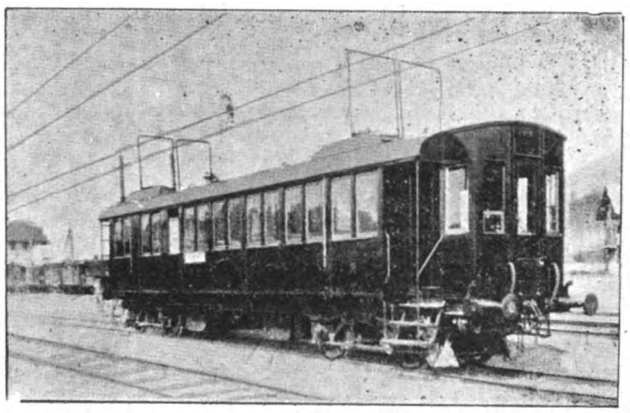


FIG. 11.—Motor Car.

The Goods Traffic.—On the Burgdorf Railway the goods traffic is hauled by locomotives specially designed for the purpose (as shown in Fig. 10), each of 300 h.p. These can haul a total maximum train weight of 50 tons at full speed up the steepest grade of 1 in 40. Details of the motors are given in Figs. 6, 7, 8, and 9. The locomotive itself, weighing nearly 30 tons, leaves only 20 tons for the weight of the train. Hence it has been found necessary to reduce the speed of the locomotive by gearing (see Fig. 9) so that they can run at half speed, and thus draw loads of 70 tons up the steepest inclines, the total train weight then being 100 tons. The time schedule of the goods trains is shown in Fig. 5. A reference to Table I. shows that if the steepest

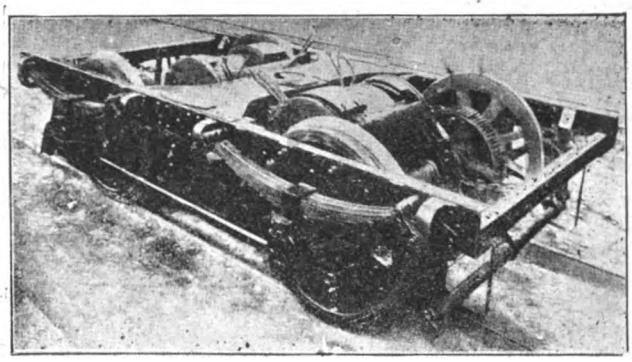
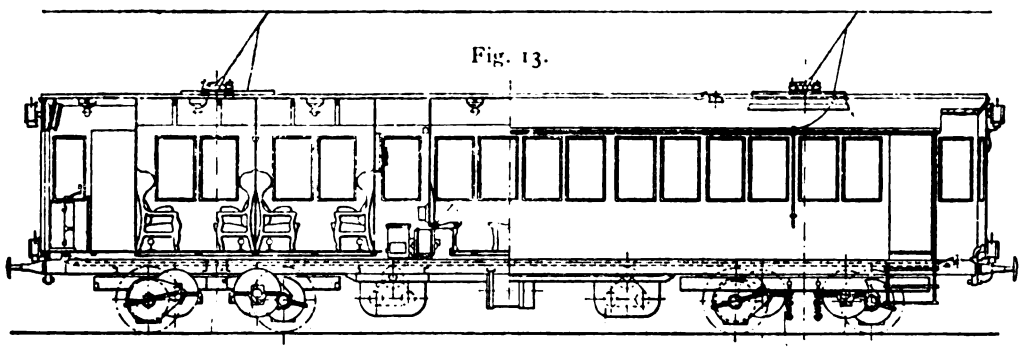


FIG. 12.—Double-Motor Truck.

Burgdorf-Thun Railway. Motor Car.

Fig. 13.



Transverse Section.

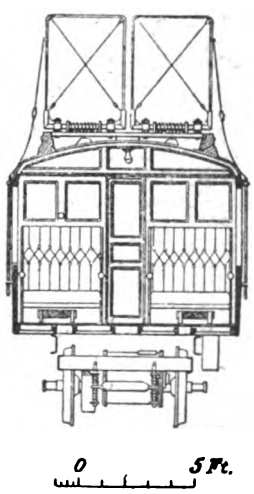
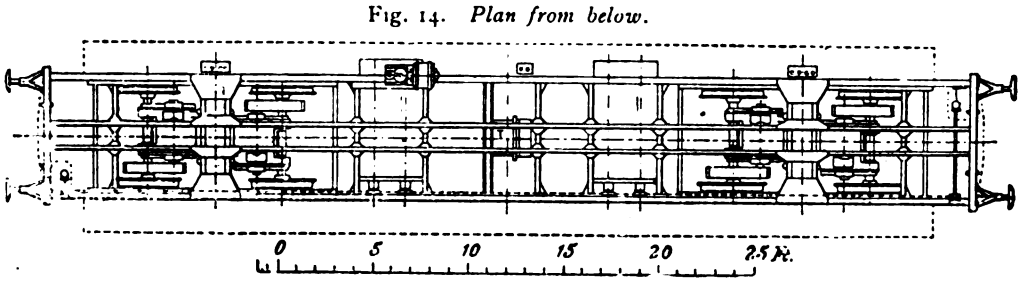


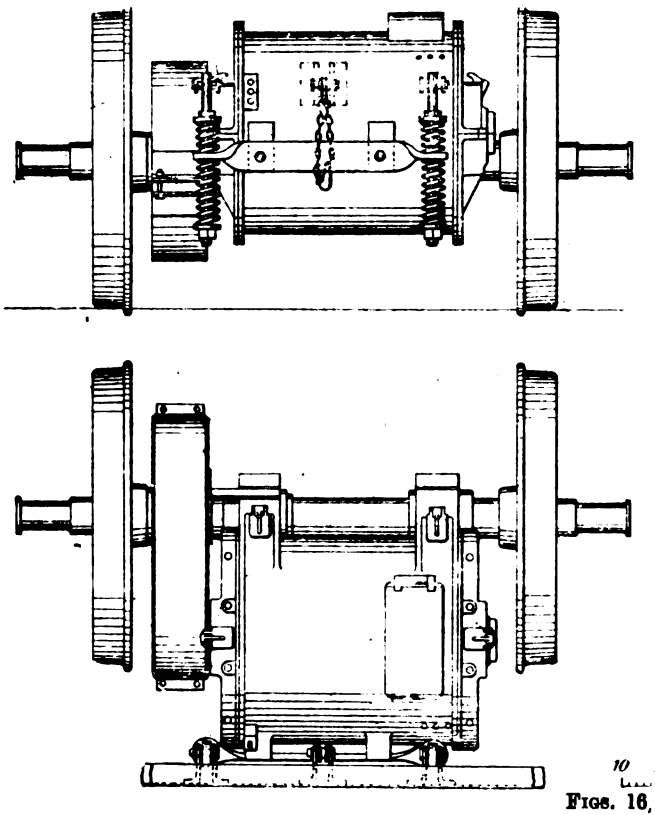
Fig. 14. *Plan from below.*

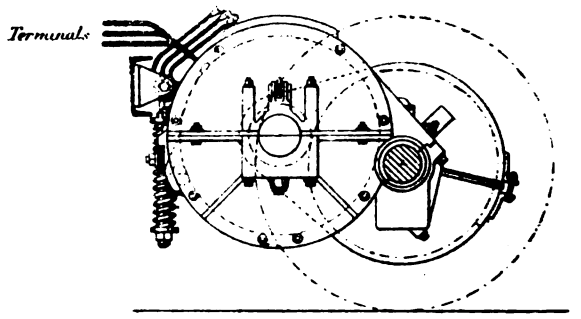


FIGS. 13, 14, AND 15.

Digitized by Google

grade had been 1 in 100 instead of 1 in 40, as at present, the same locomotive could either (1) carry a train of 100 tons at full speed, or (2) a train of 200 tons at half speed. The influence of the existing grades on the carrying power of the locomotives has already baen found to be a serious drawback. It may, however, be questioned if it is wise to use locomotives for hauling goods on such a line, since their use means so large a percentage of deadweight. The motorcars weigh about the same as the locomotives, carry 66 passengers, and can haul 60 tons behind them up a grade of 1 in 100. Supposing the average passenger load to be one motorcar and two trailers, making 56 tons, there remain 36 tons which might be made up by goods. Since there are 12 trains per day one way, the motorcars have a goods carrying capacity of 430 tons, or six times that of the existing locomotives. It would seem, therefore, that there is much to be said in favour of combining goods and passenger traffic on such a railway.





Revolutions of Motor	600	per min.
Frequency	40	„ second
No of Poles	8	
Tension	750	Volts
Diam. of Pinion	224	m/m
„ „ Gear Wheel	664	„
Gear Ratio	1:2·96	
Diam. of Driving Wheel	1020	m/m
Wt. of Motor with Pinion	1350	kg.
„ „ Gear Wheel	130	„
„ „ Casing	60	„
„ „ Suspension Parts	60	„
Total	1600	kg.

FIGS. 16, 17, 18.

PART II.—ACCELERATION TESTS ON THE BURGDORF RAILWAY

In September, 1899, a series of tests were carried out at Konolfingen under the author's direction. The tests, which had to be made during the intervals between the passing of the regular traffic, were conducted on a motorcar to which trailers could be attached. The method of conducting a test was as follows: One of the engineers of the line took charge of the controlling apparatus, and acted as motorman. In the forward vestibule an assistant gave the time from a stop-watch to an observer, who noted the ammeter reading at each instant. In the rear vestibule a second assistant gave the time from a stop-watch, while one observer noted the voltmeter reading, and another took the reading of a speed indicator. Two men were told off to keep a look-out and announce points passed on the track, such as grade posts, etc. The speed indicator made a continuous automatic record of the speed, which was detached and numbered after each test. The motorman signalled the start, at the same moment throwing over the controller so as to give the motors the maximum current, which was maintained constant as long as possible. The readings of all instruments were taken at five-second intervals from the moment of starting, and one voltmeter reading was taken immediately before starting. Each observer recorded his own observations, and filled in those of the other observers after every test. The car was allowed to proceed for some distance after full speed had been reached; the current was then cut off, the brakes

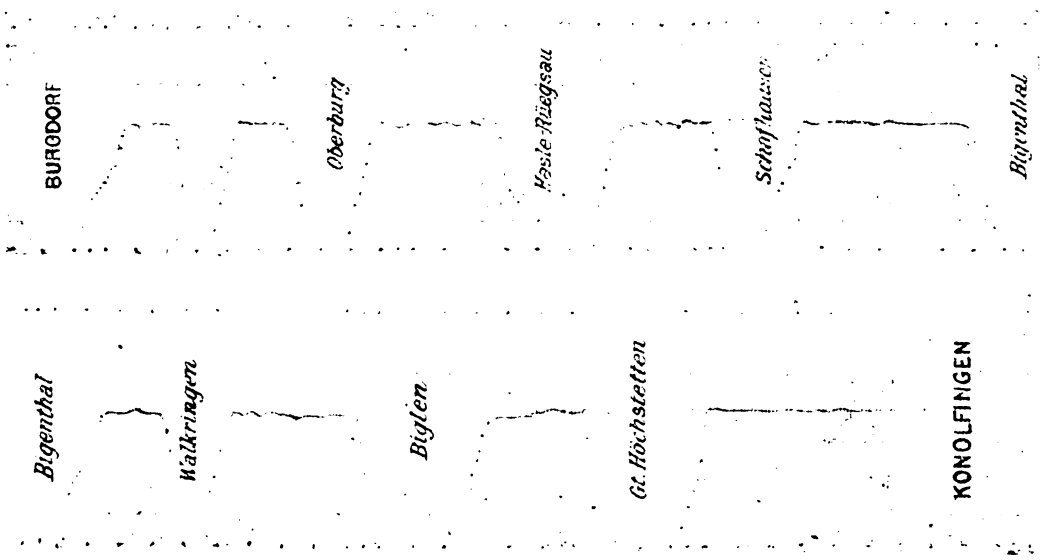


FIG. 19.—Full Size Automatic Speed Record taken on a Motorcar between Burgdorf and Konolfingen

Digitized by Google

put on, and the car brought to a standstill. Three sets of experiments were made: (1) with the motorcar only; (2) with the motorcar and two trailers; (3) with the motorcar and three trailers.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

On Thursday evening week the adjourned discussion on the paper by Mr. W. E. Langdon "On the Supersession of the Steam by the Electric Locomotive," was concluded. Prof. John Perry, president, was in the chair.

Mr. Robert Hammond thought they must all be struck on reading this most valuable and important paper by Mr. Langdon by the immense and new field which was opening out for the young as well as for the old electrical engineer. With regard to the question of lighting, it was a matter of astonishment that there was still a gaslight in existence, but in the near future there was no doubt that electricity would come in touch with every industry in the land. They had now a most painstaking and valuable paper before them, pointing out one great industry—viz., the supersession of steam by electric locomotives. There hardly seemed to be a more happier scheme than that proposed by Mr. Langdon. The paper did not deal in generalities, for the author not only said that in his opinion the thing was possible, but he showed how it could be carried out. It was clearly demonstrated that there would be a saving of over a quarter of a million a year in working expenses by the conversion of the section of the line between St. Pancras and Bedford from steam to electric power. The two main points for consideration were, first, whether the plan of running full-guage railways by electricity was feasible, and secondly, whether the estimates prepared by the author were sound. Mr. Hammond thought they might unhesitatingly let it go forth to the world as the opinion of that Institution that the plan suggested was feasible, and, further, that it appeared from the data furnished them that full-gauge railways could be run by electricity. It was actually being done in Germany at the present time on the Burgdorf-Thun line. The railway was 25 miles long, the primary voltage being 5,000 volts and the secondary 750 volts. On another line in course of construction in Italy by Ganz and Co., of Budapest, the extraordinary plan was being put into execution of having a primary voltage of 20,000 volts and a secondary of 3,000. With reference to the question of sub-stations, they must remember that in England coal could be bought at 7s 11½d. a ton, which could easily be carried to the point desired, whereas abroad there was not this facility. This favoured the views of Mr. Robinson on the advantage of several generating stations along the line of route.

Prof. George Forbes's criticism amounted to this: That this was hardly a paper to be brought before that Institution, being of too general a character. If Mr. Langdon had read his paper before a more public audience, such as at the Society of Arts, it would have deserved unqualified approval as directing the attention of the people to a question which had been engaging the consideration of engineers for a large number of years. The different methods in which the work could be carried out had not been considered by the author, nor had the details been accurately gone into. Prof. Forbes agreed, on the question of expense, that a stationary engine used less coal than a locomotive engine. He had paid considerable attention to the feasibility of working the Nile railways by electricity, and the conclusion he arrived was that, as a rule, electric locomotion would be cheaper than steam up to a distance of 40 or 50 miles from the power station. In Mr. Langdon's paper there was hardly a single item which would seem to be the right thing for his purpose. The total expenditure in respect of conductors had been put at £70,000, but there was no doubt that the cost would be very much in excess of that figure. He calculated it out at £330,000 with the voltage mentioned by Mr. Langdon.

Mr. F. Hudleston, chief construction engineer for the Central London Railway, confined himself to the question of coal consumption. Mr. Langdon had underestimated the work necessary to be done on a heavy railway. The section of line selected was hilly, with curves, and yet the author of this interesting paper said that it was practicable to haul a goods train with an average resistance of only 5½lb. per ton. As a matter of fact, an ordinary goods train along a level would require quite 10lb. per ton. On an average the coal necessary for a passenger train was 36lb. per train mile, for a goods train 53lb., and for a train laden with minerals 62lb. This figure might be reduced to 4lb. per ton mile on the Central London Railway. It must be remembered, however, that the switchback system on the Central London saved about 30 per cent. of the total energy required to accelerate the train. On the underground railway in London the average consumption of coal was from 32lb. to 36lb. per train mile. The trains weighed from 135 to 140 tons. This came out at ·25lb. of coal per ton-mile. Of course, in making this comparison, it must be remembered that the locomotives used the best steam coal, whereas in the central stations slack was used. Mr. Hudleston then expressed the opinion that the coal economy suggested was not proved in the least. With their present knowledge of electricity and steam, he did not see how it was possible to arrive at the author's result. With the exception of the coal consumption question, all the other matters in the paper were satisfactory.

Mr. A. A. Campbell Swinton could not agree with Prof. Forbes that the paper was not suitable for that Institution. It was the most interesting and suggestive paper they had had for a very long time. About a year ago he happened to have been looking into the question of expenditure of a contemplated electric line about 50 miles in length, and the conclusion he arrived at was that the total cost of equipment would be just a little more than that named by Mr. Langdon. But there the resemblance ceased. He could not understand how the author was going to do what was necessary in the way of cables, trolley wire, etc., for the sum of £140,000. A slight saving in the cost of the trolley wires would be made if a three-phase system at 750 volts were employed, as on the Burgdorf-Thun Railway. The line now being constructed in Italy was to work with 3,000 volts on the trolley wires, which would do much to keep down the first cost if the Board of Trade objections could be got over. The use of three-phase would also do away with the necessity of having rotary transformers in the sub-stations, and the necessary attendance to look after them. A very important question raised by the discussion was whether there was an economy in building a very large station. There undoubtedly was, and the larger the station the more economical it was. A parliamentary committee had been persuaded to take this view, which was certainly correct. If stations were to be placed about every mile all along the lines, how was a constant load to be got? Each station would be working for five minutes, and then it would have to be shut down for an hour, entailing unnecessary labour. Economy could only be attained by having one station to work over one length of line.

Mr. A. H. Walton thought that everything was not just as it should be in this paper. Mr. Langdon had put it before the Institution in a very broad manner, and his figures as regarded the traction efforts required were put far too low. He thought that the lowest record yet attained was 40 watt-hours per ton-mile. If one took the formulæ in Molesworth and worked them out, the result arrived at was 44·8. With reference to the author's statement that the coal consumption would be about 3lb. per kilowatt-hour, it was impossible to agree. If they got 4·5lb. to 5lb. they ought to be satisfied; 3lb. per kilowatt-hour had never been accomplished yet. On the Central London Railway, they had been told, the coal consumption was 5·9lb. per kilowatt-hour. But it was impossible to make fair comparisons by weight, because there was such a difference in the quality of coal; comparisons of cost of coal per unit would be more fair. He thought that on the question of leakage Mr. Langdon had been too liberal, because a 2½ per cent. leakage was very excessive, as it showed an absurdly low insulation resistance.

Mr. A. J. Lawson said the author had done some injustice to his case by taking too low a figure for coal consumption. He had also assumed too low figures for the efficiency of his plant. There should be no difficulty in getting motors of 90 per cent. efficiency, or in obtaining rotary converters of 93 per cent. and static transformers of 97 per cent. efficiency. In fact, with Mr. Langdon's arrangements, he thought an over-all efficiency of 71·35 per cent. could be obtained, whereas, if three-phase motors were used, this might be still further increased to 75 per cent. by the elimination of the rotary converters. As Mr. Hammond had said, a high-tension three-phase transmission had been in fairly successful use in Germany, and a higher voltage would shortly be put into use elsewhere. From this information was to be gained, and he thought it would do away with the suggestion of having many stations at certain intervals along the line. If generating stations were used at distances of about 10 miles apart, it would mean much additional labour and cost, because they would be so unequally loaded at different times.

Mr. Alexander Siemens pointed out that the discussion had entirely branched off into details. His opinion was that with a busy suburban line, with more than 12 trains per hour, electricity was cheaper than steam, but for main lines it was a question if that were so. Mr. Langdon had proposed that the railways should be connected in sections of 50 miles. Was he going to change engines at the end of these distances? For the long main-line trains, where only a few trains were run a day, the electric system would not be economic.

Major P. Cardew said that one important thing to notice in the tables given in this very interesting paper was the extremely short mileage made by each locomotive in one week. On the London and North-Western Railway one locomotive only ran 314 miles per week. The wages table came out very high for this reason, and there was certainly room for economy in that department. Mr. Langdon had dealt with the traffic as it existed, and had not taken into consideration the fact that with electrical working a more frequent service of trains would result. Major Cardew gave it as his opinion that a high-tension three phase transmission was an arrangement of very considerable economy. The arrangement proposed by Ganz and Co. for connecting the motors in series when starting and stopping to get practically half speed was very valuable. It was also worthy of note that in certain of the Continental towns electric locomotives driven by accumulators were being used with success.

Mr. E. Segundo thought that Mr. Langdon had attacked a question of national importance, and had acquitted himself in a manner worthy of the best traditions of that Institution. But as to the question of coal consumption, the figures given were not quite correct. He had worked out the average consumption, and he found it was more like 4·5lb. per kilowatt-hour than 3lb. The author had not suggested how freight traffic was to be dealt with. The tendency now was to increase the weight and length of freight trains and run them at longer intervals. But he believed that the electrical locomotive need only be half the weight of the steam locomotive, because all the weight came on driving wheels.

Mr. F. Sprague said they were all interested in the problem of the conversion of steam railways into electric. His opinion was

Digitized by Google

that the conversion would not be carried out, as suggested in the paper, by having electric locomotives constructed on the lines of the steam locomotives. In connection with rating of dynamos, the makers prescribed certain limits of heating which would not be surpassed if the dynamos were run continuously. On the other hand, the rating of a railway motor was done on most arbitrary lines with no such limit. For instance, a 150 h.p. railway motor would only be able to take 35 kw., or 47 h.p., from the mains continuously without rising more than 75deg. in temperature. The design of motor for the railway locomotive was restricted on all sides by the conditions of the very small space available under the cars, etc., and, in his opinion, it was quite impossible to build electric locomotives to pull the trains on the great railways. What was required was a complete change in the method of service, with electric motors of small power distributed throughout the train and controlled from one end. If the conversion were effected he did not believe there would be any saving of coal, but an improved service would be got at a higher speed.

Prof. Carus-Wilson was of opinion that it was not on the main steam lines that the electric locomotive would first be successful in this country. If anywhere, it would be on the branch lines—for these reasons: first of all, that the branch lines at the present time were the unprofitable part of any railway system; secondly, that it was the branch lines which were mainly responsible for the unpunctuality of trains; and, thirdly, that in consequence of the infrequent service of trains the branch lines were being menaced by the tramways systems. He estimated that on the branch lines of the Midland Railway which radiate out of Bedford the number of penny passengers required per mile in order for a profit to be made, with a service of six trains each way, was 265 per day. His point was that in order to make a profit with 24 trains per day and steam locomotive, you would want an increase in penny-a mile passengers of 75 per cent. A 60 ton train on an average branch line, conducted in the cheapest way, could be run by electricity with much better results than by steam. If the Midland Railway were to run a train every half hour, instead of one every two hours, there could be no doubt that the necessary increase in passengers (say 30 per cent.) with electric driving could be obtained, and the demands of the public satisfied.

Mr. W. Langdon, in reply, said there was no doubt as to the applicability of electricity for all purposes, and the only question remaining was, whether it was more economical to run trains by electricity than by steam. He had been attacked for bringing the paper before that Institution, but it certainly appeared to him that the subject was one which mainly affected the Institution of Electrical Engineers, and perhaps no better body could be found in the kingdom to discuss its merits or demerits. The subject had been deal with by him in an abstract manner, and the purpose of the paper was to evolve, if possible, some result as to the economy or other advantages that might attend the use of electricity as supplied to the large railway services of this country. It seemed to him that there was a greater chance of its succeeding where there was most traffic, and it was for this reason that he selected the London and Bedford section of the Midland Railway. Mr. Mark Robinson had questioned whether it was desirable to work a section of line from a central station or from a number of local generating stations. What had escaped the attention of some of those who had taken part in this discussion was the fact that with a central station you were able to transfer the load from one section to another. The estimates given in his paper were not definite estimates. They were meant to show what might be advantageous results arising from electric systems. The question whether a line could be worked from a central station was one to be very carefully considered when the time came. With regard to the question of coal consumption, it had been stated that the estimate of 3lb. per kilowatt-hour was insufficient. Mr. Cuningham had said that 3·6lb. per kilowatt-hour had been obtained in Montreal, while the Hon. C. A. Parsons estimated that 2·5lb. was a fair figure. He had recently looked up some figures on the subject published in *Engineering*, from which he gathered that on the Metropolitan in Chicago there was a consumption of 1·75lb. At Boston it was 2·61lb., at Baltimore 3 23lb., and at Brooklyn 3lb. Again, some trials made on the Berlin trams had revealed the consumption of 2·1lb. of coal per kilowatt-hour when superheat was employed, and 2·3lb. with the use of ordinary steam. All he could say was that if ½lb. of coal per kilowatt-hour could be saved, it was very material. The case of drivers of locomotives had been mentioned by Colonel Crompton, who suggested that a less wage might be paid those employed to drive electric motors. The wages paid to drivers were undoubtedly a very heavy charge indeed, but he did not see how it was possible to have it modified unless the traffic arrangements were also modified. Then in regard to the repair and renewal of machinery, Colonel Crompton had said that the charges put down in respect of that matter were high. But if anything were ever done in the introduction of electricity for main lines, it would have to be of the simplest character. The gist of the whole question lay entirely in the manner in which the current was to be conveyed to the trains. If it could be arranged to be placed outside the rails carrying the vehicles, it would prove very much more satisfactory, and would tend in a greater degree to its adoption than if it had to be laid down between the rails. It had been said that no electric locomotive could be framed to take the place of a steam locomotive. But surely that was contrary to the opinion of nearly every engineer who had studied the subject.

The **Chairman** here called attention to the length of the proceedings, and

Mr. Langdon said he would conclude his remarks on the discussion in his written reply to the *Journal*.

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Dec. 11, Mr. James Mansergh (president) in the chair, three papers were read, entitled "The Signalling on the Waterloo and City Railway" and "Note on Signalling Outlying Siding Connections," by Mr. A. W. Szlumper, M.I.C.E., and "Signalling on the Liverpool Overhead Railway," by Mr. S. B. Cottrell, M.I.C.E.

The Waterloo and City Railway, as previously described in the minutes of *Proceedings* of the institution (vol. cxxxix.), was an electrically-worked underground railway 1½ mile in length. It was a double line, in separate tunnels, with a station and accommodation for shunting the trains at each end. Trains ran every six minutes, the journey occupying about six minutes. There were two signal cabins, one at Waterloo and one at the City, the former containing 16 levers and the latter 18 levers. The line, however, was practically divided into two block sections by the provision of signals about half-way between the stations, such signals consisting of an electric lamp fixed to the wall of the tunnel, electrically controlled from both boxes and by clearance bars or treadles. In addition to the ordinary mechanical interlocking, the Sykes electric lock-and-block system had been largely introduced, and as a further safeguard "slipper bars" were fixed a short distance in front of the more important signals by means of which the current to the electric motors was automatically cut off should a train pass the 'slipper bar" when the signal was at danger. The "starting" signals at the stations had double arms, the upper one being a "right away" signal, the lower one being a "draw ahead" signal. Both these arms were worked by the same lever by means of a Sykes "electrical selector." The "stop" signals at the stations consisted of ordinary ground-discs, which were also provided for shunting movements. Treadles or fouling bars were extensively used; they consisted of an angle-bar about 35ft. in length, balanced on pivots and connected to a contact-making switch. In lieu of the ordinary repeaters, bells were fitted in the signal boxes which rang when any signal failed. This was effected by passing a wire through a series of signals by means of contact-makers on each signal and upon their corresponding lever in the signal box, terminating in a bell which started ringing should any contact be broken. Facing points were fitted with ordinary facing-point bolts, also Sykes electrical point detectors, one being fixed to each stock rail on a pair of points and connected to and working with the tongues. Both tongues had to be dead home before the selector was operative, and until then the point lever was locked by an electric lock. The block instruments used were Sykes lock and-b'ock instruments, which were electrically interlocked with the levers and signals. All the lights in the signals and discs consisted of 8-c.p. incandescent lamps in duplicate, and were repeated in the signal boxes by pilot lights.

The second paper described some modern methods of electrically controlling outlying siding connections. One system described was applicable to a railway where an electric lock-and block system was installed. The siding connection was controlled by a key, the removal of which from an instrument locked up all conflicting signals and broke down the block instruments until the key was returned. No outdoor signals at the siding were necessary. Another system described consisted of the provision of a ground box and outdoor signals at the siding, locking instruments being provided at both the section and siding boxes. When the siding was to be used, the switching in of the siding box locked up the starting signal at the section box by means of an electric lock, and released an electric lock on the siding signal, the switching out of the siding box restoring the section-box signals and instrument to their normal condition. A special feature of this scheme was electrically locking up the entrance to the siding box from the section box. Another system described consisted of the provision of a ground-box and of outdoor signals at the siding connection. When operations were to be carried out at the siding the box was switched in as a section box, and electric locks on the signals were released; during shunting operations the

Digitized by Google

siding box was treated as a section box, and when completed the box was switched out, and the signals again became electrically locked from the section box.

The third paper described the system of automatic electric signalling in use on the Liverpool Overhead Railway, which, originally promoted to facilitate passenger transit to and from the docks, had developed into a line nearly seven miles in length, and, in addition to fulfilling its original purpose, provided rapid access to Liverpool from two important suburbs, and by means of an electric tramcar system owned by the company from other suburbs. When the line had been originally constructed as a dock railway with many stations, automatic electric signals had been introduced in order to avoid the expense of men and maintenance, but with the extensions in the suburbs the automatic system had had to be supplemented at termini and junctions by ordinary mechanical signals. The intermediate stations were divided into 14 block sections; each block had a station at its commencement, and since the length of the blocks was short, each station was equipped with only four signals—viz, one home signal and one starting signal for each road, the starting signal being practically the distant signal for the station in advance. A train leaving a station passed the "breaking" contact, putting the starting signal to "danger"; it then passed the "making" contact, which pulled off the home signal of the station it had just left, and the starting signal of the station in the rear. The circuit between the making contact and the other signals was made through a switch fixed on the arm of the starting signal, so that should the latter fail to go to "danger," the circuit could not be completed, and the line behind would be blocked. The making and breaking contacts were actuated by a striking board fixed on the last coach, so that should a train break in two, the signals would not be operated. This automatic arrangement applied to all intermediate stations, and where the automatic system merged into mechanical, the alteration took place at the home signal in one direction, and at the advance starting signal in the other—that was, on the up road the advance starting signal was the first automatic signal, and on approaching the termini the distant signal was the first mechanical one. The current for working the signals was supplied from accumulators at 50 volts pressure; two sets of 27 cells were situated at each station, and these were charged in series from the generating station. These accumulators also provided light to the stations. The expenditure of electric energy in current was very small. Each station comprised four signals, each worked with a lowering current of five amperes at 40 volts, and with a holding current of 0·25 ampere at 40 volts. With a three-minute service for 20 hours a day each signal would be lowered 400 times, requiring, therefore, 2,000 ampere-seconds, or, say, 0·5 ampere-hour, per signal per day. The entire station would require 80 watt-hours per day, and the total system 1,040 watt-hours. This, however, did not include the holding-off currents. Assuming each signal to be held down 1½ minute, it would be down 600 minutes per day, requiring 150 ampere-minutes, or 2·5 ampere-hours, or five times as much as for lowering. In the first few months there had been occasions of signals failing to go to "danger," but experience enabled such failures to be eliminated, and reduced the number of other failures, which now amounted to an average of only 1 in 14,156,857 operations.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

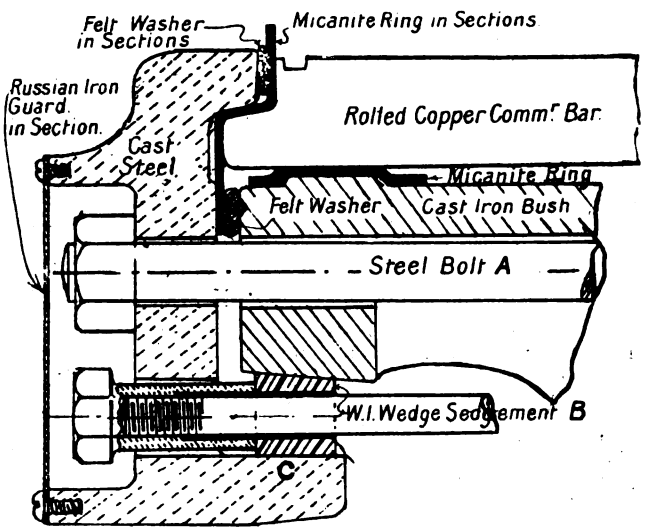
333. How can the Thomson-Houston and similar meters be adjusted without either breaking the seals on the controlling magnets or altering the position of the coils?—C. H. K.

334. An output of 2,500 h.p. has to be transmitted from a power station to a chemical works two miles away. The load is a continuous one night and day. The works generate three-phase alternating current, with 2,000 volts between adjacent wires, and the pressure at the chemical works is required to be 200 volts. Investigate what is the most economical voltage for transmission with underground cables.—P. T.

ANSWERS.

Question No. 327.—The commutators for large direct-current generators are frequently required by the engineer's specification to be assembled in such a manner that a portion of the bars may be removed without disturbing the remainder. How is this best accomplished, particularly with reference to the end insulating rings, which presumably would be in sections and would require skilful jointing?

Best Answer to No. 327 (*awarded* 10*s.*).—A design of commutator to fulfil these conditions is shown herewith.



The end ring is divided into six, eight, twelve, or more segments, the number depending on the diameter of the commutator. Through each segment two steel bolts, A, pass, also two adjusting rods, B. The bolts are prevented from turning by a recess for the heads in the back ring. The adjusting rods are screwed and riveted into the wedges at the inside end. The centrifugal strain is taken on the lip, C. The bars rest on a micanite ring moulded on to the commutator bush. The micanite end ring is made in a similar number of segments to the outer ring, the joints being made as shown in the accompanying

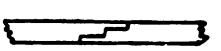
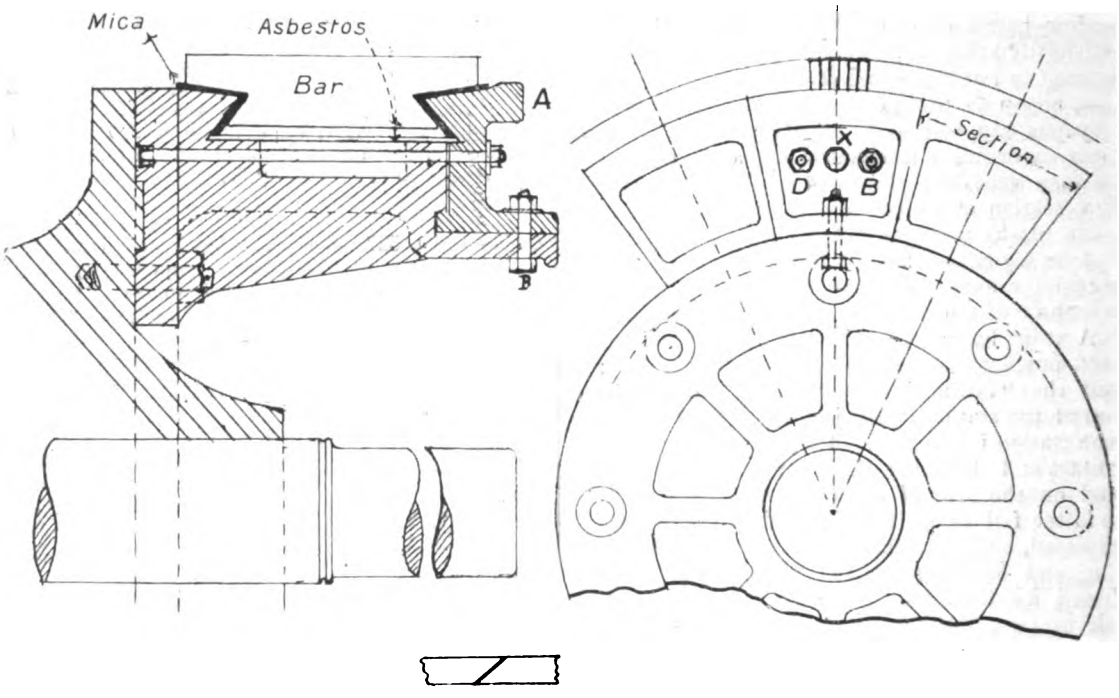


diagram. These rings are so placed so as to have the joints in them and the outer ring "staggered." A groove is turned in the bush to grip a felt ring, which prevents copper dust, etc., getting underneath the bars. To remove any bars the wedges are slackened in the two segments covering the section of micanite ring in front of the faulty bars, and then the nuts on the main bolts can be taken off and the segments removed. If the joint in the micanite ring is made coincident with the end ring joint, only one segment would have to be disturbed to get at the bars, but there would be a greater danger of breakdown through dust working through the joints in the micanite ring.—M. N.

Digitized by Google

Answer to No. 327 *(awarded* 5*s.).*—The commutators for large direct-current dynamos are assembled as shown in the accompanying sketches (Figs. 1, 2, and 3). Fig. 1 is a sectional elevation of the commutator tube, which is made of cast steel and secured to the spider by eight studs, as shown. It is insulated on the body with asbestos. The end ring, A, is made in segments, each fitted with two bolts to tighten up the bars, while a bolt, B, in each segment is shown to tighten it down on the periphery of the tube.



FIGS. 1, 2, AND 3.

To take a section out, the bolt, B, and the nuts, D and E, are removed, a forcing screw is put in at X, which on screwing up forces the section out, leaving the mica insulating intact. To get the bars out, this ring, which is usually made solid, has to be carefully cut in the form of a scarfe (Fig. 3). It is a comparatively easy matter to take a section of bars out, but a job of some difficulty to get the bars down flush with the others when new mica has been put between them. In the event of the scarfe in the mica ring being damaged, it must be patched up with mica of exactly the same thickness. Neglect of this precaution will cause the bars opposite the thickest part to be tight, and those at the thinnest part to be slack.—K. V. R.

Question No. 328.—What should be a fair coal consumption for a 10-hour day with the following output—600 amperes 105 volts steady over the 10 hours. Engine is high-speed three-crank tandem compound single-acting, with variable expansion governor (rated as 127 b.h.p. with 100lb. steam pressure), coupled direct to 80-kw. dynamo. Steam is kept at 10lb. square inch higher than is registered by gauge (75lb. square inch) on engine side of governor valve, with 600 amperes. This is Lancashire boiler hot feed water.

Best Answer to No. 328 *(awarded* 10*s.).*—The combined set working at three-quarter full load is probably working at its most economical load, and from the particulars given we may reasonably assume a consumption of steam for the combined set (including, say, 10 per cent. loss in dynamo) of 28lb. per electrical horse-power. But the coal consumption depends chiefly upon the quality of the coal. Let us take the average Lancashire coal containing carbon 77·8 per cent., hydrogen 5·32, oxygen 9·4, sulphur 1·3, and ash and nitrogen 6·18 per cent. Now, the total heat of combustion of carbon is 14,500 B.T.U., and can, therefore, evaporate 15lb. of water at and from 212deg. F. The total heat of combustion of hydrogen is 62,032 B.T.U., and can, therefore, evaporate 64lb. of water at and from 212deg. F., but we must remember eight parts of oxygen by weight unite with one of hydrogen to form water, which exists as such in the coal. Sulphur exists only in small quantities, and its heat of combustion is only 4,000 B.T.U.

Now, the evaporative power of 1lb. of the above coal

$$= 15\left\{ \cdot 778 + 4 \cdot 28 \left(\cdot 0532 - \frac{\cdot 094}{8} \right) \right\}$$

$$= 14 \cdot 325\text{lb. of water at and from } 212\text{deg.}$$

At 85lb. pressure we require an additional 3·5 per cent. of heat units. And owing to imperfect combustion, radiation from boiler pipes, etc., and other causes, a Lancashire boiler seldom exceeds 50 per cent. of the theoretical evaporation. We will take 7lb. of water as the approximate evaporation of 1lb. of the above coal at 85lb. boiler pressure. Then

$$630 \text{ Board of Trade units} \times 1 \cdot 34 = 844 \text{ e.h.p.}$$

$$\frac{844 \times 28}{7} = 3{,}376\text{lb.} = 30 \cdot 1\text{cwt. coal.}$$

We must allow for initial raising of steam—*i.e.*, losses during the 14 hours' standing—say 1·5cwt. So that we have as a fair everyday working consumption 31·6, or, say, 32cwt. of above coal per day.

On trial runs or tests far better results could be obtained. Taking the 32cwt. = 3,584lb. ÷ 630 = 5·68lb. coal per Board of Trade unit, and 2,240 ÷ 5·68 = 394·3 Board of Trade units per ton of coal, a fair average under the conditions mentioned. The feed pump I suppose to be electrically driven. Usually in small generating stations most of the preventable waste takes place in the boiler-house, but it must not be forgotten we often pay heavily for dirty water—in fact, at coal price.—F. R. S.

[N.B.—Will the writer of this answer kindly forward his address.—ED. *E. E.*]

Answer to No. 328 (*awarded* 5*s.*).—An engine of the type described, running under the conditions given, will have a mechanical efficiency of 87 per cent., and will require 26lb. of steam per indicated horse-power hour. The efficiency of the 80-kw. dynamo at the 63-kw. load will be, say, 91 per cent.; the combined efficiency of the set will then be 79 per cent.

The electrical horse-power is 600 × 105 ÷ 746 = 84·5.
The indicated horse-power is 84·5 × 100 ÷ 79 = 107.

Steam required by engine is 107 × 26 = 2,780lb. per hour. An addition must be made to this quantity for steam required for the boiler feed pump and for loss by condensation in pipes. The amount varies widely, and depends to a great extent upon the suitability of the plant in use for the work performed.

For instance, if the steam dynamo and boiler in question

Digitized by Google

form only one of a number of units at a central generating station, then it is possible that they are connected to a large steam main, and that the pump is large for the feed water required, when the condensation loss and pump steam will be a sensible proportion of the total, particularly if the engine is the only one running, say, on the day load. It is not stated in the question whether this is so, or whether the other extreme may be taken when the installation is complete and well proportioned, though small. It will only be possible to estimate this quantity, and if it is taken as 10 per cent. of the engine steam will represent a fair average. The steam required per hour will now be

$$2{,}780 + 278 = 3{,}058\text{lb.}$$

A Lancashire boiler with hot feed under ordinary working conditions, supplying this quantity of steam, will evaporate 8lb. of water per pound of best steam coal, inclusive of that required for banking fires at end of day's run. The coal required per 10-hour run will be

$$\frac{3{,}058 \times 10}{8} = 3{,}822{\cdot}5,$$

or a little more than 34cwt.

If the engine is condensing, then 15 per cent. may be deducted, reducing the coal consumption to 29cwt. This result cannot be considered economical, although as good as may be expected under the circumstances. It is a good illustration of the loss of economy due to the use of low-pressure steam in a class of engine which will give good results when using high-pressure steam and running at or nearly its full load.—E. G. B.

Answer to No. 328 (*awarded* 5*s.*).—The coal consumption under the conditions mentioned in the question would depend on the following: (1) quality of coal used; (2) efficiency of boiler; (3) temperature of feed water; (4) efficiency of engine; (5) efficiency of dynamo. Assuming that the coal used is of average quality, the boiler having the ratio of grate area to heating surface which is usually allowed in standard Lancashire boilers, and the feed water to enter the boiler at, say, 180deg. F., the weight of water evaporated per pound of coal ought to be not less than 8lb. The mechanical efficiency of the combined engine and dynamo $\left(\frac{\text{E.H.P.}}{\text{I.H.P.}}\right)$ would probably be about 85 per cent. for an engine of the type in question coupled to a dynamo of good design and make. The dynamo, however, would be working at only slightly over three-fourths of its rated power, as also would the engine, while the steam pressure at which the engine is intended to work (for full power) is not maintained. Under these circumstances it would probably be safer to assume an over-all efficiency of only 80 per cent. The actual load of the dynamo is 63 kw., or 84·5 e.h.p., which at 80 per cent. efficiency means 105·6 i.h.p., and multiplied by 10 gives 1,056 horse-power hours. The steam consumption per indicated horse-power per hour is about 24lb. In a good engine of the type mentioned in the question, and taking this figure the total coal used would be

$$1{,}056 \times 24 = \frac{25{,}344}{8} = 3{,}168\text{lb.}$$

This does not make allowance, however, for the fall in pressure between the boiler and the engine, which is 10lb. in 85lb., or, say, 12 per cent. Making this deduction, we have total coal used $= 3{,}168 \times \frac{85}{75} = 3{,}590\text{lb.} = 1{\cdot}60$ tons.

The above result would be a very fair one for the plant in question for a day of 10 hours; but, of course, there would be the coal used for boiler feeding purposes (feed pump or injector) to take into account over and above that for the engine.—R. M. W.

LIGHT RAILWAYS.

We understand that the difficulties which for the past three years have stopped progress in connection with the Cromarty and Dingwall light railway are on the point of being surmounted.

The Salisbury Town Council are urging the Great Western Railway Company to proceed with their application for an extension of the time within which they were to construct the Salisbury and Pewsey light railway.

The Tramways Committee of the Birkenhead Corporation are considering the Wirral light railway scheme, by which it is intended to unite the borough of Birkenhead with the districts of Upton, Greasby, Frankby, Caldy, West Kirby, Hoylake, Meols, Leasowe, and Wallasey.

The Bridgwater Rural District Council have passed a resolution heartily approving of the Stogursey light railway order which has just been issued by the Commissioners.

A committee of St. Combs and Charlestown and other villages has been formed with a view of approaching the parties who at present seem to be delaying the Fraserburgh and St. Combs light railway scheme.

The Batley Corporation have lodged with the Board of Trade objections to the confirmation of the Spen Valley light railways and Spen Valley light railways (extensions) orders.

Plans of the proposed light railway from Turton to Darwen have been referred to the engineer of the Bolton Corporation.

The draft order of the Nidd Valley light railway has been issued by the Commissioners.

Plans and sections have been deposited with Mr. John Berry, clerk to the Clifton Parish Council, of a proposed light railway through the township which the Barton Rural Council have given notice to apply to the Light Railway Commissioners for powers to construct.

In connection with the proposed light railway for Hemsworth and Ackworth, the Light Railway Commissioners have suggested that a level crossing should be utilised across the Wakefield and Doncaster main road, but the Hemsworth Council are opposing such action.

NEW COMPANIES.

The following new companies have been registered:

Crown Electric Heating Syndicate, Limited.—Capital, £5,000. Object: to carry on the business of electricians, electric and general engineers, suppliers of electricity, etc.

United Railway and Trading Company, Limited.—Capital, £500,000. Object: to adopt an agreement with E. A. Hopkins to construct and maintain telegraphs and other works in America and elsewhere, and generally to carry on the businesses of electricians, electric lighting, etc.

J. and E. Hall (1900), Limited.—Capital £250,000. Object: to acquire the business carried on by J. and E. Hall, Limited, at the Dartford Ironworks, Kent; to adopt an agreement with the said company and its liquidators; and to carry on the business of mechanical, marine, and electrical engineers, etc.

Gas and Mechanical Speciality Company, Limited.—Capital, £5,000. Object: to carry on the business of gas engineers, manufacturers of gas, electric, and other lighting appliances, etc.

J. Player and Son, Limited.—Capital, £1,500. Object: to acquire the business carried on at Coventry as J. Player and Son, and to carry on the business of watch, clock, scientific instrument, electric and cycle fittings manufacturers, etc.

British Electric Railways, Limited.—Capital, £100. Object: to carry on the construction and maintenance of electric and other railways and tramways, etc.

Holden Motor Patents Syndicate, Limited.—Capital, £10,000. Object: to carry on the business of vehicle builders, electricians, electrical and general engineers, etc.

Isidor Frankenburg, Limited—Capital, £250,000. We are informed by this company, with reference to our note in last week's issue, that this is their correct title, and that the capital is £250,000.

NEW COMMITTEES.

The following additional committees have been appointed:

BATLEY.—*Electric Lighting, Traction, and Tramways*: Councillor Hirst, chairman.

BERMONDSEY.—*Electric Lighting*: Aldermen Rodgers and Walker; Councillors Cox, Grace, Hole, Burtwell, Bessell, Moss, Collins, Manser, Martin, and Marner.

DONCASTER.—*Electric Lighting*: The Mayor (Councillor Theobald); Councillor Dowson (chairman); Aldermen Athron, Wainwright; Councillors Brightmore Manwaring, Bennett, Gyles, Halmshaw, Smith, Tovey, and Wightman.

HASLINGDEN.—*Electric Light, Refuse Destructor, and Tramway*: The whole of the Council; chairman, Councillor Worsley.

HAMMERSMITH.—*Electricity*: The Mayor (Councillor T. Chamberlen); Aldermen Glasier, Cramp, Pascall, Canon White; Councillors Bendon, Boarder, Davies, Edwards, Harris, Hooper, Lieut.-Colonel Hopkins, Johnson, Rutter, Tomes, and one other to be appointed.

OXFORD.—*Streets, Roads, and Lighting*: Councillor Kingerlee, chairman; Councillor Woodward, vice-chairman.

Digitized by Google

LEGAL INTELLIGENCE.

SMOKE NUISANCE SUMMONSES.

On Wednesday last the South London Electric Supply Corporation, Limited, were fined, in the Lambeth Police Court, £10 on each of 10 summonses and 10 guineas costs on the first summons, for causing a smoke nuisance at the works near Loughborough Junction The Town Clerk of Lambeth prosecuted. The magistrate had evidence before him that black smoke had issued from the shaft at the works of the company on 10 different days. It happened that the company had had careful notes taken as to the behaviour of their furnaces, and that in consequence they had direct evidence to the effect that there was no black smoke issuing from it at certain of the times alleged. On one of the days a directors' meeting was held, and the directors watched the shaft during the afternoon. Their evidence, however, was discarded by the magistrate. We hear that his decision is being appealed against, and we trust that the persecution of the company will in consequence be stopped. It will be remembered that the same magistrate recently stopped the company burning the refuse they were bound to take from the then vestry, and it is now rumoured that the new council will bring an action against the company for damages for the very breach of agreement they or their responsible predecessors caused.

CLAIM FOR ELECTRICAL WORK.

In the Westminster County Court on Friday last his Honour Judge Lumley Smith, Q.C., tried the case of Buchanan *v.* Bishop, in which the plaintiff, an electrical engineer, carrying on business at 68, Victoria-street, S.W., sued the defendant, a builder, to recover payment of an account in respect of electrical work done.

It appeared from the evidence of the **Plaintiff** that the defendant built a house for a Mr. Glenny, and his (plaintiff's) firm were employed to fix the wires for the electric installation. After the wiring was completed it became the duty of the defendant to fix the floorboards in various parts of the house, and in doing so he should have used screws, but instead of doing so his men drove long nails through the boards, with the result that they pierced the electric wires in several places and rendered it necessary to rejoint them.

Mr. Chas. Curwen, a member of plaintiff's firm, was called, and gave evidence to prove that the wires which had been fixed by his firm were punctured in many places owing to the negligent way in which the defendant's men did their work.

Plaintiff's foreman was called and gave similar evidence as to the damage.

For the defence **Mr. Wm. Bishop** was called, and said he built the house in question at Putney. He did not dispute that damage was done, but he thought it had been much exaggerated.

His Honour said that, judging from the evidence which had been put before him, he did not think the plaintiff had claimed a penny too much, therefore judgment would be for the amount claimed, with costs.

ARBITRATION.

Last week Major Cardew, as arbitrator, heard arguments in connection with the dispute between the Chloride Electric Storage Syndicate, Limited, and the Corporation of King's Lynn. The points at issue arose out of the installation of the storage batteries at the King's Lynn electricity works from the specification of Prof. Henry Robinson. We gather from the evidence, as reported in the King's Lynn newspapers, that one clause of the specification required the contractor to fill in a schedule of rates for the day work, and to include in the first tender the assumed number of years that would be required to erect the accumulators in question. It seems that this was done, but that the actual time taken in erecting these accumulators considerably exceeded the estimate. In consequence of this, the Chloride Electrical Storage Syndicate have claimed an additional £301 on a total of £1,147. It was urged on their behalf that the delay in building operations, etc., had caused this extra labour, while the case for the Corporation was that the tender of the company was for the complete battery of accumulators erected ready for working. Up to the time of going to press, Major Cardew's decision had not reached us.

COMPANIES' MEETINGS AND REPORTS.

ARON ELECTRICITY METER.

Yesterday, the third ordinary general meeting of this Company was held at Winchester House, E.C., Sir James Pender, Bart., in the chair.

The **Chairman**, in moving the adoption of the report, said they had had a most successful year, and had been able to show a good increase of business. The sales of the instruments had gone up for this year by 40 per cent. as compared with last year, and the profits, which in the prospectus showed a course of uninterrupted progress from £11,000 in 1892 to £18,000 in 1897, had now reached in the last two years £23,000 and £30,000 respectively. The increase in trade had been noticeable more particularly in England, though the profit in the United Kingdom this year did not show as favourably in proportion to the turnover as in the other countries. The reason for this was that they had arranged larger workshops, which would enable them in future to manufacture in England entirely, with the exception of the counting gears, which were manufactured for all their branches in their central factory in Schweidnitz. Now that the expenses of erection and organisation had been principally defrayed, they could look hopefully to a very much larger percentage of profit from the London business in the future. The orders for meters during the last two months since the end of their financial year—namely, October and November—exceeded in England by 40 per cent. the sales of the corresponding months of last year, and in the other branches an increase had also been made Every one of the branches had worked at a profit during the last year, the most satisfactory result being from the factory in Schweidnitz, which had shown this year a very handsome profit, and the directors had made arrangements for considerably increasing this factory, which should be the most remunerative department when the prices of raw material had again assumed a more normal aspect. The sale of the American patents was now so far effected that all but £4,000 in cash had been paid, and the stock to the face value of £33,000 had been handed to them and deposited with their bankers. Ample provision had been made for satisfying the best interests of the shareholders and the Company. Dr. Aron, during the past year, had succeeded in introducing further important improvements to suit the requirements of the station engineers, which consisted in the change over from wood to metal cases, in simplifying the design and manufacture of the meters, in the introduction of meters for special purposes, such as day and night load meters, hour meters, and automatic prepayment meters, and they looked forward to a considerable increase of business from these developments. Another distinct improvement had been the design of a small meter, which they called the "Cottage" type, now in the hands of the Board of Trade for official approval. This was a meter that could be made and sold at a considerably lower price, and could be used in small houses and shops in the poorer districts in town and country. They believed that this meter would meet completely the most stringent regulations of Government and municipal authorities, and be a large additional source of revenue in the future.

Mr. R. W. Wallace, Q.C., seconded the motion, and the report, together with the balance sheet, was adopted unanimously.

Mr. H. Hirst, a member of the Board, in reply to a shareholder, said they had never heard any rumours of legal proceedings in respect of their patents. Dr. Aron had a master patent dating back to 1883, and there was no ground whatever for such a suggestion.

In reply to another shareholder, Mr. Hirst said that with regard to the patents the Board of Trade were entirely on their side, and the County Council had no power to object to any patent which the Board of Trade had passed.

The following resolution was adopted unanimously: "That dividends at the rate of 6 per cent. per annum on the preference shares for the year ending Sept. 30, together with an additional ½ per cent. on the preference shares for the same period, and on the ordinary shares at the rate of 12 per cent. per annum for the year to Sept. 30, 1900, be paid, and that the payment of an interim dividend on the preference shares on April 1 last be confirmed.

The retiring directors, Messrs. R. E. B. Crompton and Mr. Hugo Hirst, were re-elected.

KALGOORLIE ELECTRIC POWER AND LIGHTING.

The ordinary general meeting of this Company was held on Wednesday at Winchester House, Mr. R. W. Wallace, Q.C., in the chair.

In moving the adoption of the report, which we published in last week's issue, the **Chairman** said he thought it was best that they should proceed slowly and be careful with regard to the expenditure of the funds of the Company. In consequence the Board had only spent money on such plant as could be kept in hand and dealt with on another site if they found it necessary to move from the site which they held. The shareholders must not expect that the undertaking would be remunerative in the first year or two of its existence, but there was every indication that in the course of a few years it would be earning large dividends, and the capital value of their shares would thereby be materially increased. He did not think that their Corporation ought to be mixed up in mining, and he was of the opinion that that property should be placed in the hands of a separate undertaking.

The report was adopted.

CAPE COPPER.

The thirteenth ordinary general meeting was held on Wednesday at the Cannon-street Hotel, Mr. Edmund A. Pontifex presiding.

The **Chairman**, in moving the adoption of the report, observed that the results of the Company's operations during the past year could not be considered otherwise than satisfactory. Their profits in the previous year were swollen by several adventitious aids. Another item in the accounts which had acted to the disadvantage of the present as compared with the previous year was that last year there was a sum of £22,685 which the directors were enabled to bring in to the credit of the year's operations from the Tilt Cove suspense account, which was now exhausted. Referring to the returns from the mines, he stated that the general result of the operations at Tilt Cove had been a profit available for division between the two companies of £59,299, as compared with £36,593

Digitized by Google

in the previous year. The mine at Nababeep would shortly form an important factor in their profit and loss account. The Bill which the Namaqua Company presented to the Cape Parliament asking for permission to construct a branch line from their mine to a point about 30 miles down the Company's line, and claiming running powers over this Company's railway, was eventually carried in the Lower House giving them all and more than they had asked in the first instance. Subsequently, however, the Upper House by a large majority threw out the objectionable clauses in the Bill—the clauses giving the Namaqua Company the running powers referred to. The directors had since been in friendly negotiation with the Namaqua Company, with a view to see if they could not come to such terms as to rates of carriage as would obviate the necessity of their making a branch line to join with the Cape Copper Company's; and he thought that they had practically succeeded in this endeavour though at a considerable loss of future revenue. They had made a satisfactory smelting arrangement with the Namaqua Company, and this should, in a measure, compensate for the loss incurred by the reduction in the rates of transport.

Mr. John Galsworthy seconded the motion, which was adopted.

MARCONI'S WIRELESS TELEGRAPH.

Directors: James Fitzgerald Bannatyne; Henry Jameson Davis; William Woodcock Goodbody; Guglielmo Marconi; John Mooney; Major Samuel Flood Page (managing director); Henry Spearman Saunder. Secretary: Henry W. Allen.

Report of the directors to be submitted to the fourth ordinary general meeting of the shareholders to be held at the offices of the Company, 18, Finch-lane, E.C., on Dec. 18, at 11 a.m.:

The period under review must be considered mainly as a further time of scientific and technical development, yet remunerative work has been carried out, the foundation of commercial business has been laid, and there is good promise of increased business in the immediate future; a profit and loss account is presented for the first time. The International Marine Communication Company was registered during the spring of this year, and has allotted 100,000 fully paid shares to this Company and 5,000 fully paid shares to its nominees. The International Company has commenced work. Their first installations have been erected on the Belgian coast at La Panne, and on one of the Belgian Government steamers. These have been quite successful and have attracted a great deal of public attention. The International Company has given orders for the erection of several stations on the coasts of the United Kingdom, and is engaged in negotiations with several Continental Governments. In August last, when the directors resolved to issue fresh capital, the offer of 25,000 shares at a premium of £2 was made to the shareholders, and an arrangement was made with a firm of brokers who undertook to take any number of shares up to 12,500 at £2 premium, for which the shareholders did not apply. Twelve thousand five hundred of the above shares have been subscribed and paid for by the shareholders and the brokers, subject to the brokers having a call on the remaining 12 500 at a premium of £2. 10s. per share. The transaction with the brokers was completed on Oct. 31, and £34 375 has been paid, of which only £1,076 comes into the present accounts. The chief business event has been the obtaining of a contract with the Admiralty for the supply and equipment of 32 sets of apparatus on payment of an annual royalty on each set. This is in addition to the five sets of apparatus which were transferred by the War Office to the naval authorities in South Africa. Only a small portion of the payment falls within the time embraced by these accounts; the benefit of this contract will be realised during the current year. The captain of H.M.S. "Vernon," under whom the work has been carried out, has expressed himself as satisfied therewith, and with the rapidity with which it was completed. Mr. Marconi has made great advances recently, some of which are of most undoubted value. We shall shortly be able to commence bringing them into use, and we may expect to derive much advantage therefrom. The works at Chelmsford have been improved and the plant and machinery increased, so that they can now turn out all the apparatus required, or likely to be required, during the next 12 months. The directors retiring by rotation are Mr. Guglielmo Marconi and Mr. John Mooney, who are eligible and offer themselves for re-election. The auditors Messrs Cooper Bros. and Co., also retire, and offer themselves for reappointment.

PROFIT AND LOSS ACCOUNT (FROM JULY 20, 1897.

Dr.	£	s	d.
Sundry expenditure, as per last balance-sheet	10 960	13	7
Stock, less tools	4 236	11	8
Purchases and wages	10 854	9	10
Salaries and directors' remuneration	5,926	13	1
Travelling expenses, law charges, rents, rates, taxes, etc.	8,637	15	5
Repairs and renewals, and depreciation of plant, machinery, and furniture	429	17	0
	£41 046	0	7

Cr.	£	s.	d.
Sales and royalties	6 092	3	2
Stock Sept. 30, 1900	9 111	10	4
Transfer fees	141	10	6
Interest and discount	842	14	9
Balance carried to balance sheet	24,858	1	10
	£41,046	0	7

NERNST ELECTRIC LIGHT.

Directors: Sir Henry C. Mance, C.I.E. (chairman); J. G. Dalzell; B. Zusman; J. Geoffrey Fort; B. M. Drake, M.I.E.E. (managing director).

Report of the directors to be presented to the shareholders at the first annual general meeting to be held on Dec. 19, 1900, at the Westminster Palace Hotel, S.W., at 2.30 p.m.:

The directors beg to submit their report and balance-sheet, the latter embracing the period from Feb. 23, 1899, the date of the formation of the Company, up to Sept. 30 last. The expenditure on capital account during this period is shown to have been £9,695. 10s. 11d., while the disbursements on other accounts amount to £6,757. 6s. 11d. Acting on the advice of the auditors, the directors, after deducting from the latter amount £845. 14s. 4d. received on account of interest and transfer fees, have placed the balance of £5,911. 12s. 7d. to a development suspense account, to be dealt with in future years. Apart from the purchase consideration for the patent rights, the only prominent item of expenditure on capital account is a sum of £5,000 contributed towards the purchase for this Company of Prof. Nernst's British royalties, the balance of the consideration having been provided by the vendors. Intimation of this purchase was conveyed to the shareholders in a circular dated Dec. 9, 1899. As the owners of the British rights have not commenced business in England this investment is still unproductive, but as doubtless the Nernst lamp will shortly make its appearance in the English markets, it is anticipated that these royalties will constitute a considerable source of revenue. Since the formation of the Company the directors have been engaged in further developing the automatic Nernst lamp so as to render it more capable of being manufactured and sold in quantities on a profitable commercial scale, and with a uniform degree of quality and efficiency for the various sizes; they have also taken out subsidiary patents, which, it is hoped, will prove of considerable value. The fire which occurred on the Company's premises on May 31, 1900, and of which notice was sent to the shareholders, unfortunately destroyed the patterns, instruments, and apparatus collected with infinite care during the previous 12 months, and, notwithstanding the most strenuous efforts of the staff, progress was practically arrested for more than three months. As already reported, the Company was fully insured. While every discovery involving radical changes from existing methods must necessarily take time before the result can safely be placed on the market, your directors have found that the practical difficulties to be overcome in the wholesale reproduction of the Nernst lamp to the best advantage have been greater than they anticipated. The variations which occurred in endeavouring to repeat on a more extensive scale results already obtained have involved lengthy experiments and chemical research in directions where no precedent was available. It is now, however, confidently hoped that the main causes of such variations have been traced to their origin, and means devised for their elimination. The lamps at present prepared consist of 16 c.p., 32 c.p., and 50 c.p. for either 100 or 200 volt pressure; also a lamp of 150 c.p. for street and factory lighting. These lamps are made to light automatically in all sizes. The principal difficulty in connection with the lamp is the initial heating of the rod automatically. At present your directors are using wire-wound heaters, the best solution yet developed, but the Company have also obtained the exclusive rights for the Vogt resistance heater in all their territories, as well as in England. This heater, when perfected, may prove of great value to the Company. The 16 c.p. lamp is also made for lighting by means of a match or spirit flame. Although these recently-developed lamps are somewhat similar in appearance to those previously shown, they contain important modifications in their internal structure, the result of many months of study and invention. Your directors consider that the present lamps are sufficiently practical to warrant issue on a wholesale basis, and arrangements are now being made to push on with their production and sale. In this connection it should be considered that although all the licensees possessing rights for other parts of the world commenced work many months before the formation of this Company, and had, in most cases, the advantage of an organisation already equipped, this Company has, in the opinion of the directors, made at least as rapid progress in the practical development of the lamp as other concessionaires. The different patterns of lamps will be exhibited before the meeting. The retiring director is Sir Henry C. Mance, who offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., who have been auditors to this Company since its incorporation, retire, and being eligible, offer themselves for re election.

COPPER MINES OF MOUNT LYELL WEST.

The report of the directors of the Copper Mines of Mount Lyell West, Limited, for the year ended Aug. 31, to be presented at the meeting to be held in London on 18th inst., states that the expenditure in mining expenses was £5 189; auditors' fees, directors' fees, and secretarial expenses in London, less interest and transfer fees £1 044, being a total outlay for the year of £6,233. Mr. Currie, an expert, after making a careful examination of the Company's property, and having regard to discoveries in other not distant localities of valuable deposits attaining a high percentage of copper, recommended the continuing of the adit commenced by the manager and being driven from the old Razorback tunnel in a north-westerly direction so as to reach a point where certain strata contacts favourable to the deposit of copper may be expected, especially as in the vicinity surface works had disclosed favourable indications.

Digitized by Google

BOSTON CONSOLIDATED COPPER AND GOLD.

The report of the directors of the Boston Consolidated Copper and Gold Mining Company, Limited, to Sept. 30, to be presented at the meeting to be held in London on 20th inst., states that the amount expended by the American Company upon the development of the property, office and general expenses, etc., during the past year, less the amount realised from ore sales, etc., was 48,636dol. The management at the mines has deemed it wise to lease limited portions of ground to practical miners, who pay the Company a royalty on all ore extracted and assist materially in the exploration of the property. From this source the Company has received a net profit of 3,099dol. during the year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Chinchilla.—The Municipality invite tenders for the electric lighting of the town for 20 years. Tenders by Dec. 20.

Asuncion (Paraguay).—The Municipality invite tenders for the installation of the electric light in the town. Tenders by Jan. 15, 1901.

Ploesto (Roumania).—The Municipality invite tenders for the installation and working of an electric tramway for 30 years. Tenders by Jan. 3, 1901.

Blackpool.—The Corporation invite tenders for the supply of arc lamp carbons and oils for one year. Tenders by Dec. 17. Details in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply and erection of storage batteries. Tenders by Dec. 22. Details in our advertisement columns.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and erection of electricity mains. Tenders by Dec. 17. Details in our advertisement columns.

Madrid.—The Department for Agriculture, etc., invite tenders for the installation and working for 60 years of an electric tramway from Inrepets to Fogas and Boranova. Tenders by Jan. 7, 1901.

Hendon.—The Urban District Council invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by Dec. 31. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for three high-speed triple-expansion steam dynamos, one balancer, and one motor-generator. Tenders by Dec. 24. Details in our advertisement columns.

Harrogate.—The Corporation invite tenders for two high-pressure 30ft. by 8ft. 6in. Lancashire boilers, with fittings complete, and economiser. Tenders by Dec. 25. Details in our advertisement columns.

Bristol.—The Electrical Committee invite tenders for induced-draught plant, steam and electric feed and general service pumps, and water-softening plant. Tenders by Dec. 20. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Swansea.—The Public Library Committee invite tenders for the electric wiring and fitting of public library, schools of science and art, and art gallery. Tenders by Dec. 17. Details in our advertisement columns.

Brighton.—The Council invite tenders for the supply of unarmoured and armoured lead-covered electric cables during the year ended Dec. 31, 1901. Tenders by Dec. 24. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of steam dynamos, battery-charging motor, booster, and balancer. Tenders by Jan. 7. Details in our advertisement columns.

Ayr.—The Corporation invite tenders for the work required in forming permanent way, rail-laying, roadwork, etc, of about 5¾ miles of electric tramways. Tenders by Dec. 28. Details in our advertisement columns.

Middleton.—The Corporation invite tenders for superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves, and accessories. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Leigh.—The Electricity and Tramways Committee invite tenders from manufacturers for the supply of 1,000 220-volt incandescent lamps during a period of 12 months. Tenders by Dec. 17. Details in our advertisement columns.

Ilford.—The School Board invite tenders for wiring and all ordinary fittings for about 200 lamps at 16 c.p., the Higher-Grade School, Melbourne-road, Ilford, Essex. Tenders by Dec. 17. Details in our advertisement columns.

Rathmines.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 10, 1901. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the erection of an electric tramcar shed at Duckworth-lane, Manningham. Drawings, etc., may be seen at the office of the City Architect's Department, Chapel-lane. Tenders by Dec. 24.

Worthing.—The Corporation invite tenders for the supply and erection of a main switchboard. Specifications, etc., can be obtained from Messrs. Burstall and Monkhouse, 14, Old Queen-street, Westminster, S.W. Tenders by Dec. 31.

Glasgow.—The Caledonian Railway Company invite tenders for telegraph and electrical appliances. Specifications, etc., may be obtained from Mr. J. Lorimer, stores superintendent, Charles-street, St. Rollox, Glasgow. Tenders by Dec. 17.

St. Pancras.—The Guardians of the Poor invite tenders for the installation of the Cook's-terrace Infirmary, Pancras-road, N.W., with electric light, according to drawings and specification. Tenders by Dec. 20. Details in our advertisement columns.

Leigh.—The Electricity and Tramways Committee invite tenders for the supply and delivery of the following motors and starting switches: one 10-h.p. motor, four 3-h.p. motors, three 2-h.p. motors, and three 1-h.p. motors. Tenders by Dec. 17. Details in our advertisement columns.

Tooting.—The Metropolitan Asylums Board invite tenders for the execution of certain wiring and other works in connection with the proposed electric light installation at the asylum now in course of erection at Tooting Bec. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of tramway bonds. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by Dec. 22. Details in our advertisement columns.

Thetford (Norfolk).—The Town Council invite tenders for supplying the wiring and fittings necessary for the electric lighting of the new town hall according to plan and specifications, which can be seen at the office of Mr. John Houchen, town clerk, London-road, Thetford. Tenders by Jan. 1, 1901.

Leeds.—The Lighting Committee invite tenders for electric lighting plant as follows: (Section A) two sets, each comprising engine of 2,000 b.h.p., two-phase alternator of 1,400 kw. capacity, and exciter; (B) two sets of surface-condensing plant. Specifications, etc., may be obtained from Mr. Harold Dickinson, manager of the department, 1, Whitehall-road, Leeds. Tenders by Dec. 31.

Manchester.—The Manchester Ship Canal Warehousing Company, Limited, invite tenders for the supply, delivery, and erection of 22 electric jib cranes required for work at the new transit shed, No. 8 dock, Manchester. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the company, 41, Spring-gardens, Manchester. Tenders by Jan. 4.

Winwick (near Warrington, Lancs.).—The Committee of Visitors for the County Asylum invite tenders for (Contract No. 3) wiring, etc., including ring main and feeders, sub-main, lamp circuits, switchboards, distribution boards, fittings, etc. The drawings, etc. can be inspected at Winwick Hall, and also at the offices of the architects, Messrs. Crisp and Oatley and W. S. Skinner, Edinburgh-chambers, Baldwin-street, Bristol. Tenders by Dec. 29.

Werthing.—The Electric Lighting Committee invite offers from any person, firm, or company willing to instal, equip, and maintain a system of electric tramways in the borough, with power to the Corporation to acquire the same at any specific date upon agreed terms, such offers to specify the price to be paid for current to be supplied from the central station of the Corporation electric lighting works. Tenders by Dec. 31. Details in our advertisement columns.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in Tettenhall-road, New Hampton-road, Waterloo-road, Darlington-street, Queen-square, Lichfield-street, Fiveways, Piper's-row, Bilston-street, Cleveland-road, and Bilston-road to the borough boundary, amounting to a route length of about 4½ miles, mainly double track. General conditions, etc., may be seen at the office of Mr. J. W. Bradley, M.I.M.E., borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Jan. 15.

RESULTS OF TENDERS.

Colne.—The tender of Messrs. Parsons, Newcastle-on-Tyne, at £1,161, has been accepted for a steam-turbine and dynamo.

Swansea.—The contract of Mr. Hy. Coles, Swansea, at £326, for wiring and fitting of installation in the station, has been accepted.

West Bromwich.—The tender of the Alliance Electrical Company, Birmingham, has been accepted for the supply of motors and switch gear for hiring.

Brighton.—The tender of Askham Bros. and Wilson, Limited, of Sheffield, at £3,627, for the supply of points, sole-plates, manhole covers, tie-bars, etc., has been accepted.

Salford.—The Town Council have accepted the tender of the Oldham Boiler Company, Limited, for the supply of the steam and blow-off pipes for the additional plant for the sum of £65.

Digitized by Google

Lowestoft.—The Town Council have accepted the following tenders for the extension of the generating plant: (Section A) Babcock and Wilcox, two boilers £1,519, brickwork £180 (completion within 16 weeks of signing contract); (B) Babcock and Wilcox, pipework, £419 (completion within 10 weeks of signing contract); (C) Lancashire Dynamo and Motor Company, 250 kw. dynamo in connection with the Browett and Lindley engine, £2,200 (completion within 25 weeks of signing contract)

Maidstone.—The Corporation have received the following tenders for surface condenser:

Wheeler Condenser Company, Limited	£1 010 0 0
British Power, Traction, and Lighting Company, Limited	1,164 0 0
Cole, Marchent, and Morley, Limited (accepted)	1,209 10 0
Allen, Sons, and Co., Limited	1 307 0 0
Edwards and Barnes	1 398 0 0
Davey, Paxman, and Co., Limited	1 596 0 0

Southwark.—The Electric Light Committee have received the following tenders for supply and erection of certain back E.M.F. cells at the Corporation electric light station, Penrose street, Walworth-road:

Tudor Accumulator Company, Limited	£588
Hart Accumulator Company, Limited	565
Electric Power Storage Company, Limited	509
British Power, Traction, and Lighting Company, Hull-road Works, York	390
Pritchetts and Gold	349

Cardiff.—The Tramway Committee have received the following tenders for plant:

Contract No. 4.—Motor.

Ashton, Frost, and Co.	£1,114 0 0
Bergtheil and Young	805 10 0
Bruce Peebles (accepted)	1,041 0 0
Brush Electrical Company	1,006 2 6
British Schuckert Company	1,032 0 0
Crompton and Co.	990 0 0
Geipel and Lange	1,291 0 0
India Rubber, Gutta Percha, and Telegraph Company	949 15 0
Johnston, Lundell, and Co.	1,131 11 0
Lancashire Dynamo Company	795 10 0
T. Parker	1,142 0 0
Rosalyn and Co.	1,056 0 0
Electric Construction Company	1,408 0 0
Salmony and Co.	946 0 0

Battery.

Accumulator Company	938 18 0
Bruce Peebles (accepted)	1,260 10 0
British Schuckert Company	1,336 18 0
Tudor Accumulator Company	1,265 10 0

Contract No. 5.—Cables.

British Insulated Wire Company (accepted)	22,166 16 3
Callender's Cable Company	23,614 17 4
W. T. Glover	23,468 5 0
Henley's Telegraph Company	23,828 15 0
Johnson and Phillips	24,007 0 0
St. Helens Cable Company	24,065 7 3
Siemens, Limited	22,666 15 7
Telegraph Manufacturing Company	23 702 5 4
Union Cable Company	24,762 19 5
Western Electric Company	22 667 12 1

Contract No. 6.—Crane.

J. Booth (accepted)	685 0 0
Obatteris Engineering Works	712 10 0
Carrick and Ritchie	787 10 0
J. Carrick	724 0 0
Higginbottom and Mannock	727 10 0
Musgrave and Sons	815 17 6
J. Spencer	795 0 0
T. Smith	785 0 0

BUSINESS NOTES.

LIGHTING AND GENERAL.

Beverley.—The draft electric lighting provisional order has been adopted.

Leyton.—Extensions of mains, estimated to cost £200, have been authorised.

Barrow.—A coal conveyor is to be erected at the electricity work, at a cost of £70.

Stockton.—The opening of the electric light works will take place within a few days.

Leigh.—The Town Council propose to apply for a loan of £500 for the purchase of electric motors.

Wearmouth.—The question of lighting the Wearmouth Bridge with electricity is under consideration.

Leith.—Mr. George W. Grosset, of Edinburgh, has been appointed junior assistant for generation.

Partnership.—We beg to refer to an advertisement which appears under this heading in another column.

Glasgow.—We are pleased to note that the Town Council have raised Mr. Chamen's salary to £1,000 per annum.

Boston.—The Town Council propose to obtain an expert's opinion on private and public lighting in the town.

Ilfracombe.—It is proposed that the Council transfer their electric lighting provisional order to a private company.

Gosforth.—The Urban District Council have decided to oppose the proposed North Shields and Gosforth tramways scheme.

St. Annes.—The Urban District Council have obtained a loan of £18,000 for private street work, electric lighting works, etc.

Kingston.—The Guardians have adopted a report adverse to the installation of a plant to generate their own electric light.

Sevenoaks.—Mr. W. M. Mordey has been appointed by the Urban District Council to act as consulting electrical engineer.

Walmer.—The District Council have appointed a committee with power to consult an expert on electric lighting and tramways.

Bury.—Application is to be made for a loan of £6,000 for the purposes of public lighting, including the roads on the Brown Estate.

Barnstaple.—A report has been obtained showing that an adequate electric lighting scheme for Barnstaple would cost £14,000.

Aldershot.—The report of the Electric Light Committee will be presented for consideration at the December bi-monthly meeting.

Cork.—The Sunday's Well extension branch of the Cork electric tramways system has just been opened, and trams will run regularly.

Sale.—The Urban District Council have decided to engage Mr. Charles Hopkinson to prepare plans, estimates, etc., for an electric lighting scheme.

Lymington.—The electric lighting was started at the works last week, and the supply will be available for private consumers almost immediately.

East Ham.—A Local Government Board enquiry was held on Wednesday into the application of the Council to borrow £42,220 for electric tramways.

Sheffield.—The Electric Light Committee are recommending several increases in the salaries of their staff, amounting altogether to £117. 8s. per annum.

Middlesbrough.—We learn that the laying of the electric mains is now practically complete, and that applications for the use of the light are coming in steadily.

Fulham.—The Borough Council have agreed that application be made to the Board of Trade for their sanction to supply the light to the Guardians at a reduced rate.

Leamington.—A deadlock has arisen between the Leamington Corporation and the British Electric Traction Company with regard to the interpretation of the agreement.

Surbiton.—A portion of the ratepayers appear to be much incensed against the coming tramways, but we are informed that the vote will go in favour of their introduction.

Buxton.—The engineer's estimate of the cost of laying a cable to Haddon-grove—625 yards—is £242. Additions equivalent to 300 8-c.p. lamps have been made during the month.

Hammersmith.—Application is to be made to the London County Council for their sanction to the borrowing of £15,000, being the cost of extending the electric mains in the borough.

Wimbledon.—The Urban District Council on Wednesday decided not to proceed with its Improvements Bill, which included the proposed tramway from Tooting to Wimbledon Station.

Rotherham.—The Rural District Council are enquiring into the Yorkshire Electrical Power Syndicate's circular propounding a scheme for supplying electric power in the West Riding of Yorkshire.

Dalkeith.—Messrs. Crompton and Co., Limited, propose to supply the burgh at 3d. per unit and to fix up and maintain all the necessary lamps, etc. Mr. A. Campbell Swinton is being consulted on the matter.

East Barnet.—The North Metropolitan Electrical Power Distribution Company have abandoned further action in the application for a provisional order in the coming session with regard to the Urban District Council's district.

Newport.—Mr. E. Cardin has been appointed mains superintendent at £150 per annum, in succession to Mr. Howard. An agreement will be entered into with Mr. Parshall for carrying out the electric tramways and power station.

Birkenhead.—The Electricity Committee have appointed a sub-committee, consisting of the chairman, the deputy-chairman, and Messrs. Dodds, Hazlehurst, and Moon, to report and eventually recommend a scheme for assisted wiring.

Kirkcaldy.—The Town Council have decided that Links-street, from the West-end to the cottage hospital on the tramway route, also the thoroughfares leading to the railway station, be lighted with electricity, at an estimated cost of £14,000.

Great Harwood.—A letter from Messrs. Tabourdin and Hitchcock, asking the Council to pass a resolution in favour of electric lighting for Great Harwood, and submitting plans, etc., is before the Highway Committee of the Urban District Council.

Darwen.—Messrs. D. Bruce Peebles and Co., of Edinburgh, have received an order from the Darwen Corporation for a 600-h.p. traction generator. The machine will be direct coupled to a high-speed vertical engine of Messrs. Belliss and Morcom's make.

Digitized by Google

Audenshaw.—The District Council have served a notice upon the Manchester Carriage and Tramways Company respecting the purchase of the company's undertaking in the Council's district.

Islington.—The Provisional Electric Lighting Committee are about to report upon the machinery, plant, mains, and running of the electric lighting undertaking of the Council. They will, if necessary, employ a consulting electrical expert for the purpose.

Bristol.—The puzzle, "Engineer or Architect," in connection with the foundations of the generating station is still engaging the attention of the Corporation. By last advices we learn that the report recommending to do without an architect has been rejected.

Brompton and Kensington Electricity Supply Co.—The transfer register of the 4½ per cent. mortgage debenture stock of this Company will be closed from the 21st to the 31st inst., both days inclusive, for the preparation of warrants payable on Jan. 1.

Tunbridge Wells.—Arrangements have been made for the provision of a switch-room at Tunbridge. The Town Council have resolved that the telephone cables in the borough be laid in the roadways as much as possible, and that an instrument fitter be engaged.

Stock Exchange.—Electric shares were in favour on Monday, but quotations did not move enough to call for comment. Tractions were easier. For the rest of the week electrics were almost without feature, and only a trifling business was doing in them.

Burgess Hill.—At a recent meeting of ratepayers it was agreed to urge the Urban District Council to continue the application for an electric lighting provisional order, and, when obtained, the ratepayers, in public meeting assembled, be consulted as to the best way to deal with such order.

Wigan.—From what transpired at the last meeting of the Borough Council we gather that the Electric Light Committee are now within measurable distance of being able to supply electric current not only to all those who have fitted up ready for it, but to all those who are desirous of having it.

Electric Governors.—We are informed by Mr. E. Thunderbolt that the electrical marine governors designed by him, and illustrated in one of our recent volumes, are meeting with a good reception commercially. The Allan line have recently ordered five more of the marine type of governor.

East Molesey.—Edmundson's Electricity Corporation have informed the Council that they have abandoned their intention of applying for a provisional order, and that they would be prepared to offer the Council a supply of current in bulk when the Council were in a position to carry out their order.

Kingston.—A committee of ratepayers has been formed to support the Corporation tramways proposals, and every effort will be made before the date of the polling to bring home to the burgesses the intentions of the Corporation in regard to the promotion of a Bill in Parliament for powers to construct tramways in the borough.

Clayton-le-Moors.—A plan and notice for the electric light order to be submitted to the Board of Trade by Mr. W. C. Chadwell, of Richmond-chambers, Blackburn, has been referred to a Light Railway Bill Committee of the Urban District Council. The Council have decided to co-operate with the Great Harwood Council in this matter.

Littlehampton.—The North British Electric Supply Company, of South Shields, have informed the Urban District Council of their inability to proceed this session with their intended application for a provisional order to supply Littlehampton with electric light. However, they hoped to do so the following session, before which they would seek an interview with the Council.

Stafford.—During last year the consumption of gas increased by 4 per cent., while that of the consumption of electricity increased by 160 per cent. The laying of a twin arc cable as far as the Baptist Church in Lichfield-road, at a cost of £162. 10s., will now be undertaken. The salary of Mr. J. H. Clothier, assistant electrical engineer, has been increased by £25 per annum.

Pocklington.—At the last meeting of the Urban District Council a report was submitted by a deputation of their recent visit to the Northallerton electrical works, in which they state that they see no reason why a similar scheme should not be worked successfully at Pocklington, the only question being whether a plant could be installed on a paying basis. A town's meeting is to be called to discuss the question.

Edinburgh.—The Cleaning and Lighting Committee have agreed to obtain an estimate of the cost for lighting various streets with electricity by lamps suspended in the middle of the street. Mr. Cameron considers that in narrow thoroughfares this system would be much cheaper and more efficient than ordinary lamp-posts, while in addition the suspended lights would leave the already narrow pavements clear of any obstruction.

Rochdale.—The following will be the scale of charges for current after Jan. 1 next: (1) for the supply of electricity for lighting on the maximum demand indicator system, 6d. per unit for 100 hours' consumption of the maximum demand per quarter, and 4d. per unit for all units in excess of this quantity, the maximum demand indicators being supplied and maintained by the Corporation without charge; (2) the price per unit for purposes other than lighting to remain at 3d.

Personal.—Mr. A. Heilbron has been appointed manager of the special department for cables, wires, and insulating material recently established by the Electrical Company, Limited, Charing Cross-road.—We are pleased to note that Mr. A. Hugh Seabrook, A.M.I.Mech.E., A.M.I.E.E., assistant engineer at the borough electricity works, Hampstead, has been appointed resident engineer to the Barking electricity works. We learn that Mr. Seabrook relinquishes his present post in one month's time.

Yeadon.—The Board of Trade have notified the District Council that they are of opinion that the Council's electric lighting order should not be allowed to remain in force any longer, and the Board therefore propose to revoke the order forthwith. In consequence of a circular issued by the Yorkshire Electric Power Syndicate, Limited, the various urban and rural councils in the Wharfedale Union are to be invited to attend a joint meeting for the purpose of deciding if any joint action should be taken.

Swansea.—Applications for 5,115 8-c.p. lights have been received, and the Council have decided to extend the mains through College-street and Heathfield-street, but to postpone other streets till at least three applications from private consumers had been obtained in each. The Grand Theatre will be supplied at 3½d. per unit, the standing scale being departed from in this as with regard to the Harbour Trust. A conference is taking place between the Council and representatives of a free wiring company.

London Gazette.—The discharge of W. J. S. Green, 45, Birchfield-road, Aston, Warwick, has been suspended for two years. The estates of B. Wild and J. H. Clarke, trading as Wild, Rothwell, and Co., Atlas Works, 62, Virginia-street, Southport, have been released from trusteeship. The last day for receiving claims in the matter of the Nuneaton Electric Company, Limited, has been fixed for Feb. 1, 1901. A belated advertisement appears in the last *Gazette* by the Southport Corporation for a tramways provisional order.

Aberdeen.—The drawings, etc., for the Girdleness outfall sewer and the subway in Crown-street for the electric lighting department have been completed. The actual cost falling on the electrical department is estimated at £8,400, in place of £6,600, as originally estimated, of which sum about £1,500 represents the extra expense in strengthening and altering the sewer. The Council have decided to procure a destructor capable of burning from 12 to 13 tons of refuse per working day of 10 hours. The cost is estimated at £750.

Stirling.—The Police Commissioners of Stirling have resolved to erect an additional 30 arc lamps, the estimated cost being £915 and the annual charge £435, equal to 1½d. extra on the rates. The lighting station is also to be extended by the addition of other two Lancashire boilers, two dynamos, feed pump and heater, and other plant at a cost of about £10,000. The Police Commissioners are endeavouring to come to an agreement with the British Electric Traction Company and the Bridge of Allan Tramways Company for the disposal to them of their rights.

Ayr.—A sub-committee has been appointed to consider the proposed application to the Board of Trade for permission to change the system of supply from the present voltage to a voltage of 250. It has been agreed to grant the supply to the Auction Company at 5d. per unit, plus 5 per cent. on £10, being the estimated cost of the cable extension chargeable to the company, the minimum charge to be £1 per annum; and the following terms will be offered to the G. and S.-W. Railway Company: for 100,000 units, 2½d. per unit; up to 200,000 units, 2d. per unit; up to 300,000 units, 1½d. per unit.

East Ham.—The Council have adopted a report upon the question of supplying electric light to the artisans' dwellings, showing that the capital outlay for wiring and fitting these houses is £6. 10s. per double-tenement house, to which has to be added the sum of 2s. per house covering loan charges. High-street South and the Manor Way to the Ferndale Tavern, North Woolwich, is to be lighted with arc lamps placed at a distance of 80 yards apart. The portion of the Highway to Beckton-road will be proceeded with forthwith, and the remainder at the time the tramway track is being constructed.

Appointments Vacant.—It has been decided to advertise for a general manager of the tramways about to be taken over by the Burnley Corporation, at a salary of £350, rising to £400 at the end of three years.—The Bexhill Urban District Council require the services of a shift engineer.—At the Plymouth Corporation and at the West Hartlepool electricity works there are vacancies for switchboard attendants.—The Edinburgh Corporation require, at once, an inspector to superintend the installation of electric lighting at a large public building.—The Borough Council of Bermondsey invite applications for the position of mains foreman.—The Wimbledon Urban District Council require, at once, a junior assistant engineer at their electric light station, Wimbledon. Full particulars of these vacancies appear in our advertisement columns.

London County Council.—The Council have granted notices under Electric Lighting Acts and orders from the Blackheath and Greenwich District Electric Light Company, under the Blackheath and Greenwich District Order, 1897, of intention to lay low-tension mains along a portion of London street, Greenwich; and from the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, of intention to lay low-tension mains along both sides of and across Putney Bridge-road. Also plans by Mr. W. B. Pinhey on behalf of the Charing Cross and Strand Electricity Supply Corporation Limited, for the construction of a building, to be used as a sub-station and offices, on the site of 59, 60, and 61, St. Martin's-lane, Strand. They refused to approve of the plans submitted with the application of Messrs. Church, Quick, and Whincop, on behalf of the Woolwich District Electric Light Company, Limited, for the construction of an addition to an electric light station at the company's works, Globe-lane, High-street, Woolwich.

Digitized by Google

Kingsbridge.—At the meeting of the Urban District Council last week letters from Mr. Mildmay, M.P., and the Postmaster-General were read relative to providing telephone communication. It was stated that the National Telephone Company could not continue the work begun, as too much time had elapsed before connecting with the exchange, and if 15 subscribers of £3 each were obtained the Post Office would provide it. It was resolved to let the matter stand over for a time, as probably the Post Office authorities would take it up.

Goole.—At the last meeting of the Rural District Council a circular was read from the Yorkshire Electric Power Syndicate, notifying the Council that they were about to apply in Parliament for power to launch a large electric lighting scheme for the West Riding, the area of which comprised 158 local authorities. The circular stated that the syndicate was formed by Yorkshire manufacturers and colliery owners, and they intended the syndicate to provide electricity to local authorities and not for general distribution. Nothing was done in the matter.

Presentations.—On Friday, Dec. 7, at Falcon Works, Loughborough, Mr. E. W. Jones was presented with a high-class planimeter by the members of the Brush Company's staff on his leaving to take up the position of leading draughtsman to Messrs. Reavell and Co., of Ipswich.—Sir Edward Gourley, on behalf of the Sunderland Tramway Company, last week presented Mr. William Morrison, late manager under that company, and now traffic of the Corporation tramways, with a gold watch and gold curb chain, while Mrs. Morrison was the recipient of a gold watch bracelet.

Aylesbury.—The Urban District Council will at their next meeting further discuss a report which they have received from Councillor Reader, chairman of the Lighting and Fire Brigade Committee. The report shows that the committee, after consultation with Mr. Medhurst, have come to the conclusion that with a capital expenditure of £23 211 the public lighting of the district and about 4 000 8-c.p. lamps for private supply could be maintained and that the revenue from 3,000 lamps would be sufficient to pay expenses, leaving the revenue from 1,000 lamps, on which a profit would be shown at once.

Nelson.—The Local Government Board have just sanctioned the borrowing of £2,500 for purposes of electric lighting. The date of repayment has been fixed at seven years, and the Council are protesting against the shortness of the term. An expert engineer is to be consulted on the subject of the proposed alterations and additions to the electrical works of the Corporation. The electrical engineer's report for the past month shows that the quantity of electrical current sent out during the month was equal to 12,818 units, an increase of 18 per cent. over the quantity sent out for the corresponding month last year.

Ferranti, Limited.—We have been asked to review a little pamphlet descriptive of this company's works at Hollinwood, Lancs., and of the standard manufactures emanating therefrom, and we do so with pleasure, not exactly because the booklet is a reprint from the *Electrical Engineer* of May, 1900, but also on the perhaps more justifiable ground that it is really an excellent production, giving a large number of fine illustrations well executed on hyperfine art paper. We are informed that Messrs. S. Z. de Ferranti Limited, will be pleased to send a copy of this pamphlet (No. 113) to any of our readers interested in the same.

Hackney.—A piece of land at Millfields-road, adjoining the River Lea, has been purchased of St. Thomas's Hospital authorities for the sum of £8,000, as a site for electric lighting station, refuse destructor, also disinfecting station, etc. The estimated capital expenditure in respect of the electric lighting of the borough amounts to £242 367, of which £80,000 has already been borrowed of the London County Council, and the committee last night asked for the authority of the Borough Council to borrow the balance—namely, £162,367—at such times and in such amounts as they may be advised by the Electric Lighting Committee.

Consett.—The Electric Lighting Committee of the Urban District Council have considered notices from the Northern Counties Electricity Supply Company and the Cleveland and Durham Electric Power Company as to a provisional order under the Electric Light Acts of 1882, 1888, and 1889 by the first company, and a Bill by the other company. They desire to be empowered to deal with the provisional order and the Bill, and to employ any assistance they might require. The Council have given conditional consent to the Northern Company to come into the district providing they carried out an agreement which has not yet been signed. The matter will come before a special meeting shortly.

York.—Mr. R. H. Bicknell has held an enquiry into an application of the City Council for sanction to borrow £20,000 for electric lighting extensions. It was stated that so far the electric light had been a great success in York. The original scheme, as was explained by the town clerk (Mr. W. H. Andrews) and the electrical engineer (Mr. C. A. Midgley), provided for plant for the supply of 6 000 lamps each of 8 c.p. The supply was commenced on April 1 last, and there are now applications for light equivalent to 18,000 lamps. To meet this exceptional call extra plant is required for the present winter, and also in preparation of the still greater requirements of next winter. Extensions of mains have been carried out by Prof. Kennedy at a cost of £1,475, and the demand has amply justified the outlay.

St. Marylebone.—The Guardians have adopted a report of the Infirmary Visiting Committee, recommending "That in answer to a letter received from the Local Government Board, they be asked to receive a deputation from the Guardians of this parish on the correspondence that has taken place between this Board and the Local Government Board on a proposal of the Guardians to generate their own electric current for the electric lighting of the infirmary, the committee feeling that a personal interview between the Local Government Board and the deputation may remove any doubt existing in the minds of that Board as to the saving to the parish which will be effected by generating the current in the institution." The Local Government Board had written that, having regard to all the circumstances, they were of opinion that the Guardians would be well advised to allow the matter to stand over until next year, and that the wiring, etc., of the building should alone be undertaken in the early spring in anticipation of the supply of current by the Notting Hill Electric Lighting Company in April at 4d. per unit.

A Useful Pocket Book.—We have received from the Scientific Publishing Company, Manchester, a copy of "Fowler's Mechanical Engineer's Pocket Book for 1901." In the preface we are told advantage has been taken in the new issue of the opportunity to thoroughly overhaul the contents of the book, so as to bring it up to date and eliminate any little errors that previously existed. An immense amount of useful information relating to apparatus, etc., with which mechanical and electrical engineers have to deal is condensed into its pages. Tables of equivalent weight and measures, so useful for reference, besides much valuable data in the shape of formulæ etc., are included. The section devoted to traction work should render the little annual especially useful just now, when this branch of the electrical industry is so busy. Appended are some memoranda sheets and diagram forms for graphic records—another useful feature. The book is, however, already too well known to call for further review of its comprehensive contents here. Suffice it, in conclusion, to add that as a reliable and convenient work of reference its popularity is fully deserved.

Brighton.—Colonel A. G. Durnford has held an enquiry into the application of the Town Council to borrow £56 500 for purposes of electric lighting. The Town Clerk (Mr. F. J. Tillstone) said the money was required for the expenses in respect of the electricity undertaking for the years 1901 and 1902, and it was proposed to extend the repayments over a period of 25 years. Mr. Christie, the electrical engineer, stated that the present capacity of the works was 4 710 kw., equivalent to 147,000 8-c.p. lamps, and at present they had 150,000 lamps connected. They had a prospect of also lighting the new pier that was being built, and the local tramways would be run with power from the works. The pier would probably require an additional 2,500 and the tramways 11,000. New consumers were coming on to the mains at the rate of from 400 to 500 per annum, and the increase of business might be taken at about 16 per cent. on the previous year's output, both as regards output of energy and connections for new consumers. He stated that the tenders for the proposed plant which had been accepted had proved somewhat below the estimate, and therefore the Corporation would only require some £54 798.

Cardiff.—The appointment of Mr. Ellis, notified by us last week, was ratified by the City Council on Monday. We purloin the following biographical note from the *Western Mail*: "Mr. Arthur Ellis, who was on Monday appointed by the Cardiff Corporation to the position of chief electrical engineer for lighting and traction, is a son of Alderman J. Baxter Ellis, J.P., an ex-mayor and ex-sheriff of Newcastle-on-Tyne. He was educated by a private tutor at St. Bees Grammar School, Cumberland, and served his time as a premium apprentice to Messrs. C. A. Parsons and Co., Newcastle. His first appointment was as assistant engineer to the Newcastle and District Electric Supply Company. He gave this up in order to become chief engineer of the Cambridge Electric Supply Company, with whom he remained for two years. In April, 1894, Mr. Ellis was appointed borough electrical engineer at Southport, where he laid down a large station for lighting purposes. Two years later he obtained a similar but more lucrative position at Bolton, where he extended the system very considerably. In 1897 he changed the system from alternating to continuous current, and at the same time laid down a large tramway installation over 25 miles of streets. In 1899 he was appointed general manager to the electric tramways and lighting departments of the Bolton Corporation, in which capacity he had between 300 and 400 men under his charge, and paid in wages over £400 a week. He obtained the position of electric tramways engineer at Cardiff in June last, and entered upon his duties on Sept. 1 at a salary of £500, notwithstanding that the Bolton Corporation offered him a substantial increase to remain in their employ. As chief electrical engineer for Cardiff he now receives £750, rising by annual increments to £1,000."

TRACTION.

Bristol.—The work of altering the tramlines in the west of the city was begun on the 10th inst.

Stockport.—We learn that the electric tramway system will probably be in working order by May next.

Rochdale.—The appointment of Mr. Platt as the engineer for laying the permanent way of the electric tramways has been confirmed.

St. Helens.—Trial runs are taking place on the extension of the St. Helens tramways from Ramhill to Prescot and down to the Royal Hotel.

Nelson.—Negotiations are still proceeding between the Burnley and District Tramways Company and the various local authorities as to the sale and purchase of the tramway undertaking.

Digitized by Google

East Molesey.—The Council have decided to oppose the London United Tramways Company's application for powers to construct further tramways running partly through this district.

Personal.—Mr. E. J. Marsh has been appointed chief electrical superintendent of the tramways department of Sheffield Corporation at a salary of £150 per annum, increasing annually by £10 up to £200.

Glasgow.—The Tramways Committee have postponed discussion on the proposed reduction of fares until a report has been received from the general manager on the working of the electric traction system now being installed throughout the city.

West Bromwich.—The Town Council have appointed a committee to enter into negotiations with the South Staffordshire Tramways Company, Limited, and the Birmingham and Midland Tramways Company, Limited, for the immediate purchase of their lines.

Northfleet.—The National Electric Traction Company, Limited, have now completed their arrangements for carrying out the works under the Gravesend, Rosherville, and Northfleet tramways order. The work will be commenced early in 1901. A local company will be formed.

Hampstead.—The deposited plans and sections of the Charing Cross and Hampstead Extension Railway have been referred to Mr. A. P. Johnson, town clerk, and Mr. C. H. Lowe, surveyor, for consideration and report. The scheme is meeting with strong opposition on account of the proposal to carry the railway under a portion of Hampstead Heath.

Worcestershire.—The County Council have agreed to contribute £1,900 towards £3,138, the ascertained cost of widening the canal bridge at Selly Oak, which will allow a double line of tramrails over it. The King's Norton and Northfield District Council agree to contribute £500, and the City of Birmingham Tramways Company provide the remaining sum.

Airdrie.—The Town Council have asked Prof. Kennedy to do what he considered necessary to place the Scottish House-to-House Electricity Company, Limited, under a binding obligation to construct the tramway from Motherwell-street to Clarkson Church within six years from the passing—July 30, 1900—of the Airdrie and Coatbridge Tramways Act, 1900.

Manchester.—A special meeting of the City Council will be held on Jan. 9 to consider and decide whether the Council shall require the tramways company to sell to the Corporation so much of the undertaking authorised by the Manchester Suburban Tramways Act, 1879, as the Corporation are entitled to purchase, and to adopt a resolution to require the sale if so decided.

Preparing for Winter.—At the last meeting of the Sunderland Health Committee the question of clearing the tramway routes when a fall of snow occurs came up for discussion, and it was agreed that the committee should do the work. When snow falls a car will be kept patrolling the lines to clear them as much as possible, and the Health Committee will sweep the lines clear and remove the snow.

New Malden.—The result of the recent post-card poll showed a majority of 190 in favour of tramways. The Council have agreed not to oppose the London United Company in their application for powers to construct the tramway, but they have reserved to themselves the right to negotiate as to clauses, provided the company, under their common seal, would withdraw that part of their scheme which related to the ward of Coombe.

Standish.—At a recent meeting of the Highways Committee a deputation from the Wigan Corporation waited upon the committee for the purpose of discussing the conditions of Standish Council relative to the proposal by the Corporation to construct and work electric tramways within the district of Standish-with-Langtree. A number of conditions were discussed, and eventually an agreement was come to with reference to the widening of the road and Boar's Head Bridge, fares, etc.

Hull.—The first car was run along the Beverley-road to Newland on Saturday. Alderman Larard, the chairman of the Works Committee, drove the first car, which was crowded with members and officials of the Corporation. Upon the return journey there was a capital amateur conductor on board—viz., Councillor Latus—who insisted upon collecting fares from everybody in the car, and, after doubling the amount received out of his own purse, handed over the proceeds to the Mayor's war fund.

Birkenhead.—The Tramways Committee have made arrangements to allow the Birkenhead United Tramways, Omnibus, and Carriage Company, Limited, to continue to use the existing lines after the expiration of their lease at the end of this year, and the new lines when constructed at the nominal rent of £3 a month, the arrangement to be terminable by four weeks' notice by either party, and the Corporation reserving the right to reconstruct, construct, and equip the tramways as whenever and wherever the borough surveyor may decide.

Plea for First-Class Carriages.—In reference to the new electric railway from the Bank to Shepherd's Bush, on which there is no distinction of class in the carriages, "S" writes to the *Morning Post* that the "democratic principle" is sometimes not altogether satisfactory. He does not say anything against working-men passengers, whose clothes must of necessity be suited to their work, but he points out that their raiment is sometimes such as to make it desirable on the part of those not engaged in industrial occupations to take a higher class of conveyance if that were available. "It is," he adds, "not so much for different classes of society that separate class railway carriages are needed, but that they do appear desirable for certain classes of clothes, and it is a privilege for which many well-dressed men and women would be willing to pay an increased fare." There is a good deal in this contention, especially as the people alluded to do already pay a higher fare.

Reading.—At the last meeting of the Town Council the Town Clerk reported that the Reading Tramways Company, Limited, had not accepted the offer made to them of the sum of £10,105 for the purchase of their undertaking, but that their soliciter had written to say that until a final decision had been arrived at in the proceedings now pending between the company and the Corporation, it was impossible for the directors to entertain any offer for purchase of the tramway undertaking for the sufficient reason that, in the event of the decision being in their clients' favour, the Corporation would have no power to acquire the tramways on any terms whatever. If, under these circumstances, the Corporation should proceed with their intention to apply to the Board of Trade to appoint a referee, the company would resist any such appointment. An application is to be made to the Board of Trade to appoint a referee pursuant to Section 43 of the Tramways Act 1870. It was further resolved to recommend to the Council that the borough engineer and Mr. J. E. Winslow be directed to proceed forthwith with plans and specifications of the works and machinery required for the station for generating electrical power, and to submit the same to the committee as early as possible.

Dundee.—The electric cars commenced running on the Perth-road on July 13. The passengers carried in July numbered 519,846, being an increase of 59,900 on the corresponding month of last year, and representing receipts enhanced to the extent of £221. 8s. 11½d. On October 22 work was commenced on the Lochee section. The total increase for the last six months compared with the same period last year is £1,380. 11s., while the advance in the number of passengers is 405,268. Since the introduction of the electric cars it is satisfactory to record that there has been entire immunity from accident. We learn from the *Dundee Advertiser* that "at a recent meeting of the Tramway Committee Mr. Fisher, the manager, reported that he had designed a new car, which in his opinion would fulfil all the requirements entailed by the conditions of traffic applicable to the Constitution-road tramway. The new type of car differs materially from any of those at present belonging to the Corporation. In the first place, it is larger, being 36ft. in length, which is 6ft. longer than the cars running on the Lochee section. Externally it is of elegant appearance. It is of the single-deck type—that is to say, no provision is made for carrying passengers on the top, which in construction is framed pretty much on the lines of American cars, ensuring thorough ventilation of the interior. The car is divided into three compartments. The end compartments are each seated for 10 persons, while in the middle compartment there is accommodation suitable for 24 passengers. The end compartments are fitted with movable windows, so that this part of the vehicle may be used as a semi-open carriage. By this division special accommodation may be accorded to smokers, while it also permits of a classification according to fare. At each end is a platform 2ft. 6in. long for the motorman and conductor. The new car is specially adapted for hill-climbing. The body rests on what are technically called '27 J. Brill trucks.' The propelling power is furnished by four motors, each coupled to an axle. To ensure safety of descent, the car, in addition to the ordinary and emergency brakes, is fitted with what is known as a slipper brake. By this piece of mechanism the brake proper is made to operate on the rail. The speed of the car when descending a steep gradient is thus retarded, and can be regulated to a nicety by the application of the ordinary working brake. Plans and a description of the new hill-climbing car will be submitted to the Tramway Committee on an early date."

Sheffield.—The Brightside section was only "passed" by the Board of Trade on the 6th, and 18 cars commenced running on the Tinsley section on Saturday last. At the next meeting of the City Council it will be proposed that the resolution of the Tramways Committee to lay a tramway from the bottom of Hounsfield-road along Glossop-road, Clarkehouse road, and Brocco Bank, to connect with the Ecclesall-road tramway, be not for the present proceeded with, nor until further instructions are given by the City Council after full consideration as to the advisability or necessity for such tramway. We have received a copy of Mr. Chas. F. Wike's (the city surveyor) report for the year ending March 31, 1900. Of course the electric tramways are only a portion of the vast amount of work which comes under the surveyor's department in the important town of Sheffield, and, in consequence, only a portion of the report deals with the tramway construction work. It is shown, however, that the tramways during the year were responsible for an outlay of somewhere about £50,000 by the surveyor's department. This was chiefly spent in reconstruction of the tracks for the heavier electric cars, and in the provision of the trenches and conduits for the electric conductors. In the report for the tramway department full details of the various lines which have been made during the year are given, together with information as to the way in which the tramway tracks have been paved. We gather from this section that two systems have been employed for the paving, the one being wood blocks and the other the tar macadam with granite setts against the rails. The various Board of Trade inspections are referred to, and from the short interval which elapsed in each case between the inspection and the certificate, one gathers that the work was carried out to the satisfaction of this Government department. As an instance of the work involved during the year no fewer than 152 drawings, 271 tracings, 104 reports and statements, and 80 estimates for tramway work have been prepared

Digitized by Google

in the surveyor's department. In these totals parliamentary work is not included, and the plans of sections which have to do with the Sheffield Corporation Bill of 1900 have been the cause of much extra work in the department. The figures given in the report as to the cost of the work included are exceedingly valuable for reference. It is worthy of note also that the expenditure on tramways, which it is hoped will be authorised by the Bill of 1900, will be no less than £349,495. The other improvements included in the Bill are the revision of the building of streets regulations, the acquisition of land for sewage-disposal works, and the erection of artisans' dwellings, while the area of the city is proposed to be extended by no less than 4,003 acres. The surveyor adds that the large amount of engineering work and surveying which had to be done by his department for this Bill is responsible for the late issue of his annual report.

PROVISIONAL PATENTS, 1900.

DECEMBER 3.

21837. Improvements in prepayment electricity meters. George William Lummis-Patterson, 79, Percy-street, Newcastle-on-Tyne.

21838. An appliance or device for obtaining direct electrical impulses or currents from alternating electric sources. George Beckett Batten, 2, Underhill-road, Lordship-lane, London, S.E.

21852. Improvements in electric traction. Edward Henry Tyler and Arnold Greaves Hansard, 49, Queen Victoria-street, London.

21858. Improvements in or relating to electrical contacts for detecting electrical disturbances receiving electrical vibrations or like uses. Mathias Cantor and the Prof. Braun's Telegraphie Gesellschaft mit Beschränkter Haftung, 55, Chancery-lane, London.

21860. Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

21861. Improvements in controlling electric boosters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

21862. Improvements in methods of securing pole-pieces to electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.) (Complete specification.)

21880. Improvements in or relating to electrical governing or controlling apparatus. Ernest Francis Moy and Percy Henry Bastre, 37, Essex-street, Strand, London.

21886. Improvements in electrical storage or accumulators. Louis Ernest Lacroix, jun., 65, Chancery-lane, London.

21903. Improved means of holding the inner glass and lower carbon of an electric arc lamp. Frederick James Green, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21904. An arrangement of electrical resistance specially adapted for electric arc lamps. Frederick James Green, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

21880. Improvements in and connected with wireless telegraphy. André Blondel, Norfolk House, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 3, 1900, being date of application in Belgium). (Complete specification.)

DECEMBER 4.

21922. Automatically controlling the speed at which electric tramcars, motors, and the like may be driven. Robert Foster Collinge and Harold Henry Lindon, 54, Jolliffe-street, Liverpool.

21933. Improvements in electric arc lamps. Crompton and Co., Limited, Arthur John Hodgson, and John William Ewart, The Arc Works, Chelmsford. (Complete specification.)

21961. New or improved self-acting electric fire-alarm and signalling device. Friedrich Gülbling, 187, Albany-street, Regent's Park, London.

21962. An improved adjuster or height regulator and cord receiver for electric lamps and like purposes. Horace McGowan, 33, Cannon street, London.

21991. Improvements in connections for electrical conductors. William Bingham Cleveland, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22010. An improved method of connecting electrical conductors. William Bingham Cleveland, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22019. Improvements in storage batteries. Achille Meygret, 72, Cannon-street, London. (Complete specification.)

22021. Improvements in arc lamps. Joseph Velle and the Mercury Cycle Manufacturing Company, Limited, 72, Cannon-street, London. (Complete specification.)

22022. Improvements in or relating to secondary or storage batteries or accumulators. Alfred Julius Boult, 111, Hatton-garden, London. (Louis Sauvan, France.)

22026. Improvements in electric wave telegraphs. Alfred Julius Boult, 111, Hatton-garden, London. (American Wireless Telegraph Company, United States.) (Complete specification.)

DECEMBER 5.

22068. Improvements in the construction of instruments for the measurement of electrical energy. Arthur Cecil Heap, 21, Lee-park, Blackheath, London.

22098. Improvements in the production of electric light. James Weir Graydon and Johann Otto Egestorff, 77, Chancery-lane, London.

22116. A new or improved endless electric conveyor for conveying tin plates from the bath of molten metal to a suitable or desirable place. John Baxter, Oliver Clark, and Charles Hillman, 22, Glasshouse-street, Regent-street, London.

22126 Improvements in apparatus for wireless telegraphy John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery lane, London.

22142. A new or improved telephone relay. Emil Schack Hagemann and Valdemar Poulson, 18, Buckingham-street, Strand, London. (Complete specification.)

DECEMBER 6.

22182. Improvements in or connected with electrical contact makers or switches for use at the insulated junctions of sections of electrical tramways and railways and for analogous purposes. Hugh Godfrey Nicholson, 47, Lincoln's-inn fields, London.

22196. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification)

22197. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Elihu Thomson, United States.) (Complete specification.)

22230. Improvements in or relating to electric cables or conductors. William John Glover, 6, Lord-street, Liverpool.

22233. Improvements in or relating to electric railways, tramways, and the like. Coleman Kandó, 18, Buckingham street, Strand, London. Complete specification.)

22234 Improvements in or relating to automatic electrical relays for operating pneumatic brakes in electrically-propelled vehicles and the like. Coleman Kandó, 18, Buckingham-street, Strand, London. (Complete specification.)

DECEMBER 7.

22240. Improvements in the electrolytic refining of metals. Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

22253. Improvements in and relating to electric switches for use in controlling motors. Edwin Thorley Parker, Prince's chambers, Wolverhampton.

22272. Improvements relating to galvanometers, voltmeters, and like apparatus. Thomas Edward Gambrell and Charles Thomas Gambrell, 17, Giltspur-street, London.

22273 Improvements relating to electrical plug resistance boxes and like apparatus and to switches therefor. Charles Thomas Gambrell and Thomas Edward Gambrell, 17, Giltspur-street, London. (Complete specification)

22281. Improvements in the means for suspending electroliers, electric lamps, and the like. Edwin Fletcher, 5, Corporation-street, Birmingham.

22285. Improvements in current collectors for electric vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Samuel B. Stewart, United States.) (Complete specification.)

22286. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

22287. Improvements in synchronising apparatus for electric alternators. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Fred T. Dow, United States. (Complete specification.)

22288. Improvements in means for attaching pole-pieces to electric machines. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.) (Complete specification).

22290. Improvements in telephone and telegraph apparatus. Sidney George Brown, 9, Putney-hill, Putney, London.

22313. Improvements in manufacturing laminated cores for electrical apparatus. Aron Nicolaus Thorin, 322, High Holborn, London.

22316. Improvements in or relating to electric cables or conductors. William John Glover, 6, Lord-street, Liverpool.

22330. Improvements in alternate-current measuring and indicating instruments. William Morris Mordey, 46, Lincoln's-inn-fields, London.

Digitized by Google

DECEMBER 8.

22360. Improvements in wireless electric telegraphic and audible signals particularly applicable to ships and coast points. Percy Ashton Cain, 73, St. Stephen's-road, Upton Park, London.

22362. Improvements in the construction of inductors. Victor Isodore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

22372. A method and apparatus for discharging electrified wool. J. G. White and Co., Limited, and James Gilbert White, 322, High Holborn, London.

22378. Improvements in drying apparatus for use in the manufacture of electrical insulating materials. Ernest Alexander Claremont, 4, Bloomsbury-square, London.

22379. Improvements in apparatus for the manufacture of electrical insulating materials. Ernest Alexander Claremont, 4. Bloomsbury-square, London.

22401. Improvements in the manufacture of illuminating bodies for electric lighting. Eberhard Sander, 18 Buckingham-street, Strand, London.

22403. Improvements relating to electric lighting on railway trains. James Woodside and Frederick Wilson, 27, Chancery-lane, London.

22406. Improvements in the decomposition of alkaline salts by electrolysis and in apparatus therefor. James Greenwood, 4, South street, Finsbury, London.

22411. Improvements in and relating to electric tramways or street railways. William Brooks Sayers, 46, Lincoln's-inn-fields, London.

COMPLETE SPECIFICATIONS ACCEPTED

To be published on Dec. 29.

1899.

24175. Electrically-propelled motorcars. Dickinson.

24451. Storage batteries. Lake. (Bruno.)

25032. Electric driving mechanisms for geared machines generally. Carter.

25282. Earthing devices and safety fuses for electrical circuits. Steele.

25746. Current collectors for electrical machines Lamme. (Date applied for under International Convention, June 5, 1899.)

1900.

435. Apparatus for electrically interlocking the doors or gates with the operative machinery of hydraulic or other lifts. Hollins and Amendt.

695. Magnetic cut-outs. Andreas.

1457. Electrolytic apparatus. Barnes.

3103 Arc lamps. Johnson and Wunderlich.

3471. Electrical accumulators. Renaud. (Date applied for under International Convention, Dec. 6, 1899.)

16159. Lifting magnets. Clark.

19934. Mounting of electric bells. Woittequand.

TRAFFIC RETURNS.

Line.	Returns for week Ending		1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
			£	£	£	£	£
Aberdeen Corp'rat'n	Dec.	8	589	477	+ 112	19,296	16 528
Birmingham Trams.	,,	8	4,568	4,138	+ 430	—	—
Blackburn Corp'rat'n	,,	8	416	405	+ 11	21 908	19 572
Blackpool Corporatn.	,,	6	179	138	+ 41	27 552	20,309
Blackpool-Fleetwood	,,	8	139	127	+ 12	19.852	19,864
Bolton Corporation..	Oct.	28	1,254	-	—	42 293	—
Bradford City Trams	Dec	9	767	336	+ 431	19,858	14,224
Bristol Tramways Co.	,,	7	3,065	2 630	+ 434	—	—
Carlisle Tr'mw'ys Co	,,	8	126	—	—	4 139*f*	—
Central London Ry.	,,	8	5,766	—	—	99.427*e*	—
City & South London	,,	9	1,915	1,110	+ 805	37,775	22,671
Cork E. T. and L. Co.	,,	6	348	358	- 10	19,995*c*	18,575
Dover Tramways ...	,,	8	167	145	+ 22	10.087	9,608
Dublin & Lucan E.R	Oct.	6	98	77	+ 21	1.590	—
Dublin U.T., elec. cars	Dec.	7	3,328	2,807	+ 521	—	—
Dublin S.D. Electric	,,	7	691	672	+ 19	—	—
Glasgow Corporation	,,	8	9,027	8,667	+ 380	--	—
Halifax Corporation	,,	1	672	576	+ 46	—	—
Hull Corporat'n E.S.	,,	8	1,402	648	+ 754	47,058*a*	—
Liverpool Corporat'n	,,	1	8,054	6,982	+1,072	380 550	531,096
Liverpool Overhead	,,	9	1,488	1,453	+ 35	—	—
St. Helens Tramwys.	,,	5	—	—	+ 202	—	—
Sheffield Corporation	,,	9	2,780	—	—	—	—
Southampton Trams	,,	6	626	288	+ 338	—	—
Southport Corporat'n	,,	*8	366	329	+ 37	—	—
Swansea Tramways..	Oct.	5	447	263	+ 184	7,093	4,462

a Since April 1. *c* Since Jan. 1. *e* From July 30. *f* From June 30.
* Fortnightly returns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	2-2
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	5	10	12/16-11 1/16
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6½
—— 5 per cent. Mortgage Debentures	100	—	100-106
British Electric Works, Ordinary, 50,001-95,000	1	..	1-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	1-1
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5
Brush Electrical Engineering, Ordinary	2	—	1½-1¾
—— Non Cum., 6 per cent. Pref.	2	—	2-2½
—— 4½ per cent. Debenture Stock	100	..	108-111
—— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures.	100	—	110-114
—— Ordinary	5	—	12½-12¾
—— 5 per cent. Pref.	5	—	5½-5¾
Crompton and Co.	2	—	2½ 4
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	2	—	12-2½
—— 5 per cent. Debentures	5	—	2½-4½
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Certs.	70	—	98-100
Electric Construction	2	—	2-2½
—— 7 per cent. Cumulative Pref.	2	—	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-106
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-12¾
—— 4½ per cent. Preference	5	—	5½-5¾
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	100-108
Telegraph Construction and Maintenance	12	—	38-42
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-5¾
Willans and Robinson, Ordinary, 1-80,000	5	..	10½-11¼
—— 6 per cent. Cum. Pref., 80,001-90,000	5	—	6¾-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	103-105 xd
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	3-3
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	103-105
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6½-6¾
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-6
Chelsea Electricity Supply	5	—	6½-7
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	9-10
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	125-130
County of London and Brush Provincial, Ordinary	10	—	8½-9½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	103-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	103-105
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7½-8½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	2	—	1½-2½
—— 5 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-103
Metropolitan, Ordinary	10	—	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	113-115
—— 3½ per cent. Mortgage Debenture, Red	100	—	98-101
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	..	1½-1¾
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	..	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	86-96
South London, Ordinary	2	..	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,000	5	..	15-16
—— 7 per cent. Pref.	5	..	8-9
—— 3½ per cent. Deb.	100	..	100-103
Westminster, Ordinary	5	—	12-13
—— 80,001-100,437	5	—	11½-12½
Electric Railways.—			
Central London, Ordinary	10	..	9-9½
—— Pref. Half-Shares	5	—	4½-5½
—— " " deferred	5	—	4-4½
City and South London, Consolidated Ordinary	100	—	52-56
—— Ordinary	10	—	4½-5½
—— 4 per cent. Debenture Stock	100	—	118-122
—— 5 per cent. Pref. Stock '91	100	—	138-142
—— " " " '96	100	—	130-135
Liverpool Overhead, 5 per cent. Pref.	—	—	12-12½
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9½-10½
British Electric Traction, Ordinary	10	..	14-15
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4½-5½
—— " B " 6 per cent. Cm. Pf., 1-27,500	5	—	4½-4¾
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	—	—	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9½-10½
New General Traction, Ordinary	5	—	3½-4
—— 6 per cent. Cum. Pref.	5	—	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17½
—— 5 per cent. Cum. Pref.	10	—	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	10½-11½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	102-105
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4¾
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 4 per cent. Deb. Stock, Red.	100	..	101-104
—— 3½ per cent. Deb. Stock, Red.	100	—	96-99
Oriental Telephone and Electric Company	1	—	1-1½

Digitized by Google

NOTES.

Crystal Palace Engineering School.—The committee of directors of the Crystal Palace Company's School of Practical Engineering entertained a number of guests yesterday on the occasion of the announcement of the lists of certificates awarded by the examiners for the last term. Sir Douglas Fox, past-president of the Institution of Civil Engineers, presided, and both before and after the formal function the workshops and laboratories were open for inspection.

Municipal Electrical Association.—It will be remembered that this association decided last autumn that they would appoint a permanent secretary to look after the greater amount of routine work of their association. We are now informed by Mr. E. T. Ruthven Murray, the present hon. secretary, that the council have appointed Mr. C. McArthur Butler as their permanent secretary. The address of the association will in future be St. James's Hall, Piccadilly, and all communications should now be addressed to the new secretary.

Society of Model Engineers.—On Saturday, Dec. 15, by kind permission of Mr. A. Bromley Holmes, M.I.C.E., city electrical engineer, a party of members of the Liverpool branch of the Society of Model Engineers paid a visit to the Pumpfields electric supply station, which is practically the largest owned by the Liverpool Corporation, and of which a detailed description was given in these pages a few weeks ago. A library is being formed in connection with this branch of the society, similar to that of the London branch, and contributions will be gratefully received by the hon. secretary, Mr. F. T. Stewart, 14, Adelaide-road, Kensington, Liverpool.

Electric Tramcars as Post Offices.—It is hardly to an electric tramcar that one would look to post one's letters. Nevertheless, the authorities at Coventry have carried into execution the certainly novel idea of attaching letter-boxes to cars running into the city from outlying districts at night time. A very appreciable saving of time is thus gained, as letters may be posted on the cars at the various stoppages *en route* about two hours later than the dispatch from the local post offices. This part conversion of electric tramcars into post offices, we are told, is merely temporary, but, surely, would it not be a great benefit to the public if the plan were adopted permanently

One Hundred and Fifty-Three Mile Transmission.—Some interesting experiments were recently made by the Snoqualmie Falls Power Company, in which all the transmission lines of the company were connected up in series. Energy was then transmitted through the whole length, which amounted to 153 miles, and an electric motor was successfully driven through this length. We are not told, however, what the voltage employed was, but the experiment was made to see if any unexpected results occurred. What is wanted to be known, however, is whether a sufficiently high voltage can be used without trouble on the line to make transmission of power over such a distance economically possible.

The Paris-Rome Telephone.—We hear that the work of constructing the telephone line which is to bring France and Italy into close unity is making great progress, the connections with Paris on the French side of the Alps having already been completed. Operations on the Italian side, however, are even more advanced, for the installation, which for this particular part of the line cost only 100 million francs, has been made, and now the engineers are turning their attention to the erection of the line between Turin and Novi. After this it will be carried to Genoa, and thence along the littoral to the Italian capital. Paris and Rome, it is expected, will be in direct telephonic communication by March or April next.

Copper Electrodes.—In the latest edition of his book on "Medical Electricity," Dr. Lewis Jones recommends that electrodes employed in giving various kinds of electric baths should be made of copper for preference. With this statement Mr. Richard J. Cowen, L.R.C.P. (Ireland), cannot agree, for we notice that in a letter to the *Lancet* on the subject he states that electrodes made of copper "rapidly discolour and corrode under the influence of the products of electrolytic decomposition of whatever fluid is used for the bath, and consequently are troublesome." Mr. Cowen goes on to state that for the last two years he has used electrodes of thin sheet aluminium, finding them practically untarnishable in the solutions usually employed, and in every way much more suitable. The writer concludes by saying, for the information of those who use electric baths in their profession, that in the case of aluminium the terminals should be clamped on, as soldering the metal is difficult and unsatisfactory.

Glasgow Local Section.—The attendances at the two meetings that have already been held of the Glasgow local section of the Institution of Electrical Engineers have been so well attended that the committee have found it necessary to engage the large hall of the Institution of Engineers and Shipbuilders for their future meetings. It is fortunately disengaged for all except the January date, so that after that meeting, which will unfortunately have to be held in the small hall, the large hall will be utilised. At the first meeting in November, when Mr. Chamen read his paper, the small hall was so uncomfortably crowded that the committee engaged the large hall for the important discussion on Mr. Langdon's paper, which we print on another page, and seeing the number that turned up it is fortunate they did so. Mr. R. F. Yorke will read his paper on "The Utilisation of Water Power for Electrical Purposes" at the January meeting. The local hon. secretary tells us that the total membership of the section now numbers 118, and that there are nearly a score of new candidates up for election. One point of considerable gratification to the committee is the number of members of the Institution resident in other parts of Scotland whose business frequently brings them to Glasgow, and who appear to make it a special point of so arranging that they are there for the meetings.

London County Council Scholarships.—The *London Technical Educational Gazette* issued under the date of November last, which has just reached us, contained a number of regulations in connection with scholarships and exhibitions which will be awarded during the coming year. For instance, it deals with intermediate county scholarships, senior scholarships, art scholarships and exhibitions, evening exhibitions in science and technology, the Swanley horticultural scholarships, the junior scholarships in practical gardening, training scholarships in domestic economy, and also cookery. The large number of awards which are described in this issue, and the regulations in connection with which they are given, brings us again to the question as to whether the large amount of money which is given annually by the London County Council for scholarships and exhibitions is well spent. There are, for instance, 100 junior artisans' evening art exhibitions, each the value of £5; the value is not sufficient to enable the student to give up his daily work and to devote his time to perfecting himself in art, and we think that the money would be more usefully spent if it were divided up among fewer students. The same argument applies in other departments, and it

Digitized by Google

is our opinion that it would be more useful to put means of obtaining higher education in the way of a select few of the students than to give small doles, which get to be looked upon as a reward for past attainments.

A Corean Electric Railway.—The *Street Railway Journal* gives some interesting particulars of the Seoul electric railway, which is not only the first electric railway in Corea, but also the first railway of any kind to be built there. It extends from the Queen's Tomb, east of the city of Seoul, through the centre of the city, and beyond the southern wall to the Han river The main line runs through the east and south gates, while a branch line runs through the west gate, and nearly surrounds the terminal of the Seoul and Chemulpo steam railroad, which is located just outside the city walls on the south-west. The total length of the road is 10 miles, five miles of which are inside the city walls and five miles outside. An extension from the Queen's Tomb eastward to Toksoh, a great distributing centre six miles away on the Han river, is now being constructed. The road is owned by the Corean Government, but was built and is still operated by Messrs. Collbrand and Bostwick. The number of passengers per month average about 110,000, out of a total population of about 400,000. The road is divided up into six sections, the fare on each of which is about 1½d., or a charge of 7½d. is made for the whole journey of 10 miles. A speed of nine miles within the city walls and 17 miles outside is maintained. The prejudice of the people against the line, which led to the riots referred to in one of our previous issues, has now been largely overcome. It will be remembered that these riots were partly in consequence of a boy having been killed by one of the cars.

Improving the Load Factor.—A boot manufacturer in Switzerland is reported to have hit upon a novel means of improving the load factor of the plant which supplies electrical energy to his factory. This energy, it should be mentioned, is required principally for lighting purposes at night. With the exception of a comparatively small amount required for a motor load, most of the available power has hitherto been unutilised during the day, although a constant supply has to be maintained by the supply company, and paid for accordingly by the manufacturer. An arrangement has now been devised whereby it is proposed to remedy matters. Curiously enough, the idea was suggested by the abundant fruit harvest of the past season, and consists in no less novel an innovation than the artificial drying of fruit by means of heat generated by the surplus electrical energy. Apparatus has been constructed by means of which dried apple rings of excellent colour and quality have been produced. From a description of the apparatus which we have before us, it would appear that its arrangement is very ingenious. The apples are peeled, cored, and sliced by machinery, the rings being thereupon consigned to electrically-heated ovens of the travelling type, wherein the evaporation may be regulated to a nicety. Judging from the success which seems to have attended the experiment, it appears quite within the bounds of possibility that the method may find favour in such isolated cases where the local conditions are so eminently adapted. But of economy in such an arrangement there can be no question, unless water power be the prime mover available. Certainly the idea in no sense lends itself to a general solution of the load-factor problem, from which we are apparently as far off as ever.

Power Distribution in North London. — The North Metropolitan Electric Power Distribution Company, which in July last were granted powers to distribute electrical energy over a large area of the North of London, have this year been making applications for provisional orders for a number of the districts within their area. Under the terms of their Bill they can only supply in these districts with the consent of the local authority, and there are, of course, two ways open to them—*i.e.*, they can either supply in bulk to the local authority, who would distribute the electrical energy throughout the district, or they can supply to a subsidiary company holding a provisional order. In the case, however, of Stoke Newington, it seems that they have applied themselves, but the Electric Lighting Committee of the borough are strongly opposed to the granting of a provisional order to the company. The objection is based on the ground that, having obtained a provisional order, they could supply electricity in Stoke Newington without any agreement with the Borough Council, or supervision by them. These, of course, are points which can be overcome, and without doubt the company will make a further attempt to get the necessary consent within the prescribed time. The whole question turns round the cost of supply, and it must be remembered by the Borough Council that although they may be supplied in bulk at what seems to be a low figure, the mains necessary for distributing the energy will require a very considerable capital outlay, the interest charges on which will bring up the cost of the energy as delivered to consumers. In fact, in order to ascertain whether the company's proposals are advantageous, they must compare the cost per unit supplied in bulk with the works' cost of generation in other towns much of the same size. To be quite accurate, the interest charges on the cost of the central station and plant should be added to the works' cost when making a comparison.

New Alternating Arc Lamp.—The need of an alternating-current arc lamp to yield a hemispherical diffusion of light equal to that obtained with the continuous-current arc has led a well-known Continental firm to introduce a lamp which claims to conform to this requirement. The carbon rods of the lamp in question are inclined at an angle of about 50deg. relative to each other above the horizontal, whereby it is ensured that the available light with the exception of a small fraction is reflected downwards, the objectionable shadow cast by the lower carbon in a lamp of the ordinary type being at the same time avoided. However, the inclined position of the carbons does not of itself suffice to ensure the requisite diffusion, since experiments proved that carbons of the ordinary type when so inclined caused the arc to mount and flicker violently. This difficulty was overcome by an expedient simple in itself, but surprising in its efficacy—namely, by flattening the upper sides of both carbons. The fraction of the light rays which go upwards from the arc are reversed by means of a small reflector, while the two craters emit their light rays to the right and left of the vertical centre. Photometric measurements have shown that the hemispherical intensity of the light obtained with this new lamp exceeds by considerably more than half that yielded by previous types of alternating-current arc lamps, while the diffusion is also favourable to the new lamp, since practically the whole of the available light is reflected downward. For exterior lighting the lamp should be hung as high as it is usual to hang continuous-current arcs, so as to obtain uniform illumination at the ground level. In virtue of the inclined position of the carbons, constructional advantages accrue in that a globe of much smaller dimensions may be used. Further, there are no rods either below or at the side of the arc to cast objectionable shadows, nor are there any of those bands and chains which so frequently cause trouble

Digitized by Google

in the ordinary type of lamp. As a rule, the lamp is constructed on the differential principle. The requisite difference of potential between the terminals is from 29 to 30 volts, according to the current strength.

Starting Torque.—In connection with cable tramways, and also with moving platforms as installed in connection with the Paris Exhibition, the standing friction which has to be overcome in order to start the platform or heavy cable into motion is a factor not easily predetermined. We notice in the *American Electrician* that when a cable line in Kansas City was converted from steam-engines to electric motors some interesting experiments were made for the purpose of ascertaining what the starting torque would be. In this case the whole system of tramways was not converted to electrical working, but electric motors were used to drive the cables. The indicator diagrams taken from the engines in the usual way gave a fairly accurate means of determining what power would be required when the cable was running with the cars in regular service. It was necessary to ascertain what it would take to start the cable from a standstill under such conditions as would exist should a circuit-breaker open when the cable was in regular operation, and make it necessary to start up from a dead stop. To do this, a series of indicator cards were taken on the cable engine starting from a standstill with all the lost motion taken out of the gears. The engine crank was put at exactly half stroke, and steam was admitted to the cylinder gradually until the engine would just start the cable. The pressure shown on the indicator card at the instant of starting was noted, and this process repeated until a number of indicator cards were obtained. From this a fair average could be calculated. The torque exerted by the engine was then figured from the total steam pressure on the piston head at the instant of starting. From this the starting torque to be required from the electric motor when geared at the proper ratio to run the cable at normal speed was obtained, and this was compared with the torque the motor would exert when running at its rated speed and horse-power. Then by allowing a good margin for overloading the motor, the current required to start the motor and cable machinery from a standstill was determined.

Method of Charging.—The number of engineers who have devised new means for regulating the charges for electric energy for lighting and power is legion. The last system we have had brought to our notice is that devised by Mr. Ralph J. Patterson in the December number of the *American Electrician*. This gentleman starts with a correct basis, in that he proposes to charge all consumers a fixed sum per annum to represent the interest on the capital outlay required to supply them. He also makes this fixed charge dependent upon the maximum demand, but we do not see that he proposes any accurate system of determining the actual maximum demand. He suggests, however, that excess current cut-outs could be used to dim the lights if the maximum demand is exceeded, but this will not find favour with consumers. Besides this first charge a small charge of 2½d. per Board of Trade unit is also proposed, so that it will be seen the system is not unlike that which has been used in Manchester. What, however, we do object to is that Mr. Patterson proposes to vary the fixed charge per lamp per annum, and to make it dependent on the number of lamps demanded. Converting his figures into 8-c.p. lamps instead of 16-c.p., it seems he would charge a consumer demanding four lamps 10s. per lamp per annum, over and above which sum the consumer would have to pay for all energy supplied at 2½d. per unit. This fixed sum per annum per lamp falls down to 5s. if 20 8-c.p. lamps are demanded, and to 3s. per lamp if 50 8-c.p. lamps are assumed by the consumer to be his maximum load. It must be borne in mind that it is the lamps demanded at one time, and not the lamps fixed, which Mr. Patterson works with, and hence we fail to see why the capital charge should be reduced to larger consumers. It has been the experience in a number of electric light stations in this country that it is the small consumers taking, say, half a dozen 16-c.p. lamps whom it really pays the central station most to supply. We think, on the whole, that the system reviewed is much too cumbersome, and that it is, in consequence of its differential rates, inferior to the Brighton system, which uses maximum demand indicators to ascertain what the consumer actually takes.

Electrical Progress in Japan.—How wonderfully advanced Japan is in the practical applications of electricity may be gathered from a brief survey published in the *Zeitschrift für Elektrotechnik*, which reports, amongst other information, that the Japanese Government have sanctioned important railway extensions in the island. A number of new full-gauge lines, including a 20-mile stretch between Osaka and Kobe, and two other stretches having lengths of 18 and 13 miles respectively, some of which are already in course of construction, will be equipped for electric traction. An extension of the network of street railways connecting Tokio and the principal factories with the more important seaports is also proposed—this to be likewise equipped for electric traction. It is stated that Japan already possesses upwards of 400 electric generating stations, of which 19 serve solely to supply energy for working street, mine, and factory railways, while the remainder supply energy to towns and villages for lighting purposes, and to factories, etc., for both power and lighting purposes. Central supply stations having an individual output of 4,000 h.p. and upwards exist in Tokio, Kobe, Nagoya, Yokohama, and elsewhere. The motive power is supplied in each of these cases by steam. Considerable water power is also available. This is notably the case in Kioto, where a large turbine plant is driven by the waters of Lake Bitwa, also at Osaka, where the natural outlet of the same lake represents an available force of over 25,000 h.p., a portion only of which is at present utilised. Although Japan is making rapid headway as regards the manufacture of its own requirements, it is, nevertheless, an important market for electrical machinery, etc., of foreign manufacture, and especially in view of the traction work proposed is likely to remain so for some time to come. Most of Japan's railways run transversely across the country, and the island being of inconsiderable breadth, these lines are, therefore, admirably adapted for electric traction. But at some future date it is proposed to construct a line from the southernmost extremity of the main island *vid* Yeso up to the northernmost point of the same, thereby intersecting the transverse lines and so connecting the interior with the excellent harbours along the east and west coasts. It will, then, be seen that Japan bids fair to possess a model system of inter-communication, to the realisation of which natural conditions so strongly contribute.

Pacific Cable Surveys.—The work done not long ago by the American authorities on the survey of the Pacific Ocean to ascertain the best route for the proposed American Pacific cable has recently been reported on by Rear-Admiral R. P. Bradford, of the U.S.A. navy. This report has just been published, and the following information is extracted from it by our contemporary the *Electrical World*. It may be remembered that last year it was announced that submarine peaks and chasms were dis-

Digitized by Google

covered by the surveyors, and that the surveying ship "Nero" established the fact that a practical cable could be laid across the Pacific. Later last year and this year surveys have been conducted to discover a practicable route between Guam and Yokohama, Japan, and from Dingala Bay, Island of Luzon, to Guam. The zigzig survey from Dingala Bay to Guam was completed on Sept. 7 last year. The "Nero" sailed from Guam on Sept. 9, and arrived at Yokohama on Sept. 24, having run a line of soundings at close intervals between the two ports along a route 1,332 knots in length. After leaving Yokohama on Oct. 10, the "Nero" made a zigzag or traverse return survey to Guam, arriving there on Nov. 2. On Nov. 12 the zigzag survey toward the United States was resumed. It was completed to the Midway Islands on Jan. 3, 1900, and to Honolulu Jan. 29, 1900. Mention was made in last year's report of an obstacle in the nature of a submarine abyss on the route between the Midway Islands and Guam, not far to the eastward of the latter. The abyss, which is the deepest yet discovered in the world, was then only known to be of a greater depth than 1,900 fathoms. It now appears that, on the trip of the Nero to the westward, while attempting to sound, 4,913 fathoms—or 29,478ft.—of the sounding wire, all that was on the reel, were unwound without reaching bottom. Upon leaving Guam Nov. 19, 1899, on the trip to the eastward, Lieutenant Commander Hodges made further explorations in this locality, now known as the Nero Deep, which confirmed the previously announced conclusion regarding the necessity for deflecting the cable route from the Midway Islands to Guam, and added to the knowledge of the greatly depressed area already referred to. This region, the extent of which the survey has well defined to the north-eastward, afforded an opportunity for the "Nero" to make the two deepest casts and take the two deepest water temperatures ever recorded. The depths found were 5,160 fathoms and 5,269 fathoms, and the temperatures were 35·6deg. F. at 507 fathoms and 36deg. at 5,101 fathoms.

Lifting-Electromagnets.—The design of electromagnets for lifting heavy weights is confined to a few electrical engineers, and practical details in connection with this design are not readily available. We notice, for instance, in the *American Electrician* for December an article on the subject by Mr. E. B. Clark, who has evidently had considerable experience in the matter. Even this gentleman does not give any practical figures from an actual design, and his undimensioned drawing of a circular lifting magnet is of little service. His general conclusions, however, are interesting. He points out that for lifting steel plates of considerable length and width, the electromagnet, which is able to seize the plate in the middle and lift it clear of obstacles, has a wonderful advantage over rolling tables. There is certainly the danger that the plates might be dropped if the circuit through the electromagnets was interrupted, but the author rightly says that there is no reason why the route over which the plates have to pass should not be kept as clear of workmen as has to be the case in the older methods of transport. He states that in designing magnets it is not well to press the induction up to a point higher than gives about 150lb. pull per square inch of pole surface. The uncertain feature in their design is the air-gap between the faces of these poles and the iron to be lifted. It is, therefore, necessary to provide ample magnetomotive force in such magnets. When long plates have to be lifted, the circular form of pole-face is not to be recommended, as the iron is apt to bend, and hence tear away from the magnet. For instance, a circular magnet which will lift on a straight pull 10,000lb. easily will refuse to pick up a long thin plate which weighs only 1,000lb. In order to avoid this effect, a group of rectangular poles acting along the line of the bent plate is to be preferred. It is sometimes desired to alter the lifting power of the magnets so that they will only hold one of a number of articles. The author does not advise reducing the current through the magnets in order to do this, but states that by rapidly switching on and off, the operator can cause the magnet to drop all but one of the articles. It is also important with these lifting magnets to have a discharging resistance to take the throw when the circuit is broken. For this purpose it is well to shunt the electromagnet by introducing lamps in parallel, which should have a capacity about 50 per cent. more than the current absorbed by the amgnet. The voltage of the lamps should also be rather more than that of the supply circuit. The only guide given to current consumption is the statement that an electromagnet for handling plates weighing 3,000lb. should be easily operated by 1,000 watts. Under favourable circumstances these magnets will then lift considerably more than the load mentioned above.

Municipalities and Income Tax—The litigation between the London County Council and the Crown, which was commenced some years ago with the view of determining the Council's liability in regard to the payment of income tax, has recently culminated in a judgment of the House of Lords in the Council's favour on all issues. The Council's case was that it was wrongly asked to pay the tax twice over upon the same revenue, and apparently this was the view taken by their lordships in the House of Lords. The fund out of which the dividends are paid to the stockholders, it would seem, consists principally of interest, rents and rates received. When the Council pays these dividends it deducts income tax, and the question raised was as to how much of the tax so deducted the Council was entitled to retain. The Crown originally claimed the whole of the tax deducted from the stockholders dividends, but in the course of the proceedings they moderated their contention by admitting that the Council was entitled to retain some proportion of the tax in respect of the interest item. But this was not enough for the London County Council, and the case was fought out on the issue that the Council was entitled to some proportion of the tax in respect of rents as well as interest. Income tax on the interest and rents was already paid before coming into the hands of the Council, and therefore the Council took up the position that they had a right to retain so much of the tax deducted from the stockholders' dividends as was equivalent to the tax so paid, otherwise it would be paying income tax twice over upon the same moneys. The House of Lords was unanimously in favour of the Council's contention, and reversed the decisions of the inferior courts in the case. The Council are to be warmly congratulated on this success, for the question is one to which the greatest interest and importance attach. The highest tribunal has in effect decided that bodies, whether municipal or otherwise, are not liable for income tax on revenue which they receive in respect of interest and rents, because the tax has already been paid on these moneys. If the Crown had succeeded even on its modified contention, the Council would have had to pay over to the Inland Revenue authorities no less a sum than £32,000, and, of course, the tendency would be for this sum to increase as the Council's financial operations grew. Between 1892 and 1897 the Council paid all the tax deducted from the dividends, and also tax on the interest and rents, but a summarised claim for all sums, which, it contended, had been overpaid, amounting in all to £71,686, was sent to

Digitized by Google

the Inland Revenue Office. Shortly afterwards it was agreed that the tax payments for back years should be adjusted on the basis of the final decision of the Law Courts, so in the long run the Council will not be the losers. A difficult and complicated question of far-reaching effect has thus been finally settled, and the necessity for litigation on the subject, it is to be hoped, will be considerably lessened in consequence.

The Paderno Transmission Plant.—We notice in the *Electrical World* an interesting *résumé* and investigation of the working of the Paderno transmission scheme by Mr. G. Semenza, who has had so much to do with the engineering details of the scheme itself. The interest in this plant is due to the fact that it represents conditions which will apply in a great many power transmission schemes. In the first instance, no less than 4,000 kw. of plant are provided, the transmission line being 25 miles long. One most important point is that the generators produce a higher voltage than is commercially used elsewhere. In this instance no less than 15,000 volts were generated in the three-phase circuit's armatures, and it seems that the machines are getting successful results. Our contemporary in America, however, is rather sceptical as to the advantage of generating such high voltage direct in the armature of the alternator. It holds that it is rather apt to encourage resonance effects if the machines are constructed in the usual way, because it is not easy to obtain a wave form which is nearly a sine current. In consequence of this there are harmonics developed which may cause trouble on the line or in the machine. The Paderno machines, however, seem to have good regulation on non-inductive loads, but they are somewhat sensitive to inductive loads. On the transmission line there has been considerable trouble with lightning, in spite of the use of iron poles and lightning arresters. In fact, on two occasions the works have been shut down from lightning discharges. Another interesting feature of Mr. Semenza's report is the very careful investigation of the power factor of the load. The very large use of synchronous motors in the Paderno plant is striking, and the result is highly satisfactory, so far as the power factor is concerned. The induction motor part of the load seems to give about the same results as are found in similar cases in American practice, and the same difficulty of underloaded motors seems to have been encountered. If induction motors are worked somewhere near full load little trouble with lagging current is met, but if many of them are habitually worked underloaded the case may be quite different. The synchronous motors employed for driving dynamos and worked with over-excited fields, seem to have acted as an almost complete corrective of the inductive load elsewhere, so that the net result of 0·91 for the power factor of the system is excellent, particularly when one considers the effect of the reducing transformers. Synchronous motors form a convenient and useful part of most transmission systems, but we know of few cases in which they are so advantageously used on so large a scale as at Paderno. The author has also devoted considerable attention to investigations on the line, in which no less than six complete three-phase circuits are provided. The impedance factor of the line was found to be 1·35, while the charging current proved to be 1·03 amperes. The author succeeded in separating out this last figure into leakage and capacity components. He found that the leakage was not quite a quarter of an ampere, which is exceedingly good considering the high voltage used and the length of the line.

Electric Traction in Italy.—A paper recently read in Paris by Mr. Tremontani, and reproduced in *L'Elettricista*, contains some interesting information about the full-gauge railway line between Milan and Gallarate, which is being equipped for electric traction. The line has a double track and is 25 miles long. Three single-track lines branch off from Gallarate; one, having a length of 16 miles, going to Arona, a second, 19½ miles long, to Lugano, and a third, 21 miles long, to Porto Ceresio. All these lines are at present worked by steam locomotion, but after the introduction of the electric service the steam hauled trains are to be entirely dispensed with. A 12-minute service of trains will be run in each direction over the main line, some of the trains being express, while an hourly service in each direction will be inaugurated on the branch lines. It is proposed to provide 20 motorcars and a like number of trailers, the first-mentioned to accommodate 75 and the trailer 99 passengers each. The motors are of the two-bogie type, and will be equipped with four motors each. The express trains are to accomplish the distance between Milan and Gallarate in 30 minutes, which corresponds to a speed of 50 miles per hour. All calculations relating to current consumption have been based on an estimate of 104 watt-hours per ton-mile. The necessary power for working the line will be generated and transmitted in the form of multiphase currents, and afterwards converted into direct current for the motors. As a site for the power station Tornavento has been selected, which is situated at a distance of seven miles from Gallarate. Water will ultimately be the prime mover, of which 11,000 h.p. is available from the River Tessin. Having regard, however, to the considerable time which the necessary hydraulic work will take to complete, an auxiliary steam plant is being put down, which later on will be held in reserve. The steam-engines, three in number, are of the tandem compound condensing type, with a maximum output of 2,000 h.p., each being coupled to a 750-kw. multiphase generator. The current, generated at an initial pressure of 13,000 volts, is transmitted to Gallarate by means of two overhead circuits of 7·8mm. wire, there being consequently six high-pressure wires in all. Provision is also made for five sub stations to be equipped with transformers and rotary converters. In three of these sub-stations will be placed two converters of 500 kw. capacity, and in each of the remaining two a converter of 250 kw. capacity. The overhead feeders are suspended parallel to the railway at a distance of 16ft from the track, while the height of the lowest wire above the ground level is 23ft. But where tunnels occur these high-pressure feeders are diverted from the railway. Wooden poles, provided with wooden cross-arms, are used to carry the feeders These poles are placed at intervals of 130ft., and, contrary to American practice, iron pins are employed to support the insulators. Each pin, however, has a porcelain cap, and upon this is mounted the insulator proper. The distance separating individual wires is 20in., while the loss in the high-pressure lines is estimated at 1·8 per cent. But the mean efficiency of the transmission line from the switchboard in the generating station to the collectors of the motorcars is estimated at 80 per cent. The converted current, at 650 volts pressure, will be conveyed to the motorcars by means of a third rail. This has the form of an ordinary Vignoles rail, and weighs 91lb. per yard. It is laid in 39½ft. lengths upon special insulators, at a distance of 2ft. 2½in. from the nearest running rail. The joints are made with fishplates and electrically bonded. Two collector shoes are provided at each side of a motorcar—one pair for each direction of travel. At crossings and points the third rail is, of course, interrupted. Underground cables are employed at such points to maintain the electrical circuit. The bearing rails serve as a return conductor in the usual way.

Digitized by Google

THE PHILOSOPHY OF DYNAMO DESIGN.

(Specially contributed.)

(Continued from page 839.)

Limits of Load.

It has been already stated that there are two factors which govern the output of a dynamo—viz.: firstly, the rise of temperature in the armature due to the flow of the current, and which, considering R_a to be constant, will vary as C_a^2, where C_a represents the total armature current; and, secondly, the difficulty of obtaining such a position for the brushes as the load increases as will enable the short-circuited coils to be in a field of the requisite strength for sparkless commutation. The difficulty would be one easily overcome were we only concerned with the heating of the armature, as it would be a very easy matter to rewind a given size of core with a larger gauge of wire in order to increase the current output; and as the heating effect varies as $C_a^2 R_a$, and the resistance varies inversely as the area of the wire, by a suitable selection of the gauge of the wire the heating could be kept within any specified limit for any given output. But when we come to consider the question of sparkless commutation, we find that this easy method for increasing the output of a dynamo is not sufficient, and that more radical alterations are requisite, as the whole question of sparkless commutation is dependent upon the theory of the armature reactions.

The principles upon which the modern theory of commutation and armature reactions is based were first enunciated in the "Original Papers on Dynamo Machinery" by Drs. J. and E. Hopkinson in 1886, and were further developed at the meetings of the Institution of Electrical Engineers in January and February, 1890, when two papers were read—one by Mr. Swinburne on "The Theory of Armature Reactions in Dynamos and Motors," and the other by Mr. Esson on "Some Points in Dynamo and Motor Design"—and at a further meeting in April, 1891, when Mr. Esson read another paper on "The Design of Multipolar Dynamos"; and it is from these papers and the discussions which followed their reading that we have obtained almost the whole of our present-day knowledge of the armature reactions and the causes which limit the output of any armature; and it is only as they are in accordance with the principles which the authors of these papers laid down that the various devices which have been adopted to overcome the armature reactions are of value.

We have already seen that the magnetising force of the armature may be resolved into two components—viz., that due to the cross ampere-turns and that due to the back ampere-turns—and that the relative values of these two sets of turns will depend upon the position of the brushes; if the short-circuited coils lie upon the vertical diameter (in Fig. 31) there will be no back ampere-turns, while if they lie upon the horizontal diameter there will only be back ampere-turns and no cross ampere-turns. Consider Fig. 31, where X X represents the horizontal diameter and A C are two points taken at equal distances above and below it, then the magnetomotive force of the cross ampere-turns between these two points is proportional to the number of coils which lie between them, and if we join A O, C O, and call the angle formed by these lines α, and the total number of conductors on the armature τ, the number of conductors lying between A and C for any value of α will be $= \tau \times \frac{\alpha}{360}$, and the number of cross ampere-turns will be in a bipolar machine $= \frac{C_a}{2} \times \tau \times \frac{\alpha}{360}$, since half the armature current passes through each conductor, and the magnetomotive force of the cross ampere-turns will then be $1{\cdot}256 \times \frac{C_a}{2} \times \tau \times \frac{\alpha}{360}$. The lines of force due to this magnetising force will flow, as shown in Fig. 7, through the iron of the core, across the air-gap, through the iron of the pole-piece, and across the air-gap again into the armature core. If the induction of the iron is not so great as to saturate the iron, very little magnetising force will be requisite to force the lines through the iron, and the whole of the force may be considered to be utilised in propelling the lines across the two air-gaps, or along a length $2 l_g$, where l_g is the distance between the iron of the armature core and that of the pole-piece. If, as will be the case with a well-designed dynamo, the positions of A and C are close to the polar horns, the lines of force due to the cross magnetising turns will, as shown in Fig. 9, flow in the opposite direction to the lines of force due to the field at the leading horn, and in the same direction at the trailing horn. If A t_g equals the field excitation which is expended over the air-gaps, then the magnetomotive force due to the field coils on each air-gap will be $1{\cdot}256 \frac{A t_g}{2}$, and the total magnetomotive force at A and C respectively (Fig. 9) will be

at A $$1{\cdot}256 \left\{ \frac{A t_g}{2} - \frac{C_a}{2} \times \frac{T}{2} \times \frac{\alpha}{360} \right\},$$

at C $$1{\cdot}256 \left\{ \frac{A t_g}{2} + \frac{C_a}{2} \times \frac{\tau}{2} \times \frac{\alpha}{360} \right\},$$

and the induction B_g will vary between A and C within the limits of

$$B'_g = \frac{1{\cdot}256 \left(A t_g - \frac{C_a}{2} \times T \times \frac{\alpha}{360} \right)}{2 l_g},$$

and $$B'_g = \frac{1{\cdot}256 \left(A t_g + \frac{C_a}{2} \times \tau \times \frac{\alpha}{360} \right)}{2 l_g}.$$

In other words, as we have seen before, the induction under the trailing horns is as much increased as it is decreased under the leading horns.

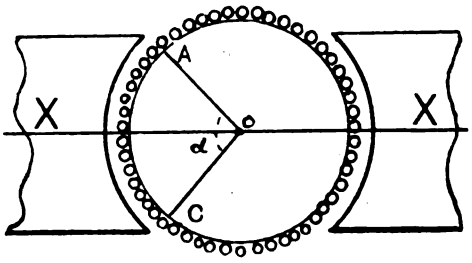


Fig. 31.

Now, the magnetising force of the back ampere-turns is proportional to the number of coils included in twice the angle of lead, and if λ = lead of brushes it will be equal to $\frac{C_a}{2} \times \tau \times \frac{2\lambda}{360} = C_a \times T \times \frac{\lambda}{360}$. But with a compound-wound machine we may consider that the series winding will increase the field excitation over the air-gaps by exactly the same amount as it would be reduced by the back turns, so that these turns may be left out of the question.

We have already seen, when dealing with the theory of commutation, that the short-circuited coil must be in a field of sufficient strength to produce in the closed coil a current equal to that flowing in the series of coils into which it is about to enter, and we have also just seen that the induction at the leading horn $= \frac{1{\cdot}256}{2 l_g} \left\{ A t_g - \frac{C_a}{2} \times \tau \times \frac{\alpha}{360} \right\}$. Now, if the output of the machine is too high, $\frac{C_a}{2} \times \tau \times \frac{\alpha}{360}$ may become equal to, or greater than, $\frac{A t_g}{2}$. In the first case there will be no field at all, and in the second case the flow of the lines of force will be in the wrong direction. In either event there would be such disastrous sparking as would prevent the dynamo being used at such a load; so that the output of the dynamo is, independently of any heating effect limited by the fact that $\frac{C_a}{2} \times T \times \frac{\alpha}{360}$ must be something less than $\frac{A t_g}{2}$. Let $A' t_g$ equal the excitation required for the field induction over one

Digitized by Google

air-gap, or $A' t_g = A t_g \div 2$. Messrs. Hawkins and Wallis in "The Dynamo" give as the limiting value for safe working of the above factor that it shall not be more than $\frac{A' t_g}{1{\cdot}5}$ for drum armatures and $\frac{A' t_g}{2}$ for Gramme armatures. Accepting these figures, we get for a drum armature

$$\frac{C_a}{2} \times \tau \times \frac{\phi}{360} = \frac{B_g \times 2\, l_g}{1{\cdot}5 \times 1{\cdot}256}$$

$$\frac{C_a}{2} \times \frac{\tau}{2} = \frac{B_g \times 2\, l_g \times 360}{3{\cdot}768 \times a}$$

$$= \frac{96\, B_g \times 2\, l_g}{a}$$

and for a Gramme armature

$$\frac{C_a}{2} \times \frac{\tau}{2} = \frac{72\, B_g \times 2\, l_g}{a'}.$$

It must be noted that in a bipolar dynamo the magnetising force which we have been considering above is that equal to half the total armature current multiplied by half the total number of inductors. This is evident from the fact that we have only been dealing with one pole-piece, and similar reactions occur upon the other side of the armature. Mr. Esson calls the product of the number of inductors multiplied by the current flowing through each the volume of current carried by the armature, and this will be, of course, double the amounts given above—viz.:

$\frac{C_a}{2} \times \tau$ will equal $\frac{192\ B_g \times 2\, l_g}{a}$ for drum armatures; and

$\frac{C_a}{2} \times \tau$ will equal $\frac{144\ B_g \times 2\, l_g}{a}$ for Gramme armatures.

Upon examining these equations it is seen that the volume varies directly as the induction, and as the length of the air-gap, and inversely as the angle a, or since a will be approximately equal to ϕ (the angle of polar embrace), the volume varies inversely as ϕ. So that in order to increase the output, the induction and air-gap must be increased or the polar embrace decreased. But if we desire to build an efficient dynamo, these alterations cannot be made to any great extent, and the output for a given size of armature, although it may be increased, will be found to have a limit.

Messrs. Hawkins and Wallis assume that the radial depth of iron of the core for drum armatures is 0·28 of the diameter, and that the induction is 14,500 in the armature; and, further, that the length of the air-gap is 0·0365 of the diameter of the armature. Then, substituting these values, we get for the limiting value of the volume,

$$\frac{C_a}{2} \times \tau = 600\ D \text{ for drum armatures,}$$

where D is the diameter of the core in centimetres.

Similarly we get $\frac{C_a}{2} \times T = 400\ D$ for Gramme armatures if we take the radial depth as ·2 D and $B_a = 18{,}000$

Mr. Esson in the paper he read in April, 1891, gives these figures, which he obtains somewhat differently. Let v = volume of current, or what we have expressed by $\frac{C_a}{2} \times \tau$; ϕ = the angle of embrace; l_g = length of air-gap; and B_g induction per square centimetre in the air-gap.

If, then, the armature is so loaded that the cross induction and forward induction exactly balance each other under the leading horns, we have $\frac{v\,\phi}{360} = \cdot 8\ B_g \times 2\ l$, and upon simplifying this we shall get $v = \frac{576\ l\ B_g}{\phi}$. Mr. Esson suggests that since it would be folly to run a machine at such a load that the slightest increase might ruin the commutator, this should be considered as the absolute limit, and that for practical purposes we should have a factor of safety of 2, and take as our safe working load

$$v = \frac{288\ l\ B_g}{\phi}.$$

If r = radial depth of core, w = width of pole-piece, and B_a the induction in the armature, $B_g = \frac{2\, r\, B_a}{w}$, and substituting this value in the equation, we obtain

$$v = \frac{576\ r\ B_a\ l_g}{w\ \phi}.$$

Taking the induction in the armature as 18,000 C.G.S. per square centimetre and ϕ as 122deg., we obtain

$$v = \frac{r\ l\ 85{,}000}{w}.$$

If we now insert the values in terms of the diameter for r and l we have previously used and take $w = 1{\cdot}5$ D, we shall obtain for Gramme armatures

$$v = \frac{\cdot 2\ D \times \cdot 0365\ D \times 85{,}000}{1{\cdot}5\ D} = 413\ D,$$

and for drum armatures

$$v = \frac{\cdot 28\ D \times \cdot 0365\ D \times 85{,}000}{1\ 5\ D} = 572\ D,$$

which practically agrees with the figures previously obtained of 400 D for Gramme armatures and 600 D for drum armatures; and as the values given for r, l, w, and ϕ in the above equations cannot possibly be absolute for all makes and types of dynamos, there must be a certain amount of elasticity in any formula, and, therefore, we may take these values, 400 D and 600 D, as our working rule for the absolute limit of load for all practical purposes.

It will be readily seen that while the question has only been dealt with so far as applying to bipolar machines, it is easy to extend it to multipolar types. In obtaining the equation $v = \frac{576\ l\ B_g}{\phi}$, we were concerned with one pole of the dynamo only, and this equation will hold good for one pole if the number of poles be increased to four, six, or more, for as the number of poles is increased the value of the angle ϕ must decrease.

The student will notice that the limiting output is less for a Gramme-wound armature than for a drum. This is due to the fact that there is a greater liability to sparking with a Gramme than a ring. The primary cause of this is that the resistance of two coils of a Gramme machine is, with well-designed dynamos, greater than the resistance of one complete coil of a drum armature owing to the greater length of wire necessary, while the number of face or active inductors is the same in the two cases, hence a stronger reversing field or greater lead will be required with the Gramme. The self-induction of a coil of a Gramme armature will also be greater, as both the external and internal lengths will carry the current, which has to be stopped and reversed; and as these are wound round the iron of the core, unless the forward induction in this part of its path is pushed well up to the saturation point, the self-induction will be of very great magnitude, consequently it is usual to work with a much higher induction in the core of a Gramme armature than in that of a drum. This will explain why in our equations for the limiting value of the output of a dynamo we took $B_a = 18{,}000$ for a Gramme armature and $B_a = 14{,}500$ only for a drum.

In calculating the magnetising force required, and the induction in the various parts of the path, the student must remember that there will be a certain amount of leakage of the lines of force, and only a proportion of those passing through the magnets and yoke will travel through the armature core. The calculations necessary to obtain the amount of leakage are long, and when completed can only be approximations, as much must depend upon the type of the machine, upon whether the poles are let into the bed-plate or kept a long distance away, upon the shape of the poles and magnets, and the proximity of other masses of iron, such as the bearings, flywheel, or coupling, in addition to which a small variation in the permeability of the iron or steel, as compared with that of the magnets of machines already tested, will require a greater alteration in the excitation than would a large error in the calculation of the leakage coefficient. The usual practice is to employ a leakage coefficient which has been obtained, not by laborious calculation, but by noting in previous machines of a

Digitized by Google

similar type what was the additional excitation required in order to obtain the specified E.M.F. at the stipulated speed, beyond that which would have been necessary were there no leakage.

With slotted or perforated armatures and multipolar machines the leakage will be considerably less than with smooth-core armatures, owing to the air-gap being considerably reduced in length, as many makers now give an air-gap of only little more than sufficient length to allow free clearance for the revolving armature.

The use of slotted cores has now become very general, and it is worth while to point out some of the advantages and disadvantages of this type of armature. The chief advantages are the small air-gap necessary and lower reluctance in the magnetic path (with consequent saving in field excitation), the positive driving of the inductors, the greater mechanical protection of the winding, the prevention of Foucault currents in the inductors, and the lessening of the field distortion between full load and no load. The chief disadvantages are that eddy currents are set up on the polar faces by the teeth, the increased self-induction of the short-circuited coils (owing to their being embedded in the iron), and the increased cost of manufacture. The proper number and size of the slots can only be obtained by compromise, as, owing to the tendency of the teeth to create eddy currents on the polar faces, shallow slots and narrow teeth should be used; while in order to reduce the hysteresis loss in the teeth, narrow slots and wide teeth should be employed; and, also, to reduce the magnetic reluctance of the teeth, the area at the bottom should be as large as possible, and consequently the teeth should be made as wide as possible, and the slots deep and narrow. The most suitable proportions can then only be obtained by experience and the careful noting of results obtained from different armatures, or, failing this, the information must be obtained from tables such as those given by Mr. Wiener in his "Dynamo-Electric Machines."

(To be continued.)

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 841)

Solid-laid systems take up much less room than conduits, although it is at times quite difficult enough to find space for these on the footway. If there should be insufficient room, however, the troughing can be taken into the roadway and laid at a much less depth than that at which it would be possible to lay a conduit, as it will take no harm from the compression due to traffic, simply because it is a solid system. If it is found necessary to take the troughing into the roadway and the cable is to be used as a distributor, care must be taken to lay it so deep that the top covering of the service cables tapped off the main does not come at a less depth than 2ft. from the surface of the road; this would make the main about 2ft. 6in. deep—say 2ft. 8in to the bottom of the trench.

The chief materials in use for troughings for solid systems are wood, iron, and earthenware. Wood troughing, if used, should be creosoted or boiled in Stockholm tar, but it does not make the most satisfactory job that one could wish for; it certainly does not seem right to bury wood in the ground and expect it to be a lasting thing. The use of wood also entails a lot of cutting with a saw—in fact, it requires almost a joiner to manage it properly so as to make a good job of the angles and bends; also it is not much use to expect the wood to act the part of an insulator, as the bitumen in which the cable is laid, or, rather, with which the trough is filled, is very often nearly dead earth, or giving very low insulation resistance indeed. From experiments made with wood troughing to try its lasting properties when buried in earth, it has been found to last longer in wet clay, a shorter time in dry clay or loam in which roots of trees abound, and a shorter time still in sand. This is probably because air does not find its way through the wet clay, the other two conditions giving it an easy passage. If wood is used, at the junction of every two lengths of troughing, whether short or long lengths, there should be fixed underneath a saddle or junction piece so as to prevent the ends of the troughing from sinking out of place, and thus causing a strain on the cable immediately over such junction. This junction piece should be at least 1ft. long, the grain of the wood running along its length; thus it will stand no chance of being broken after it is laid.

Care must be taken when laying troughing that it rests well on the bottom of the trench along its whole length, the junction pieces being let into the ground where they are required. If this is not done, the ground above will continue to sink for some time after being filled in, at the same time straining the cable. Owing to the spring of wood, this is more important with wood troughing than with iron or earthenware. The wood used for troughing should be at least 1¼in. thick, and after the cable has been laid ground should be filled in about 6in. deep; then another plank of prepared wood should be laid immediately over the troughing as a warning to people opening the ground afterwards. It is always well to use this warning plank if iron or earthenware troughs are used.

Troughs made of cast iron should be coated with a preservative coating, such as Dr. Angus Smith's compound. The iron should be at least $\frac{3}{16}$in. thick, and each length of troughing should be socketed at one end so that the following length will fit into this socket, the two being then bolted together with a countersunk headed bolt, the head of which will come a little below the level of the bottom of the troughing inside, a nut being placed underneath. Iron troughing in ground that is much crowded with pipes gives a lot of trouble in cutting, and joints are never well made. It would be well if makers of iron troughing would keep in stock bends and angle-pieces for several different angles and radii. The bends and angle-pieces should be made in both planes—*i.e.*, vertical and horizontal; they should also be made left handed and right handed. The engineer would then be able to order a percentage of these bends over the total length of the troughing required. When using iron troughing, the cable gang should be provided with a small bench drilling machine, plenty of three-faced files and cold chisels, flat and diamond pointed.

Earthenware troughing would last longer than either iron or wood, and certainly would offer the best resistance (electrical) between the cable and earth. Each two lengths of such troughing ought to fit together by self-locking socketed joints.

As to the class of cable to be used on solid-laid systems, almost any insulation can be used, and the cable may be lead-covered whether continuous or alternating supply. Rubber insulation, because it has given so much trouble in many places, might well be left out of the question, the preference being given to fibre, paper, or vulcanised bitumen; the first two probably would give the best results. If the cables are not lead-covered, they should be strongly protected with braid or tape to prevent damage when being drawn in.

When the trench is ready and the troughing has been carefully bedded and swept out, the cable should be drawn along in the troughing before the cable bridges have been placed in position, a man being stationed at every bend or angle in the run to prevent the cable being unduly rubbed. Two men can then easily place the bridges, one lifting up the cable and the other placing them at equal distances, varying according to the size of the cable. The bridges should never be more than 2ft 6in apart, even for the largest cables. A most important point when laying cables on the solid system is to see that the bitumen gets all round the cable as nearly as possible. The bridges should be designed to assist this as much as possible. If the radius of the hollow in the bridge is made much greater than the radius of the cable, the best form will be obtained, as the cable will then only touch the bridge on a very small surface. The minimum thickness of bitumen should be ½in., the troughing being designed to this end. The bitumen leaves the boilers at a temperature of about 450deg. F. It is then to be stirred and cooled by pouring into smaller pouring buckets until it has reached a temperature of about 350deg, at which heat it is poured into the trough. It is almost absolutely necessary that fine weather should prevail while cables are being laid on this system, and if rain should come on the cables must be wiped and allowed to dry before bitumen is poured on, as if they are wet the bitumen will not adhere, and a small channel is thus left between the

Digitized by Google

cable and the bitumen. A great benefit to be derived from a solid-laid system is owing to the fact that when a fault occurs, however bad, it is nearly always possible to burn it out without shutting down, as the bitumen in the trough is melted and runs into the fault, so offering some resistance on which to run; this takes place more easily when single-conductor cables are used.

Armoured cables take up less space than any other system, and room can nearly always be found for them on the footway. It is probably the cheapest system to use, as a great length of cable can be got in in a little time. It is also such a flexible system that pipes and drains offer very little, if any, obstruction, and cellar-roofs can always be negotiated by cutting away a narrow channel through the arch, a cast-iron pipe being then laid in the channel and the cable drawn through the pipe, the whole being then concreted solid. All armoured cables should certainly be concentric cables and lead-covered. The armouring and the lead covering would, however, be liable to be attacked by electrolysis if used for continuous current; this system is therefore better for alternating-current supplies. Fibre or paper-insulated cables give excellent results on this system.

When the cables are laid on the footway and after they have been drawn in, the soil should be sifted over them until they are covered by about 2in.; they may then be protected by new bricks laid on the flat, the length of the brick being placed across the trench. Bricks used thus form a much more flexible covering than planks, though planks should be used wherever possible. The bricks being new will never quite lose their new look, and will thus warn any people opening the ground. If the cables are laid in the roadway they should be laid at least 2ft. 6in. deep, earth being again sifted over them and covered by stout planks if possible, if not, then by new bricks as before, but placed on their edges in this case.

Armoured cables ought never to be laid direct in clay, as the clay, or the salts in it, often eats away the armour. In case clay is found, it is well to throw sand along the bottom of the trench to a depth of about 2in. before the cables are drawn in, then to cover the cables with more sand; this sand is never lost. Another way to stop the action of clay is to lay the cables on a sort of solid system, the troughing being made in this case of unprepared wood—*i.e.*, just rough sawn and of sufficient size inside to allow about ¼in. of bitumen to adhere round the cable. If the wood soon rots it does not matter, as the bitumen is still left to protect the cable or cables. Bricks should be used as a protection. If this system is adopted and more than one cable is laid in one trench, then room must be left between the troughings to allow joint-boxes to be fixed. Rough wood bridges should be used in this troughing also. This semi-solid system has been used at Cheltenham with excellent results. A gang of about 25 men can easily lay and cover up a trench 200 yards long into which four cables have been drawn in one day if the trench is on the footway, and a proportionally smaller length, according to the hardness, if on the roadway.

(To be continued.)

THE BARMEN-VOHWINKEL SUSPENDED RAILWAY.

(Concluded from page 844.)

In the suburbs, where the track is suspended over the roadway, the vertical supports are placed in line with the rows of trees to either side, so as to obtain minimum unsightliness. As regards the elevation of the super structure above the road level, an important limiting factor consists in that no constructional work in the shape of cross ties is placed below the level of the car floor. Compared with elevated railroads of the ordinary type, the height of the station platforms above the road level may be lessened by the amount corresponding to the depth of the permanent way plus the height of the car wheels. In fact, the height of the platform need not exceed 15ft., which corresponds to the height of the lower edge of the carriage above the road pavement. The girders which support the permanent way have the form shown in Figs. 8 and 9. All the vertical forces which come into play are taken up by the centre girder, *a b*, which is supported on bearings spaced at intervals of 10ft., while the lateral and torsional strains are provided for by the horizontal girders, *c d* and *e f*. As shown, the booms of the lower horizontal girder, *e f*, are formed by rail bearers, *e* and *f*. The ties, *a e* and *a f*, serve to transfer the vertical forces acting at *e* and *f* to the girder, *a b*. This method of construction was invented by Rieppel. The weight of the ironwork is relatively small. For the Wupper section, where the railway has a span of about 98ft., the weight of the ironwork amounts to only 1 ton 2cwt. per yard run,

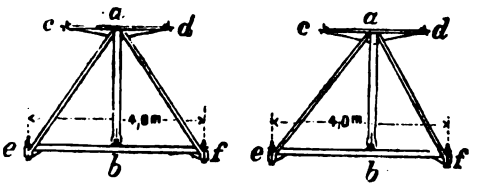


FIG. 8.—Details of Permanent Way.

and for the land section one ton. These weights are considerably less than those holding for elevated railways of the ordinary type. The arrangement of the superstructure also facilitates the inspection and maintenance of the same. There is a space of 13ft. between the rails, but half only of this space is covered in, whereby sufficient provision is made for the inspection of the rail tracks and conductors, while at the same time undue darkening of the roadway is avoided. Each car is suspended from the track in the manner shown in Fig. 10. The frame, *r*, of the suspension arrangement is bent round the rail

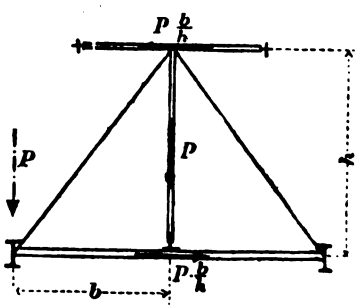


FIG. 9.—Details of Permanent Way.

carrier, *t*, in such a way as to leave very little play between the bevelled undersurface of the latter. By virtue of this arrangement, not only is the lifting of the driving wheels from the track rendered impossible, but also a detachment of the car from the track consequent upon an axle or other part breaking also rendered inconceivable. It is, however, apparent that the round railhead of the track constitutes a centre about which the car can oscillate. In this connection it was at first a matter of some doubt as to whether a strong wind acting against the side of the car, or the

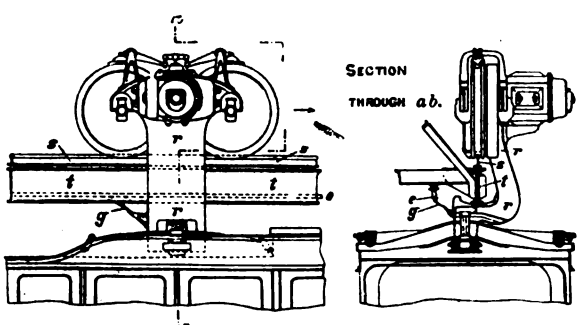


FIG 10.—Suspension of Car.

centrifugal force acting round curves, would not give rise to undue oscillation. To determine this point, exhaustive experiments were made with a car 26ft. in length, but weighing only 2 tons 8cwt. The track, it should be mentioned, allows the car a maximum swing of 15deg. from the vertical. Theoretically this swing would be produced by a continued side pressure of 16½lb. per square foot of surface exposed. The assumption of such a pressure, which would suffice to overturn a tramcar having a length of 39½ft. and a gauge of 3ft. 3in., amply suffices to

Digitized by Google

meet the conditions prevailing in Elberfeld. Some experiments conducted during a violent storm showed that wind pressure is not uniformly maintained. Even when some very sharp gusts occurred, they were not maintained for a sufficient length of time to give the car appreciable side acceleration. The car commenced to swing somewhat in a position slightly out of the vertical, but this inclination was found to be considerably less than that corresponding to the assumed maximum continued wind pressure. As regards railways which are exposed to the full force of the wind only at street crossings, this action of the wind is practically negligible. It was further proved by the experiments that movement of the living load did not result in the slightest displacement of the car; in fact, its weight relative to the weight of the car is too small. As regards the centrifugal force, it need only be

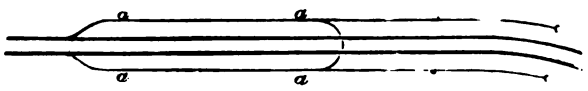


FIG. 11.—Return Arc.

remarked that, generally speaking, the swing of the car might amount to as much as from 30deg. to 40deg. without causing inconvenience to the passengers, so nothing need be feared on this score so far as the Elberfeld line is concerned, since here the swing is limited to about 15deg., as already observed. During the course of the experiments in question curves were negotiated at a speed sufficient to give the car a swing of 25deg. from the vertical, without causing the slightest inconvenience to passengers. It was deduced from the experiments that a car on the suspended railway, which in respect to the inclination of the trains from the vertical is more independent than the ordinary type of railway, may negotiate with safety a given curve at three times the speed holding for an ordinary railway. For the same speed the surface-type railway must be provided with curves of nine times the radius sufficing for the suspended track. A speed of 94 miles per hour would necessitate curves of a radius of not less than 270 yards for the suspended railway, while in order to allow the same speed to be maintained on an ordinary railway, no curve of less than 2,440 yards radius could be permitted. Petersen, a well-known German expert, regards the suspended type of railway as the express transit system of the future.

Although curves of smaller radii may be employed for the suspended railway than for a railway of the ordinary type, on the other hand special care has to be devoted to the shape of the curve in the former case. At the moment in which the car leaves the straight track and enters a curve of a given radius the equilibrium is changed, in consequence of which a pendulum motion is set up round the double angle of the point of equilibrium. Exhaustive experiments with curves of 10 yards radius and upwards led to the conclusion that at least that length of the curve must constitute the transition section as will suffice to allow the car or train to execute a double swing, so that the swing imparted to the car when it has reached the new point of equilibrium may be balanced. If the transition curves are made longer, the pendulum motion is thereby rendered inappreciable. The transition curves must be considerably longer for the suspended railway than for a railway of the ordinary type.

To enable cars to be reversed and transferred to the return track before they have reached either extremity of the line, return arcs (Fig. 11) have been provided at intermediate points, the arc being a curve of 26ft. radius. The loop lines, *a a*, slope from the main tracks sufficiently to allow the electric motors which serve to propel the cars to clear the track above without obstructing the service. When a car is to pass from a siding on to the main track, or *vice versâ*, a sort of climbing switch is employed to raise the wheel flanges clear of the rails. Similar arrangements are provided at the extremities of the line.

At the Vohwinkel terminus a large car depôt has been erected. This depôt contains eight rails (Fig. 12) of which the six outermost ones are connected in pairs by means of loops. Outside the shed the rails are connected by means of the switches, *a b* and *c d*, to a semi-circular track, *a c*, which enables the cars from any rail upon one side of the shed to be conveniently transferred to any rail on the other side. By means of this arrangement and the switches, *e*, *f*, *g*, *h*, the cars are enabled to enter at night into the shed through *f* and *e*, and leave in the morning through *g* and *h*. The cars may be lowered to or raised from the ground level by means of a lift. A cross-section of the shed is shown in Fig. 13, in respect of which it should be mentioned that

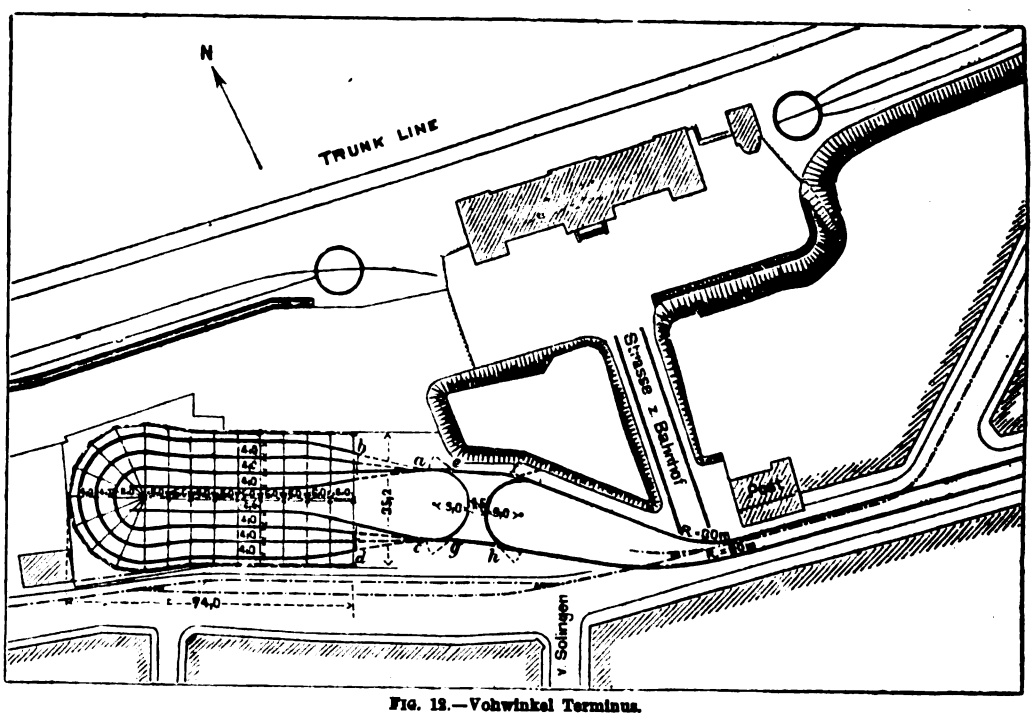


FIG. 12.—Vohwinkel Terminus.

the cars accommodated in the lower storey are street cars belonging to the old electric tramway line. The depôt also embraces repair shops for both services. There is little to be said about the stations *en route*. These are of very simple construction, and have platforms of from 10ft. to 12ft. in width. They are 39ft. to 43ft. broad, and covered in for a length of 82ft., which corresponds to the length of two cars.

Coming now to the electrical equipment of the cars, it must be mentioned that each car is suspended from two bogies (see Figs. 14 and 15), spaced 26ft. apart. Midway between the wheels of each bogie is fixed a 35-h.p. electric motor. This motor is designed to work with an average terminal pressure of 550 volts, and both axles of the bogie are driven by it. The output of the motors may be

Digitized by Google

modified by running them in parallel or series, or by the switching in of resistances in the usual way. The necessary driving current is taken up by the contact shoe, *g* (Fig 10), from the trolley conductor, *e*, which latter consists of an iron rail of light section, and is supported by obliquely-placed insulators. The contact shoe is held by an inclined lever and pressed against the conductor by means of a spiral spring. When several motorcars are coupled together to form a train, the motors belonging to the respective cars are controlled from the driving cab of the front car, which alone in this case collects current from the conductor rail. It may be mentioned here that the conductor rail has a round head, which is embraced by the collector shoe at all positions of the car. The trailer cars are each equipped with a simple controller, motor, and collector shoe, which latter may be let down if necessary, and the car thus rendered self-propelling for shunting purposes, etc. The couplings are at the top of the cars. Great care has been bestowed upon the braking arrangements, several alternative means of braking being provided. A Westinghouse air brake actuated from the driving cab acts from above upon the driving wheels. The same brake mechanism may be actuated by hand both from the driving cab and by the guard. Further, the usual means of electrically braking the car by reversing the current to the motors or by cutting the line current off, and allowing the motors to act as generators, are provided.

The automatic signalling arrangements adopted allow of a two-minute service of cars. At each station are placed signals to indicate whether the line and next station in either direction are clear. The signal indicating the line "clear" is automatically raised to the "stop" position by the rearmost axle of the passing train, while the next signal to the rear is simultaneously placed at "clear" by means of an interlocking arrangement. Should a signal for any reason fail to act when the train is passing it, the next signal to the rear must necessarily remain in the "stop" position, whereby the service is rendered secure. So soon as the driver sees the signal in the "clear" position, he is sure there is no obstruction between his train and the next station. During the journeys between stations he has no signals to bother with, and has only to see that he stops at the next station. A maximum speed of 25 miles per hour is observed for the present. In spite of the frequent stoppages, it has been found that an average speed of 18¾ miles per hour can be maintained. Later on, however, it is intended to increase the maximum speed to 31¼ miles, which will enable an average speed of 22½ miles per hour. With a service of four-car trains the line will be capable of dealing with 6,000 passengers per hour. It may be mentioned, in conclusion, that the current required to work this suspended railway is proved to be very little more per unit of accommodation provided than for ordinary tramways. The manner in which the work has been carried out reflects great credit upon the principal contractors, Messrs. Schuckert and Co.

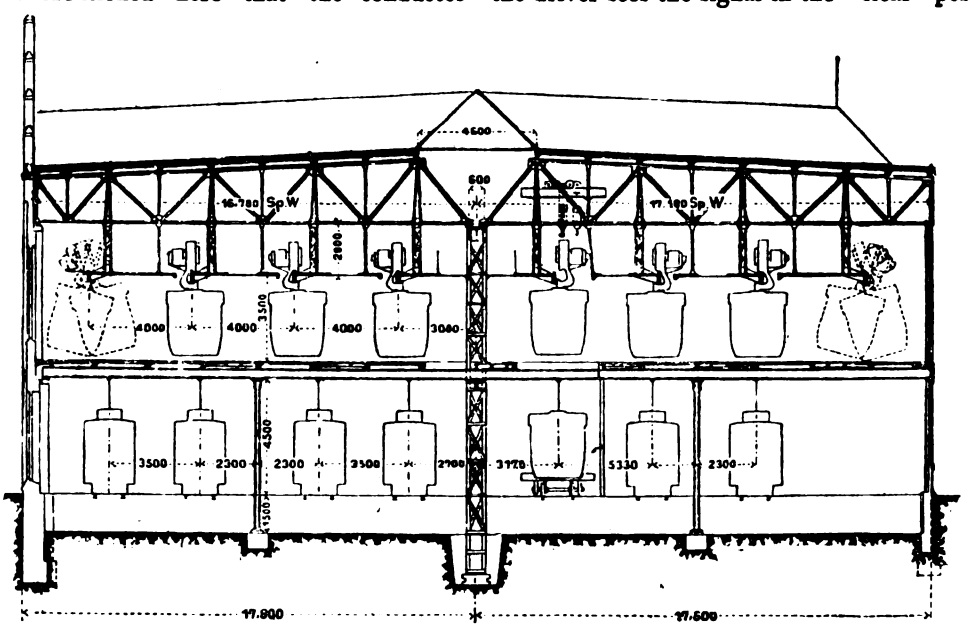
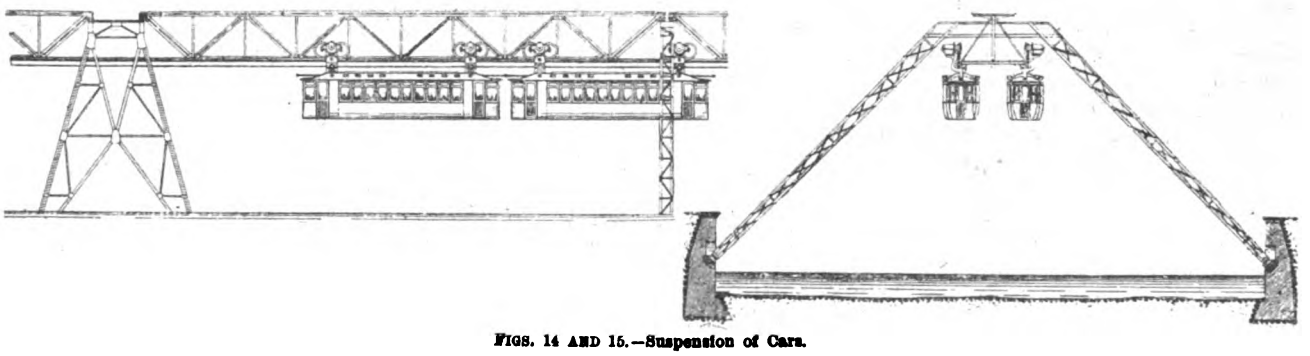


FIG. 13.—Cross-Section of Car Shed, Vohwinkel.



FIGS. 14 AND 15.—Suspension of Cars.

As regards the construction of the car bodies, it may be mentioned that by means of the loop connections already described, the same position of the car relative to the direction of travel is always preserved; that is to say, the driving cab is always in front, so that entrance and exit doors are required only on the right side of the car looking in the direction of travel. These are situated near the ends of the car; they open inwards, and while the car is in motion are kept bolted. Each car is capable of seating 30 passengers, while it provides standing room for a further 20. The cars are run singly at present, but the station arrangements are designed to allow trains consisting of four cars to be run.

THE DEVELOPMENT OF THE DENSITY FACTOR*

BY C TURNBULL, BOROUGH ELECTRICAL ENGINEER, TYNEMOUTH.

The density factor of an electricity works may be defined as the number of 8-c.p. lamps connected per £1 worth of mains laid, or perhaps better as the number of units sold per annum per £1 worth of mains laid. Mains in

* Paper read before the Newcastle Section of the Institution of Electrical Engineers.

Digitized by Google

this case should include transformers and the like. Owing to the great cost of every yard of cable laid, it is of the utmost importance to have a good density factor. Indeed, it may be said, take care of the density factor—*i e*, get the main loaded up with every kind of consumer within reach—and the load factor will take care of itself. The density factors of the following towns, taken quite at random from "Garcke's Manual," will serve to show the great differences that exist:

	8-c.p. lamps connected per £1 worth of mains.	Number of units sold per annum per £1 worth of mains.
Aberdeen	1·21	7·8
Brighton	1·03	25·4
Derby	·89	17·5
Edinburgh	1·12	20·6
Harrow	·64	6·5
Manchester	·94	18·8

The cost of transformers has not been taken into consideration in the above, as it is not shown separately in the manual. Seeing that mains represent some 40 to 50 per cent. of the capital expenditure, I think the figures are worthy of consideration.

Rented Wiring.—To meet those who do not wish to be at the expense of wiring their premises, it has been proposed to take the mains throughout the building instead of stopping at the meter only, and to charge more for the current consumed to cover the extra cost. This method is not entirely satisfactory, especially seeing that the modern tendency is to make consumers pay a fixed sum per annum to cover standing charges, with a comparatively small charge for current used. I would suggest that the following points are desirable in a system of rented wiring: For a plain fitting, including lamp and switch complete, a fixed quarterly rental should be charged. Additional fittings on the same switch should be charged at a second and lower rate. Additional lamps on a fitting not having independent switches should be charged at a third and still lower rate. The hirer should have the option of hire-purchasing the installation at rates based on the rentals, or he should be allowed to purchase outright at any time for a reasonable sum. When the station does the wiring, the rentals, etc., may be settled by an examination of the average costs of installation, but, personally, I prefer to have the wiring done by a wiring firm, as it needs more supervision than most of resident engineers are prepared to give. Besides, with smaller stations at any rate, there will not be a sufficient flow of work to keep an efficient staff busy, unless outside firms were discouraged, which would be foolish. When the wiring is done by contract, the terms must be settled by bargain. In Tynemouth we have arranged with a private firm to do the wiring, we to collect their rentals. A plain fitting costs 5d. per quarter, or a fitting without a separate switch 4d. per quarter; while an additional lamp on a fitting is 3d. per quarter. Double these rates will pay off the cost in 4½ years, or 1½ times the rates will pay it off in 6½ years, or the hirer may buy at any time at a moderate price. Of course these terms are not suitable for large houses, and in many towns special arrangements would have to be made to meet special cases, but it is to be observed that rented wiring is intended mainly for small consumers.

The Two-Meter System.—It has always been a trouble with the maximum demand system that consumers are in fear that their accounts will go up with a jerk if they happen to put on two or three extra lights some night. This has been met in various ways, such as by allowing the demand indicator to be short-circuited on special occasions, or by having two-way switches arranged so that if one lot of lights is switched on, another lot will be switched off. In many cases people will only wire a few rooms in their houses to make sure that they will not at any time be let in for a big bill. It has been proposed to meet the difficulty by having two meters—one to register during the hours of heavy load, and the other during the hours of light load—the units registered on the latter being charged at a lower rate. On examination this will be found unsatisfactory, for a shop which, say, averages two hours a day throughout the year will be charged at the high rate although undoubtedly a good customer, while an office which occasionally overlaps the station maximum demand and takes current only during the winter months will get off at far too light a rate. I would suggest to you that houses which have a good steady load throughout the year will not appreciably increase the station maximum demand by having bedroom and other short-hour lights connected up in addition to their long-hour lamps, nor will they require any heavier mains. It is therefore worth while to do something to rid their occupiers of the fear of a largely increased maximum demand if these occasional lamps are connected up. This can be done by allowing consumers to have two meters, one for the long-hour lights and the other for the remainder. The units registered by each meter are charged as if for a separate consumer, so that practically the full rebate is obtained on the long-hour lights and none on the occasionally used ones. A small extra rent is charged for the second meter, which may generally be of the cheap kind now coming into use. It is also often possible to omit the demand indicator, as, of course, the demand on each meter is the full number of lamps connected thereto This concession has the effect of relieving people from anxiety, so that they wire their houses freely, and I doubt not they will use their light freely too.

THE ELECTRICAL ENGINEERS VOLUNTEERS' WELCOME-HOME FESTIVITIES.

The South African detachment of the Electrical Engigineers (R.E.) Volunteers was entertained to a welcome-home dinner by the other members of the corps at the Trocadero Restaurant, Piccadilly-circus, W., on Saturday night last, Major Erskine presiding. The company numbered about 250 persons, and among those present were Lieut.-Colonel Crompton (the commander of the contingent in South Africa), Captain Lloyd, R.E., Prof. Perry (president of the Institution of Electrical Engineers), Mr. H. Hirst, and Captains Pott, Leaf, Hopkinson, and Baine.

The loyal toasts having been given,

Major ERSKINE proposed the toast of "The South African Detachment." In the course of his remarks, the Chairman read a letter from Lord Kelvin expressing his regret at being unavoidably prevented from presiding at their first welcome-home dinner, and congratulating the men on their safe return from the war. His lordship also sent his best wishes for their health and prosperity. The Chairman, after extending a hearty welcome to the South African detachment, said they would all deeply regret the loss of four of their number from sickness, and also the severe wounds sustained by Lieutenant Stubbs. In reference to sickness, he must congratulate them all on the kindness that both the officers and men showed to their comrades. One man had told him that he believed he owed his recovery to Captain Leaf. The relatives of Sapper Weakley, who died in hospital, had asked that Sapper Cooke should be thanked for his kindness to Sapper Weakley during his illness. He (the chairman) knew they would all join in that sentiment. He hoped that the Royal Engineers who were attached to the active service contingent would carry back with them, when they returned to the regular service, splendid reminiscences of the time they had had with the volunteers at the front, and he thought he might say that the detachment must have gained considerably by having had some of the regulars with them to assist them with their experience in the army.

The toast was enthusiastically received.

Lieut.-Colonel CROMPTON, who was greeted with loud cheers, said he rose to make a speech which to him would be one of the proudest speeches of his life. They, no doubt, expected him not only to return thanks for the kindliness with which they were received there by their own regiment, but also to tell them the story of their life at the front. The circumstances of the war in South Africa were so special, so extraordinary, and the defiance flung down by Mr. Kruger so roused the blood of every Englishman, that it was impossible that they, the scientific arm of the British people, should sit still and do nothing That was why he accepted the honour of being their

Digitized by Google

commandant in South Africa. Those who went to the war tasted for the first time the sweets of soldier comradeship, never to be regretted. Before the detachment started they obtained the services of the very best officer of the regular army that they had met with in the course of their regular training—Captain Lloyd. The presence of this one regular officer proved to be of the very greatest advantage to all of them. The work carried out by the contingent included railway construction—a work which, when the history of this war came to be written, would be set down as the most creditable of the whole campaign. No one would be able to say that the work of reconstructing the railways that was done by Colonel Girouard and his merry men—and the merriest were the Electrical Engineers—did not establish a record in the engineering work of the present century. It was really mechanical engineering carried out in the face of extreme difficulties, and that they were able to do this was due to excellent organisation alone. When passing through the Orange Free State—now the Orange River Colony—the defence of the communications was expedited by this detachment, and this reduced the cost of the war no less than by £10,000,000. Their organisation, their plant, and their equipment were so good that they were able to do work which no other engineers could do. They became railway men and had to do all sorts of hard work, even to carrying sleepers. This continued for about two months, and during that time, although the work was hard, the living bad, and in spite of having to sleep under an open sky with the thermometer 20deg. below freezing point, they managed to struggle up to the Vaal River, and to take their part—and a very large part it was—in the reconstruction scheme. But they were learning to be real soldiers. A man was not a soldier in the full sense of the word until he had tasted the sweets of comradeship. He was sure there was not a man in the detachment who did not feel the better for having seen active service in South Africa. There came a time when the authorities suddenly found out that they could not do without the Electrical Engineers in Pretoria, for it was no secret that they lightened the darkness that existed there, and set the electrical gear to work again. Two months were occupied in real slogging work of that kind, but there were many interesting novelties introduced, and altogether the work was of a very novel nature. He alluded to the different methods of defending the forts by means of light wire entanglements, and these would, no doubt, be copied by the Continental nations before long. Then they went in for a special light type of telephone which enabled them to keep England informed of what took place in the district round which De Wet was operating. Again, there was the work of repairing the telegraph communications, and the danger and risks attending it were very great. These were the services rendered by Captain Baine and Lieutenant O'Shaughnessy, but they never heard a word of them from the newspaper correspondents. Owing to the fact that they were the universal handy men, they had to become gunners as well as engineers—that was, extricating the big 6in. guns out of difficult situations. Their success was such that from that time forward a new duty was found for them. The last words of Lord Roberts to him were that "he considered that the Electrical Engineers had done their duty to an extent utterly unexpected, and that he was extremely cognisant of their value to the army." They had losses from fever never to be sufficiently deplored, but they might congratulate themselves on the fact that so few died, and feel pride in the deeds of those who had passed away. They had left others behind them in South Africa—not to be deplored—those who had secured professional appointments in the country. In conclusion, Lieut.-Colonel Crompton said that if there should happen to be another war, he might say on their behalf that their services would be available, and they had a right to congratulate themselves on the fact that so much of our success in South Africa was due to them.

Captain LLOYD, whose name was also coupled with the toast, said there was one point upon which they might all pride themselves—namely, that, as Colonel Crompton had just said, they had saved the country £10,000,000, and therefore each man was entitled to £160,000. But they had not got it yet, though probably the War Office would eventually, after the proper lapse of time, discharge its obligation to them. He took it to be a very great honour, and one which he would never forget nor under-estimate during his life, to be asked to assist the Electrical Engineers in their work. They had rendered excellent service in keeping the communications open in the troublous times when Lord Roberts was making his famous march to Pretoria. He went forward confidently knowing what he was doing, with the Electrical Engineers in his rear. The detachment then left behind at Bloemfontein had to do very uninteresting work, in lighting the sidings and performing similar jobs, and therefore they had rightly been called "handy men," and for what they had done the army would for ever thank them. Speaking as a regular officer, the men appeared to him to have been under training for years, and he heartily congratulated them upon the efficiency they had displayed.

Prof. PERRY, in proposing the toast of "The Electrical Engineers (R.E.) Volunteers," said he could not speak without preparation, for those lovely impromptus with which he had been credited had taken weeks and weeks of thought; even the printers knew 24 hours before he did that he would have to say something that night. He had suffered a great deal from this war, because for three years before he went to South Africa their colonel had accompanied him on a bicycle ride round Battersea Park every morning, and after he had gone he was compelled to go round the lonely track by himself. He should just like to say that this was the last time they would see Captain Lloyd in his present position, for he would bid them good-bye that night. He (Prof. Perry) happened to be president of the Institution of Electrical Engineers that year, and he must tell them there was not one member who did not congratulate the corps of Electrical Engineers on what had been done by those of the active service contingent in South Africa. Those of them who had stayed at home had obtained a good deal of credit for it, and they were proud of many things they had heard about those who had gone to the war. They had shown great devotion in going out and leaving home comforts, and it was due to the enormous amount of commonsense displayed that they were able to do what was required of them. They were in reality, as had already been said, the handy men in South Africa, and this was a fact that they were most proud of, because they owed their power to the circumstance of their having been trained as electrical engineers. He knew how exceedingly sorry Lord Kelvin was for having been prevented from presiding on that most interesting occasion. His lordship was an oldish man, and his only regret was that he himself was unable to go out to South Africa with the electrical contingent. He (the professor) also felt a large amount of regret that he could not go with them, but their colonel thought that the only thing he was capable of being in the corps was chaplain. He regarded the business of electrical engineers as a very big thing, and there were ample signs that greater things would come of it in the future. It meant that England was going to be able to command the services of professional men like themselves in time of war. In conclusion, the learned professor congratulated them all, and asked them to drink with all cordiality the toast he had had the honour of proposing.

Lieutenant-Colonel CROMPTON, in replying, said if it had not been that the electrical corps had been proposed and organised by the late Dr. Hopkinson up to its present unexampled strength of 400 in three years, there would have been no active service contingent in South Africa, and they should all feel extreme pleasure for the remainder of their lives at having served their country at a time of need. He thought that when this war was over the position England would occupy in the world would be quite different from that she had held before it broke out, and her future prosperity would to a large extent depend upon the advances made by the science of electricity. England had always been a great naval power in the estimation of the world, and who would say that she was not now a great military power as well? The

Digitized by Google

experience gained by the members of the corps abroad would help them now to work out the highest of electrical problems involved in actual warfare.

"The Visitors" was proposed by Captain HOPKINSON and responded to by Mr. HIRST.

An excellent programme of music was provided, a number of artistes kindly volunteering their services. Master Hall sang in fine style "The Lost Chord," while Mr. Will H. Collings supplied the comic element, which was much enjoyed. Miss Esmé Gordon contributed some coon songs, which were warmly applauded. Miss Lily Power and Miss Minnie Pyne sang respectively in character "There is no Dream" and "I'd never Wed a Man like him.' The stirring patriotic song, "When the Boys come Home once more," was rendered by Mr. Scott Russell with striking effect, and Colour-Sergeant-Major Paynton, E.E., gave "Sons of the Motherland" with happy and telling expression. These ladies and gentlemen helped to make up a most interesting and enjoyable programme.

On Monday last the detachment was entertained to another welcome-home dinner at the Prince's Restaurant, under the presidency of Prof. John Perry. The hosts were a number of gentlemen, most of whom had previously combined to give the detachment a send-off dinner at the same place. An excellent dinner was served by the proprietors of Prince's, and a most enjoyable evening was spent both by hosts and guests. Mr. Henry Edmunds, as in the previous dinner, together with Mr. MacMillan, were responsible for the organisation of the evening.

The Reception.

The last of the series of welcome-home functions in honour of the South African detachment of the Electrical Engineer (R.E.) Volunteers was held in the Covent Garden Opera House on Tuesday last, owing to the kindness of Mr. Frank Rendle and Mr. Neil Forsyth. These gentlemen, besides lending the Institution the Opera House, were present themselves, and did all they could to meet the convenience of the large audience. The parquet floor, arranged for fancy dress balls, was in position. This gave a good space for the men of the corps to be drawn up. A guard of honour, consisting of those members of the corps who did not go to South Africa, kept the large central space free until after the formal welcome had been completed. The band of the Royal Engineers played selections of music from eight till nine, during which time the members of the Institution and their lady friends were finding their places. The Council of the Institution, and a number of distinguished military gentlemen, took their stands in the balcony, the platform being occupied by Prof. Perry and Major-General Salmond, R.E. Lieutenant-Colonel Crompton then marched his men in, and they were drawn up in line opposite the guard of honour.

Prof. J. PERRY, in an address of welcome, referred to the inauguration of the corps by Dr. John Hopkinson, who advocated that the professional men of England should train themselves in times of peace so as to serve their country in time of war. The present struggle in South Africa had proved the success of the experiment, and the Institution were proud of the detachment which they now welcomed home. The members of this detachment had not only relinquished, in common with other volunteers, their home comforts, and undertaken the dangers of war, and the still more fatal dangers from disease, but they had also given up positions and chances of promotion in their profession, a sacrifice which the Institution was particularly well able to appreciate. Speaking of those who had died, Prof. Perry said: "We do not mourn as those without hope. Hope that a life laid down by a man for men is not a life thrown away. Hope for a country that can still breed sons who for her sake are not afraid to die." The generals under whom the detachment had served spoke highly of the good work it had rendered, and particularly of the aid the electric light had been in the work of repairing broken bridges, which was able to go on night and day, owing to the exertions of the Electrical Engineers corps. Referring to the general work of the corps, the President said they did any kind of engineering work that had to be done, and showed themselves the handiest of "handy men." Officers and sappers alike took their full share of actual physical toil, but to the civilian members of the Institution the distinction between officers and sappers was merged in the fact that all alike were worthy representatives of the electrical engineering profession. As electrical engineers those present stood higher in their own opinion—and, as he believed, in that of the world—in that the profession had developed in the South African detachment that common-sense, that resourcefulness in time of trouble, that reserved power and moral courage, which had distinguished them particularly in an army of distinguished men.

Major-General SALMOND gave a brief *résumé* of the history of the corps from the time the late Dr. John Hopkinson came to him in 1896. Lord Lansdowne had then at once recognised the importance of the suggestion, which was immediately adopted, in spite of the fact that the estimates for the year were completed. When it was proposed to take a detachment of the corps to the front the Government had done all they could in providing an equipment, and they had also given Lieut.-Colonel Crompton a free hand to provide additional equipment, such as bicycles, etc., out of private funds. He was particularly pleased with the request from the corps that Captain F. L. Lloyd should be sent out in command. He was able to bear testimony to the useful work which the contingent had done in South Africa, and congratulated the regular army on having trained men of their class available in any emergency.

Lieut.-Colonel R. E. CROMPTON, replying for the corps, said how proud he was of the work which the South African detachment had done. He had tried since the lamented death of Dr. John Hopkinson to follow in his footsteps, and had considered it his duty, therefore, to offer the services of the corps when the present war commenced. Their work under Colonel Girouard in repairing the railways had been arduous, but they were pleased to be associated with such an important work. When they got to Pretoria, they found much work to do with which they were thoroughly conversant. Thus they had provided the electric light for various hospitals, and particularly for those on the heights round Pretoria, which proved so successful in fighting the enteric fever. Their work in hauling 10-ton guns up such slopes as 1 in 6 had earned special commendation from the head of the army in South Africa. In conclusion, Lieut.-Colonel Crompton referred to the trophies they had brought home, and presented the captured electric exploder we have referred to before to the President, asking him to add it to the museum of the Institution.

Captain F. L. LLOYD referred to the pleasure it had given him to take out the detachment of the Electrical Engineers Volunteers. They had had hard work to do, and it had been well done by officers and men alike. He thought, however, that due credit should be given to certain electrical engineers whom they had found in the country, and without whose local knowledge they could not have done the good work they did in certain directions. Amongst these was Mr. S. C. Woolley Dod, who stayed at Pretoria during the war looking after the electric lighting installation. When they arrived there, there was no oil to be had and no candles, but with the little coal available and Mr. Dod's mains they were able to provide light to the various camps, stores, and hospitals. Mr. J. Cushing, of Johannesburg, had also done great service in showing them where they could find hidden stores of electrical apparatus which they required in carrying out this work. A third name deserving of mention was Mr. G. M. Clark, of Cape Town, who came to Pretoria to assist in the electrical communications.

After these speeches an exhibition of lantern slides illustrating scenes in the war were shown. Colonel Crompton, in explaining these, was able to give a very good idea of the very varied duties which the detachment had to undertake. It seems that these duties ranged from carrying sleepers for the reconstruction of railway tracks up to defending their lives from attacks from De Wet.

During the rest of the evening the programme was

Digitized by Google

interspersed with selections from the band, while the guests had ample opportunity of conversing with the members of the South African detachment.

A hearty vote of thanks was passed by acclamation to Mr. Frank Rendle and Mr. Neil Forsyth for their kindness in lending the Opera House to the Institution.

The following is a full list of the officers, non-commissioned officers, and men who have returned from South Africa: Lieut.-Colonel R. E. Crompton; Captains F. L. Lloyd, R.E., A. Bain, and H. M. Leaf; Lieutenants A. H. Pott and J. J. F. O'Shaughnessy; Second-Lieutenants H. F. Bigge and F. Powell Williams; Dr. Masters; Sergeant-Major G. A. Brown, R.E.; Sergeant-Instructor C. T. Ruse, R.E.; C.S.M. E. Rorke; Sergeants J. H. S. Phillips, W. S. Entwistle, and A. H. I. Graham; Corporals H. H. Bicker-Caarten, A. Charlton, W. Dalton, and W. H. Hossack; Second-Corporals E. M. Sellon, J. Rook, A. J. Hodgson, and C. Landon; Lance-Corporals H. R. Allen, G. Charlton, S. W. Melsom, D. F. Colson, C. F. Love, M. N. Crawford, A. R. Peart, and A. O. Wiltshire; Sappers F. D. Arundel, H. Bertram, W. C. Cooke, W. G. Carter, A. J. C. Devonshire, R. H. Brander, G. J. H. Elliott, R. W. Holliday, E. C. Horsley, L. H. Hounsfield, A. E. Minns, H. A. Paris, N. W. Pirrie, F. J. Phillips, F. G. Payne, R. B. Roberts, B. H. Tilley, J. D. Taylor, F. J. Wallis, E. J. Wright, and F. J. Young.

The following non-commissioned officers and men are staying in South Africa in the various capacities mentioned: Second-Corporals J. H. Stone and D. G. W. Hume, second-lieutenants Royal Field Artillery; Sergeant T. H. Brown, electrical engineer-in-charge Government Printing Works, Pretoria; Lance Corporal A. E. Levin, private employment; Sapper J. M. Bowrey, employed under the electrical adviser to the Cape Government; Sappers H. R. Claxton and C. W. S. Paine, employed as electricians under the Imperial Military Railways, Pretoria; and Sappers C. E. Silverthorne and F. C. Stephens, private employment. Two men were left behind in hospital—viz., Lieutenant J. H. Stubbs and Lance-Corporal C. H. R. Thorn. The first of these has now just reached England.

The four men who succumbed to enteric fever were: Second-Corporal A. Holdaway, and Sappers E. C. Short, W. C. Weakley, and E. J. West. Their names will stand first on the roll of honour of the corps.

THE GLASGOW LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The above local section of the Institution of Electrical Engineers met in the Institute Buildings, 207, Bath-street, Glasgow, on Wednesday, Dec. 12, at 8 p.m., for the purpose of discussing the paper recently read by Mr. W. E. Langdon (vice-president), to the Institution of Electrical Engineers in London. Lord Kelvin wrote regretting that he was unable to be present, so Prof. MACLEAN, who occupied the chair, opened by giving a short summary of the paper, and then read the following communication which the secretary (Mr. E. G. Tidd) had received from Mr. Langdon.

Dear Sir,—Your section is to do me the honour of discussing my paper on the "Supersession of the Steam by the Electric Locomotive" on the evening of the 12th. I hope it may not be thought that in submitting for the consideration of your president the following observations I am attempting in any way to direct or influence the discussion, but questions having been raised on the occasion of last Thursday's discussion, at the Electrical Engineers in London, of the accuracy of the formula employed by me for obtaining the pounds tractive effort per ton (on which, of course, my calculations are very largely based) I am particularly anxious that this important question should, if opportunity arises, be dealt with. It may be that you may be favoured with the presence of locomotive or mechanical engineers who may be prepared, if the formula which I have used is in their opinion inadequate, to furnish a formula which they may regard as reliable. I may, perhaps, add that I have every confidence in the source from which I received the formula which I have used. I know it to be the result of a number of practical experiments, but I have not yet ascertained that it is applicable to goods trains. The various formulæ given do not attempt to make a distinction between goods and passenger trains. If reference is made to the diagram furnished in Fowler's "Mechanical Engineers' Pocket-Book" for 1900, it will be seen that there are three curves which practically coincide, whilst that of Clark's deviates from these three to a very great extent.

"Molesworth" expresses Clark's as follows:

$$6 + \cdot 009\ V^2.$$

If this is carried out in respect of the No. 1 class of train, shown in my Table IV., it will be found to result in a per train horse-power of 1,045, as against 477 by the formula which I have used; and if it is applied to No. 4 class of train, the demand will be 386 h.p. as against 183 h.p. The difference is, as you will see, very great; indeed, so great as to raise the question whether a steam locomotive travelling at the speed of 50 miles an hour could give that horse-power output.

Another point commented upon was the scheme of plant—whether it was more desirable to employ a central generating station supplying certain sub-stations, or for the sub-sections to be provided for by what I may perhaps call local generating stations. I am clearly of opinion that those who argue in favour of local generating stations have not thoroughly appreciated the many advantages that attach to the central and sub-station system. If each section is to be worked by local generating services, then the machinery established and in operation must be sufficient to meet any demand that may arise on that section, which would mean an increase in cost for plant, coal, and labour. It would be impossible to guarantee a fixed demand. The varying difficulties which arise in working trains at the present time will not be inseparable from trains worked electrically. Practically the same conditions will attend them. The load in the several sections will be continually varying. With a central generating system, the load as it shifts from one section to another will not vary to any great extent the load at the central station; that will remain practically constant, depending upon the *sum total* of the load comprised within the demand of the several sections served by the central station.

Another argument in favour of the central station and sub-section system is that it will be capable of meeting, to a large extent, without stress, the varying demand consequent upon the starting of trains. At the moment when inertia is being overcome in one place there would no doubt be a relaxation of the demand for power at another point—*i.e.*, as an instance in point, a train may be running into a station simply under the influence of momentum without any help whatever from current, whilst at another station a train may be starting, and will require, for a moment of time, a large accession of current. Of course, this would apply to some extent in a local section generating its own current, but it will apply very much more largely with the central-station scheme—that is, as it will take a larger area, so the opportunity for equalisation will be greater.

If after reading this you should think that the matter I have taken the liberty to submit to you is of sufficient importance to read to the members at your meeting, I should feel obliged if you will do so. My great desire, of course, is to get at reliable data. In adopting the formula which forms the basis of my calculations, I placed, as I still do, every confidence in it; but if it can be proved to be wrong to such an extent as to materially modify my deductions, it would be only honest that such should be done. I need hardly, however, add that the matter is one of so great importance that there should be no doubt as to the absolute accuracy and source of any formula that may be advanced in place of that which I have used.—Yours faithfully,

(Signed) W. LANGDON.

P.S.—Since inditing the above, I have received from the author of the formula used by me a communication thereon, copy of which I append. The data was, as you will see, collected from actual experiment in 1891, since which date the tendency due to improved lubrication, etc., should be, if anything, to reduce the tractive effort result.

Midland Railway, Locomotive Department.

W. Langdon, Esq., Derby.

Dear Sir,—I am sorry that I was unable to be present to hear your paper read, and offer some facts in support of the train resistance figures you submitted, for I quite agree with your conclusions on this matter. The formula you have adopted agrees with the results I obtained in 1891 with trains running on the Midland Railway between London and Nottingham. In all about 400 sets of figures were taken, and in calculating the train resistance from them, proper allowance was made for gradient acceleration, energy of revolving wheels, etc. The results agree closely with others obtained by Barbier, Du Bosquet, and other careful investigators. The train resistances at high speeds given by Clark and some others are quite unreasonable. The coal and water consumption of a locomotive is well known, and if such high train resistances were met with we should have to take it that locomotives sometimes

Digitized by Google

run as economically, or even more so, than the best stationary compound condensing steam-engines. Barbier found that the locomotive resistance was greater than that of the train. A comparison of the resistances, I found, for long trains as compared with short trains on the Midland, do not support this view. He also found that four-wheeled coaches offered greater resistance than bogie stock. The figures you have quoted are about midway between those given by Barbier for the two kinds of stock. It must be remembered that on the Midland every care has been taken to use the best possible form of axle bearing for coaches and wagons, and to lubricate the bearings also as perfectly as possible. The locomotive has also been designed, as will be seen upon reference to Mr. Johnson's presidential address, with a view to reduce frictional resistance in every way. It should be borne in mind that even if some steam locomotives offer greater resistance to motion per ton than do the trains they draw, such would not be the case with the electric locomotive, owing to its shape, small size as compared with its weight, evenly distributed load, and absence of all friction except that of the journals. The figures found for passenger trains will, I think, also apply to goods and mineral trains. Should you desire to do so, you may with pleasure make use of this letter.—Yours sincerely,

(Signed) R. M. Deeley.

Mr. Henry Mavor, after some general observations, said that, as Mr. Langdon pointed out, his figures were to some extent hypothetical. Fortunately, however, his figures were not so important as his general conclusions, which were of great value. In Table VII. the generating charges were given at about one-fourth of the total. Looked at from the standpoint of the relative efficiency of a steam and an electric locomotive, and from the fact that the generating plant of an electric power-house gave high electrical and mechanical efficiency, one would expect good results. One must bear in mind, however, that the working results in a generating station supplying a railway demand were far below those obtained on trial with steady load. As an instance, an engine giving 1 i.h.p. for 18lb. steam on trial was found to require nearly 10 times as much on daily running with the variable load obtained in a power-house. He thought it not unfair to estimate the repairs to machinery, motors, etc., from existing data, and in looking over returns of several lines he (Mr. Mavor) found that generally repairs cost from 10 to 20 per cent. of the total expenses; in no case did they reach 30 per cent., as shown in Table VII. He also thought that the advantages of electricity would come out more strongly in the matter of repairs than coal, and expressed the hope that Mr. Langdon's estimate of leakage loss in line at 2½ per cent. would prove excessive.

Mr. Dyson (assistant to Mr. H. F. Parshall) said that Mr. Langdon's general conclusions were of more value than his particular data, and stated that train resistance worked out much higher than Mr. Langdon assumed. He thought that the total efficiency of 58 per cent. taken by Mr. Langdon could be made higher. Of the figures which went to make up this total, the efficiency of static transformers, rotary converters, and ohmic loss might all be increased by 5 per cent. The gearless motor might have an efficiency such as Mr. Langdon had assumed, but it had yet to be proved superior to the single-reduction motor of, say, 78 per cent. efficiency. He suggested a joint committee of electric traction and railway engineers as the best means of solving the problem.

Mr. David Home Morton, M.I.C.E., admired the cheerful optimism with which electrical men faced great problems. The mere fact that they were now discussing trunk-line electric traction before the urban and suburban lines were equipped was proof of their sanguine temperament. Public opinion would, he thought, force railway companies to adopt electric traction on their short-distance lines first, and then data would be available to enable them to judge of its merits on trunk lines. Speaking of results already obtained on the City and South London and Liverpool Overhead lines, both of which were sufficiently long established to warrant deductions being drawn from them, it seemed to be indicated that, in economy at least, the self-propelled car was superior to the locomotive. Notwithstanding this, he questioned if any railway manager would place self-propelled carriages on his line, notwithstanding that they would be much easier on the line. A 45-ton locomotive with, say, four 10-ton coaches, and the average number of passengers, would total up to about 100 tons; this could be taken a mile for 6d., and he had yet to see the electric line which could do that. The boiler of a locomotive was a very efficient steam generator, while the engine was not by any means so inefficient as generally supposed. Moreover, the use of compound engines in a power station was not always justifiable. The power costs of the London and Liverpool lines already mentioned, where compound condensing engines were in use, came out higher than the Glasgow district subway, where simple non-condensing engines were in use.

Prof. Archibald Barr, D.Sc., said that there seemed no immediate prospect of locomotive-building shops being under the necessity of giving up business. The condition most favourable to electric traction was the improved load factor and its influence on economical power generation. In no case could the influence of this improved load factor be better felt than on main lines. The value of levelling up the load could be seen by taking the figures given in Tables II. and III., and plotting the mean as a curve. He also expressed the opinion that electric traction would first be applied to local lines, and afterwards extended to main lines. The smoke problem of large cities would, in a large degree, be solved by the use of electric locomotives in and around large cities, where steam locomotives were responsible for more smoke than at first sight would appear.

Mr. W. W. Lackie also spoke, and in the course of his remarks he pointed out an error in Table VII., where interest was given as ·6901d. per kilowatt-hour. That should be ·0901d.

Mr. B. Field (chief electrical engineer, Glasgow tramways) expressed his total disagreement with Mr. Langdon's figures. First, in his attempt to imitate the traffic on the section of the Midland Railway under consideration he had provided for only half the number of trains actually on the line; second, his choice of an electric system was not necessarily the best; and third, the items which went to make up costs per train mile were open to question. Taking Table IV., it seemed that some of Mr. Langdon's calculations rested on a fallacious basis: the columns headed total mechanical horse-power and kilowatt per train mile being deduced from the number of trains in each class and the corresponding figures for mechanical horse-power per train. This, however, could only give the total kilowatts required to propel all the trains which passed a given point in one hour. Later, the author assumed that there were only 14 trains on the whole 50-mile route. It was clear, however, that with 14 trains at an average speed less than 50 miles per hour, there could not by any means be 14 trains passing a given point in one hour. Further, taking trains of Classes 1, 2, 3, and 4 (Table IV.), run at their respective speeds for 24 hours, there would be between 25 and 30 trains at one time on the 50-mile section—approximately double allowed for in the paper. That would not be of any great consequence if Mr. Langdon had taken the right proportions, but instead of the apportioned trains of each class per hour (third column, Table IV.), there should be: for Class 1, 3 trains; Class 2, 2·85 trains; Class 3, 5 trains; and Class 4, 10 trains. That, the speaker pointed out, threw all the subsequent calculations out. Mr. Langdon had also assumed that because five trains of Class 4 passed a given point in an hour that there were only five trains of that class on the route. That cannot be, unless they run at 50 miles per hour. Proceeding, he expressed the opinion that the tractive effort assumed by Mr. Langdon was inadequate. Regarding Table VII., he pointed out that as each locomotive covered 1,900 miles per week, and the combined wages of driver and assistant would be, say, 80s. per week, the cost would work out to ·5d. per train mile instead of 2·65d. given in the table. With regard to systems, probably three-phase motors on the locomotive would prove best; it would then be possible to have a 15,000-volt transmission line transformed to 1,000 or 2,000 volts, at which pressure the motors would be worked. If that were done, sub-stations, with their moving machinery and attendants, would be replaced by static transformers requiring no attendants. The 10 per cent. loss in rotary converters would be eliminated, while the loss due to conductors

Digitized by Google

would be reduced to about 4 per cent. As a result it might be possible with three-phase motors throughout to improve Mr. Langdon's total efficiency by 20 per cent. Where stops were frequent and speeds always varying, three-phase working could not in the nature of things be efficient; but over long lines, where much of the distance was traversed at constant speed, three-phase working was best. Special slow-speed locomotives could be built for goods traffic and for shunting.

Mr. R. F. YORKE sent a letter to the secretary on the paper, in which he suggested that even if the railway companies would not accept the proposal in its entirety, the Highland railways would benefit by the adoption of auxiliary electric locomotives for working their steep gradients. Where these heavy gradients existed, water power was nearly always present. Take the Highland Railway, for instance, with the steep climb from Struan to the top of the Grampians. The River Garry would furnish any amount of power for auxiliary locomotives. Again, on the West Highland Railway, with the long climb from Spean Bridge up to the summit of the Corrour, the water power of the Spean Valley could provide some 10,000 h.p., which would be greatly in excess of what would be required.

Mr. BARNET, chief engineer, Great North of Scotland Railway, spoke of the disadvantages of the third rail where the line had level crossings, and of the danger to permanent-way employés.

Mr. JOHN L. MACINTOSH, locomotive superintendent, Caledonian Railway, referred to the effects of snow on the lines where a third rail was used.

Mr. PICKERSGILL, locomotive superintendent, Great North of Scotland Railway, pointed out that the influence of excursion traffic had evidently been neglected by Mr. Langdon. In the holiday season from two to three times the number of trains given in Mr. Langdon's table would pass over the line, and the demand, occurring as it did only two or three times in a year, would have to be met by the provision of extra generating plant; thus the load factor would be considerably reduced. He thought Mr. Langdon's figures as to tractive effort were not far wrong. He had made a number of experiments in order to determine the value of that, and his figures came very near to those of Mr. Langdon. A train of 275 tons, such as Mr. Langdon gave in Class 1 (Table IV.) would, according to Mr. Pickersgill's formula, require a tractive effort of 3,300lb., while Mr. Langdon gave 3,575lb. In Class 4 (Table IV.) (goods train) his (Mr. Pickersgill's) formula gave 3,000lb., and Mr. Langdon gave 2,750lb. in his table. Speaking of Mr. Langdon's estimate of £50,000 to cover shunting expenses, he thought that was far too little; bearing in mind the enormous amount of shunting which the Midland Railway had, Mr. Pickersgill thought that the figure might reasonably be multiplied by 4.

At the close of the discussion Mr. H. A. MAVOR moved that the meeting send a hearty welcome to the corps of Electrical Engineers on their return from active service. Some would no doubt be present at the reception in London on Tuesday, but those who could not would, he felt sure, be glad of an opportunity of expressing their appreciation of their electric soldiers.

Mr. WM. MACWHIRTER, as a member of the corps—not at the front—and the oldest member of the Institution in Glasgow, expressed the pleasure which it gave him to second Mr. Mavor's motion, which was carried with patriotic enthusiasm.

OPENING OF STOCKTON ELECTRICITY WORKS.

A distinct step of progression in the history of the ancient borough of Stockton-on-Tees was made on Tuesday of this week, when Alderman Richard Hind (ex-master of the Worshipful Company of Plumbers, and chairman of the Gas and Electricity Committee of the Corporation) formally opened new electric lighting works in that town. At 3.30 in the afternoon he received a large number of guests at the works, which adjoin the Corporation gasworks. These included the Mayor and Mayoress of Stockton (Councillor and Mrs. Crosby), several other members of the Corporation and their wives, the Mayor and Mayoress of Thornaby (Alderman and Mrs. Crossthwaite), Mr. Thompson (representing the Brush Electrical Engineering Company), Mr. C. S. Vesey Brown (electrical expert and adviser to the Corporation), and many others. Through illness the manager of the works (Mr. W. Ford) was unable to be pretent.

Refreshments having been served, and an inspection of the works made, the MAYOR took the chair and opened the formal proceedings. He expressed regret at Mr. Ford's unavoidable absence, and said he hoped that the electric works would prove as profitable to the ratepayers of the town as had the Corporation's gasworks.

Alderman R. Hind then started one of the engines, after which Mr. THOMPSON, on behalf of the Brush Company, presented him with a bronze standard lamp as a memento of the event.

Alderman HIND returned thanks, and then his youngest daughter presented a handsome bouquet of flowers and silver stand to the Mayoress, who turned on the first lights, which were a signal to illuminate the station and town electric lamps.

A number of speeches followed giving the history of the scheme up to date, from which we gather that Mr. Ford prepared the plans for the buildings, and Mr. C. S. Vesey Brown, of Lincoln, the plans and specifications for the electrical section of the work; he also acted as expert adviser and inspector. Mr. Ford then became the general manager of the whole works. The tender of the Brush Electrical Engineering Company, Limited, of London and Loughborough, was accepted for the electrical installation complete. Application was made to the Local Government Board for power to borrow £26,500, the estimated cost of the scheme, after which the work was proceeded with. Demand has already been received from 75 consumers for lights equal to 5,700 8-c.p. lamps, in addition to the street lamps, and it is expected this demand will be increased when the mains are laid in January next in Yarm-lane, Oxbridge-lane, and to West Villas.

Mr. C. S. VESEY BROWN then gave a technical explanation of the scheme, and informed the company that the engines were not of the same pattern as those used by the local tramway company, but still, if at any time anything went wrong with the tramway company's engines, the Corporation's engines could be used to supply the motive power for the tramways.

Alderman J. RICHARDSON (ex-member for South-East Durham), in moving a vote of thanks to Alderman Hind, observed that the gasworks during the 30 years they had been in their possession had been a source of profit to the town to the extent of £5,000 a year. He trusted that the electric works would turn out as profitable a concern.

Alderman J. SAMUEL (ex-member for Stockton) seconded, and spoke of Alderman Hind, who had for the past 10 years taken a deep interest in the electric lighting scheme of the town, and who, as a matter of fact, took a very deep interest in everything appertaining to the welfare of the municipality.

Alderman HIND replied, and moved a vote of sympathy with Mr. W. Ford.

The TOWN CLERK (Mr. M. B. Dodds) seconded, and it was carried.

On the motion of Councillor T. B. WATSON, seconded by Councillor GREEN, a vote of thanks was accorded the Mayor and Mayoress; and after a reply from his Worship the interesting proceedings terminated.

FORTHCOMING EVENTS.

FRIDAY, DEC. 21.

Institution of Civil Engineers.—At 8 p.m., students' meeting, Prof. Alex. B. W. Kennedy, F.R.S., in the chair. Paper on "The Use of Geometrical Methods in Investigating Mechanical Problems," by Mr. C. E. Inglis.

THURSDAY, DEC. 27.

Royal Institution of Great Britain.—At 3 p.m., lecture on "The Sun and its Heat," by Sir Robert Ball.

SATURDAY, DEC. 29.

Royal Institution of Great Britain.—At 3 p.m., lecture on "The Earth and its Heat," by Sir Robert Ball.

Digitized by Google

THE

ELECTRICAL ENGINEER.

Published every Friday

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET.

LONDON, E.C.

CONTENTS.

Notes	865	Reviews	884
The Philosophy of Dynamo Design	870	Electric Oscillations	884
Practical Notes on Electric Mains	872	London County Council Tramways	885
The Barmen - Vohwinkel Suspended Railway	873	On Rapid Variations in the Current Through the Direct-Current Arc	886
The Development of the Density Factor	875	Catalogues Received	888
The Electrical Engineers Volunteers' Welcome-Home Festivities	876	Questions and Answers	889
The Glasgow Local Section of the Institution of Electrical Engineers	879	Companies' Meetings and Reports	891
Opening of Stockton Electricity Works	881	Contracts for Electrical Supplies	893
Forthcoming Events	881	Traction Notes	894
Science and Practice	882	Lighting Notes	896
Correspondence	883	Physical Society	898
		Provisional Patents	899
		Traffic Returns	900
		Companies' Stock and Share List	900

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
United Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered, price 8s. 6d.

SCIENCE AND PRACTICE.

It is generally considered by devotees of pure science that they lose caste if they attempt to deduce practical applications from their scientific researches. It is claimed by such that the pursuit of science has its own reward, and that it should not be debased by any considerations such as the financial gains from commercial applications of the discoveries made. In spite of this, we are repeatedly assured by certain scientific men that the laboratory experiment of to-day is very frequently the workshop practice of to-morrow. In fact, we are assured that in electrical engineering this is almost always the case, and we are therefore warned that we must not allow our practical work as electrical engineers to interfere with standard laboratories. While not concurring with the conclusions to be drawn from the last statements, which premise extreme commercial value to the deductions from observations on terrestrial magnetism, we admit fully the first part of the statement. As a practical example, we would give the remarkably successful work carried on by Mr. W. Duddell at the Central Technical College. The paper read by this gentleman before the Institution of Electrical Engineers last week on the "Rapid Variations in the Current through the Direct-Current Arc," is a remarkable combination of scientific research with practical applications of that research to everyday practice. We have not space here to refer in detail to the various interesting discoveries first published in this paper, and which are so carefully explained by the author. It is worthy of note, however, that in every case he is not content with giving the physical phenomena he has observed, but has traced down the causes of these phenomena by means of other scientific experiments and deductions. As an instance of this, we would refer to the experiments shown by the author on the extinction of a direct-current arc by connecting across the electrodes a condenser. This primary fact was so thoroughly investigated by Mr. Duddell that he was able to give to the meeting information as to the extremely small interval which must elapse between the extinction of the arc and the re-establishment of a high resistance between the electrodes. Thus, if the arc takes place between carbon electrodes, it can be interrupted for an appreciable time and then re-established by again applying an E.M.F. With the arc between metallic points, however, Mr. Duddell clearly shows that if the current is interrupted for so short a time as a twenty-seven thousandth of a second, it cannot be relighted by the application of from three to four times the normal voltage required to maintain it. Another interesting observation made by the author was that on the interruption of an arc between metallic electrodes due to a condenser being connected across it, the voltage rose to an exceedingly high value. For instance, with an arc taking three amperes at about thirty volts, the rise of pressure when a condenser is shunted across the arc was quite sufficient to rupture a sheet of paper which took about a thousand volts to pierce. This rise is increased

Digitized by Google

by having an inductive resistance in series with the arc. Having ascertained this fact, the author was able to apply it to the perfection of the common induction coil. In this, instead of leaving the condenser always connected to the two sides of the contact breaker, he arranged a commutator which only connected the condenser to the contacts immediately after the circuit had been broken, and while the small spark between the contacts still persisted. By this means the length of spark was increased very largely. The increase of length of spark on the coil exhibited at the Institution was quite three times the length of the spark when the condenser was used in the ordinary way. This application of a commutator with an induction coil to inject the condenser into circuit at the right instant is one which alone would have been worth all the time devoted to the subject by Mr. Duddell. An application, however, which will be of much more interest to the electrical engineer who devotes his time to heavier work, is the application of Mr. Duddell's discovery to ordinary switch contacts. It has been the aim for years to design switch gear which shall give an extremely rapid break in order that destructive arcing may not take place at the contacts. It is now clear from the experiments that when such switch gears have to be used in connection with the underground cables, the quick break may be absolutely harmful, as it may result in a rise of voltage which may pierce the insulation. Mr. Duddell has shown that with certain proportions of self-induction and capacity, the rise of voltage at the instant after the break in the circuit may amount to over thirty times the normal voltage of the circuit. From this it will be seen that if the primary voltage were one thousand, a most destructive E.M.F. might be caused. It will be a consolation, however, to practical engineers to learn that by using carbon breaks with their switches these ill-effects are practically avoided. There were many beautiful experiments shown by Mr. Duddell at the Institution, a description of which will be found in our columns, and it only remains for us to congratulate the author on the success of his investigations from both a practical and scientific standpoint.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM ALTERNATOR TEST.

SIR,—I have pleasure in giving herewith the results of a steam consumption test made on a 300-kw. steam alternator supplied recently by Messrs. Ferranti, of Hollinwood, to the order of the Cardiff Corporation. The figures are sufficiently good to interest, I believe, several of your readers, and the names of the gentlemen who conducted the tests are a guarantee of their reliability and accuracy. The plant comprises a vertical compound condensing engine having cylinders 18in. and 34in. by 18in., with an alternator of Ferranti's well-known copper armature type between the high-pressure and low-pressure engines, the whole designed to give 300 kw., 2,500 volts and 120 amperes, 40 periodicity, and 200 revolutions per minute. The valves are of the gridiron type, driven by cam gear, the governing being effected by a throttle valve, and there is forced lubrication. The alternator drives its own exciter.

The test was made on Nov. 8, 1899, there being present, as experts on behalf of Messrs. Ferranti, Mr. M. Longridge, Mr. A. B. Mountain, and Mr. Gillert; on behalf of the Cardiff Corporation there were Mr. H. R. J. Burstall and Mr. Llewelyn B. Atkinson. The test was started at 9.15 a.m., and continued at full power until 4.12 p.m. The steam from the engine was discharged into a surface condenser, which only received the steam of this engine. The air-pump discharge was measured by being run into two barrels, one being filled while the other was being emptied, each being filled up to a mark. During the trial 69 pairs of barrels were used, making a total of 53,030lb. The next day a test was made to ascertain whether the condenser was tight, and it was found a leak equal to 1 per cent. existed, making the total water used equal 52,500lb. It was found that 92lb. of water had collected in the drain sump under the engine, having escaped from the glands, which has to be added, making a final total of 52,592lb. The duration of the trial being 6·95 hours, the quantity of steam used by the engine was 7,568lb. per hour. The vacuum as measured in the exhaust pipe close to the engine was 18·7in., or 9·2lb. per square inch. The alternator was run on a water resistance, the power was measured by a number of ammeters and voltmeters, one of each being chosen after comparison with a Kelvin watt balance as being the most accurate, and readings were taken every 15 minutes. There was also a Thompson recording voltmeter, which was read every 30 minutes.

Each of the instruments read during the trial were sent to the Board of Trade laboratory immediately after the trial for calibration, and the necessary corrections have been made in the calculations. The mean output of the alternator was 315 kw. The mean horse-power shown by the indicator cards was 499 at the mean speed of 204·9 revolutions per minute as got from the engine counter. The combined efficiency of the engine and alternator, taking the above figures for electrical output and indicated horse-power, was 84·6 per cent.

Taking the figures actually obtained, the steam per kilowatt-hour was 24·03lb, being practically 2lb. below that required by the specification. I think this is very good, and if the vacuum had been 26 or 27, the result would, of course, have been materially better. No special preparations were made to prepare the engine for this test. The steam was not superheated, and supplied from boilers of the dry-back marine type.—Yours, etc.,

N. APPELBEE, Electrical Engineer.

Cardiff, Dec. 11, 1900

MUNICIPAL TRADING.

SIR,—May I draw your attention to the following extract from a judgment given recently by Mr. Justice Bigham in a case claiming a declaration that the chairman of a certain urban district council was disqualified from sitting as a member of the council, on the ground that he was concerned in a bargain or contract entered into with the council, and participated in the profit derived therefrom:

"Bigham (J.) said he was of opinion that the defendant was concerned in the contract, and that, therefore, he was disqualified from remaining a member of the council. His experience showed him that there were on these local bodies too many men—builders, and men of that class—who were liable to become, and did become, interested in the work which the councils had to carry out. Such persons, in his opinion, ought not to be elected on such bodies at all, because they were tempted by their own interests to undertake contracts and to enter into dealings with which they ought to have nothing to do."

That this is not an isolated case would appear from the following extract from the *Daily Express*:

"Manchester.—Town Councillor Resigns.—Councillor Rigson yesterday resigned his position on the Salford Town Council in consequence of allegations made against him of carrying out contracts for the Corporation. He admitted having done sub-contracting work, and said he had no ulterior motive. The Mayor did not think there was

Digitized by Google

any council in England some member of which was not interested in a corporation contract."

Again, in consequence of another complaint, the Manchester Town Council have laid down the principle that a member of the Council is prohibited from trading, directly or indirectly, with the Council or any of its committees; and this would seem right, as the members of these councils are trustees for the ratepayers.

I have pointed out in a previous letter that the outstanding loans of local authorities have increased by 150 per cent. in the last 20 years, and they now stand, according to the Local Government Board's report, at £252,135,174.

Local authorities generally throughout the country are embarking more and more in trading undertakings, necessitating contracts for the supply of goods and materials to an enormous extent.

In the result it would seem that either :

1. Municipal trading must be stopped ; or,

2. These trustees must be allowed to be personally interested in the contracts they enter into on behalf of those for whom they are trustees.

Is the latter desirable in the public interest ?—Yours, etc.,

KENRIC B. MURRAY,
Secretary, Municipal Trading Committee.

Botolph House, Eastcheap, E.C., Dec. 19, 1900.

REVIEWS.

The Life Story of the late Sir Charles Tilston Bright, with which is incorporated the Story of the Atlantic Cables and the First Telegraph to India and the Colonies. By his brother EDWARD BRAILSFORD BRIGHT and his son CHARLES BRIGHT, F.R.S.E. Two vols. Archibald Constable and Co.

These volumes we intended to use as a text for a monograph, but for many reasons that has been found impossible, and we must content ourselves for the present with a short and incomplete notice of the many matters treated therein. We must content ourselves with a bald uncritical narrative, in that a number of controversial matters are raised in the text, to fully examine any one of which would need a volume. It may be held that a brother and a son would, in writing the biography of a brother and a father, be somewhat biassed in his favour. This is as it should be, and we commend them for it, yet in future years the strict historian will probably place other men upon an equal pedestal to him whose life's work is recounted in these pages. Sir C. T. Bright was amongst the pioneers in cable work, and especially in Atlantic cable work. We have always held that owing to the rapid progress in telegraphy the world has never really understood the great temerity, perseverance, and plunge into the unknown made by these pioneers. To carry out their projects, the value of which, if successful, was but faintly understood, needed not only the conviction of scientific men as to the possibility, but the far more difficult task of converting moneyed men to finding the capital in return for promised dividends. It is easy to talk now when the work is accomplished, but the difficulties in the way of those who proposed Atlantic cables in the early fifties can hardly be understood. Sir C. T. Bright was one of the band who fought the fight and who lived to taste success. As his biographers say, the part he played "in this then unprecedented enterprise included the scientific demonstration of its practicability, the projection, the provision of capital, and the ultimate successful laying of 2,200 miles of cable across ocean depths of two or three miles. . . ." The great interest of these volumes centres around the history of the work in connection with the first Atlantic cables, and in a minor degree to that in connection with other cables laid east and west in the years following the successful laying across the Atlantic. Thus the early history of the brother, the position of telegraphy given in the pages prior to the section (p. 109) concerning the "formation of the company and construction of the cable," though immensely interesting to relatives and personal friends, are not so to the ordinary reader. Those who carefully read the section just referred to will form some ideas of the difficulties overcome. Can we imagine America, the land of the masterful, the go-ahead and the speculative, subscribing for only 27 shares, or less than one-twelfth of the total capital. Evidently there was not much faith in the venture, but these pioneers persevered and ultimately succeeded. The specification of the cable was hardly so definite as one would be now, and was not altogether in accord with the views of the engineer, nor those of Prof. Thomson (now Lord Kelvin). But we cannot enter into details. The rest of vol. i. reads like a chapter in a novel, wherein for a time the villain carries everything before him, till towards the end come the ringing of the bells to the shouts of victory, while all that troubled is at rest in that bourne from whence there is no return. Bright received recognition from his country for his services. The exact position he holds in the history of the work is hardly to be determined, but whatever that position, his claims and his work are described with great skill by his biographers. The second volume of these memoirs is less interesting. It describes work of various kinds, most of which was rendered easy by the experience gained in the Atlantic. It shows, moreover, that Sir C. Bright was an indefatigable worker—that he interested himself in business matters altogether wide of electricity.

ELECTRIC OSCILLATIONS.

The fourth and last Cantor lecture on this subject was delivered by Prof J. A. Fleming at the Society of Arts on Monday last. The lecturer stated that, whereas previously he had gone into the question as to how electric waves could be produced and the medium through which they could be transmitted, he proposed in the present lecture to look into the question of what the waves resembled and the properties by which they were rendered apparent. He gave the following list of types of waves and the resistance against which each was exerted in the propagation of the waves in question :

Type.	Resistance to
Gravitational waves	Change of level
Capillary waves	Increase of surface
Compressional waves	Change of volume
Distortional waves	Change of shape
Electric waves.....	Electric displacement

As a rule, in order to set up any kind of wave a sudden movement was required, which would cause the energy to leave the wave-forming body and to travel through space. He would warn his audience that the term "electric displacement" had not yet been thoroughly defined. Even Maxwell, who introduced the expression, did not see his way to explain in a few words what he considered electric displacement to be. Dr. Fleming then proceeded to describe Hertz's historical experiments by which he found evidence of the existence of these electric waves. He repeated to a very large extent the original experiments of Hertz, dealing first with the Hertz oscillator connected up to the high-tension terminals of an induction coil, and with the Hertz resonator, which consisted of a circle of wire with a small air-gap of about a millimetre in it. It was experimentally shown that when this resonator was touched against one of the plates of the oscillator, a spark passed between the balls unless the point of contact was diametrically opposite the spark-gap. In view of the fact that 1,000 volts are required to make the spark pass over the gap, electrical engineers would not have predicted that the discharge would have occurred, in spite of the fact that the copper wire connecting the balls was only 1½ yards long. The reason why this occurred was that the oscillations were too rapid to allow the discharge to get round the wire, as the frequency used was about 150 millions per second. Hertz then tried isolating the resonator from the oscillator, and found that in certain conditions he still got sparks. In fact, as long as the spark gap in the resonator was parallel to the axis of the resonator the sparks passed, but if the resonator was moved round so that this spark-gap was at right angles to the axis of the oscillator, there was no discharge. In order to make

Digitized by Google

this experiment clear to the audience, Dr. Fleming introduced a condenser into the resonator circuit, as illustrated in the diagram. A gold-leaf electroscope was connected to one side, and the resonator was then charged up. When the spark caused by the electric waves passed the air-gap, this gold-leaf electrometer was discharged, affording an indication of the fact. The next experiment made by Hertz was the effect of a large zinc plate behind the resonator, and he showed that certain positions of the zinc plate behind the resonator stopped the sparking, while in other positions it still continued.

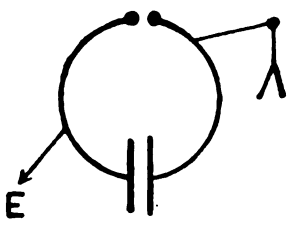


FIG. 1.

The first idea was that the oscillator sent out waves, and that by means of the zinc plate the position of the nodes and loops in these waves had been discovered. It was shown afterwards, however, by Messrs. Sarasin and De la Rive that the distances between the zinc plate and the resonator when sparking took place were functions of the size of the resonator. The lecturer explained that this was due to the fact that the oscillator used by Hertz was in such a form as to send out exceedingly few oscillations. In fact, the waves so rapidly died away that it was doubtful if more than one complete wave occurred. The Hertz resonator, on the other hand, was an exceedingly good oscillator, and hence had a very distinct period. What then occurred was that the oscillator caused one big displacement in the resonator circuit, which died away in a number of waves, and the wave-length was indicated by the position of the zinc plate. When the zinc plate was at a quarter wave-length from the oscillator it helped in the production of these waves, whereas if it were at a half-wave distance it stopped it. The Hertz experiments required great space in which to conduct them, but Dr. Fleming had designed and he exhibited at the lecture a most interesting apparatus by which the whole of the Hertz effects could be shown on a lecture table. As an indicator of the presence of these waves he used a Branly radio-conductor, or, as it is commonly called, a coherer. The two discharge balls of the oscillator were enclosed in a

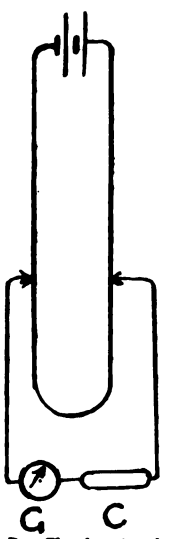


FIG. 2.—Apparatus used by Dr. Fleming to show that a coherer suddenly became conductive as the E.M.F. applied increased.

zinc box with a rectangular opening, so that the electric waves were sent out in one direction only. The conductors to the balls were encased in ebonite tubes, in which spirals of copper wire were coiled to prevent these wires sending out radiations. The radio-conductor was also encased in a zinc box with an opening so as to allow waves to enter from one direction only. The lecturer explained that it was most important there should be no unsoldered joints in this box through which the waves would enter. The connections between the radio-conductor and the relay were also encased and surrounded by a choking coil to prevent the waves acting on anything but the radio-conductors. When these two pieces of apparatus were placed with the openings opposite each other, the discharge from the oscillator sent electric waves which influenced the resistance of the radio-conductor, causing the relay to act and the bell to ring. It was then shown, by inserting a number of substances in the space between the two openings, that all metals stopped the waves, whereas other substances, such as paraffin, wood, cloth, etc., were transparent to the waves. Anything which contained water stopped the waves, but ice when dried did not. From these experiments it was then shown that those substances which have true dielectric constant, and obey Maxwell's law, were transparent to the waves. In the case of water the dielectric constant was 80, whereas the square of the refractive index was about 2. Experiments in reflection and refraction were also shown very conveniently by the apparatus in question. It was explained that the reason why wireless telegraphy was much more successful over sea than over land, was because the land would absorb the waves, whereas they were reflected from the surface of the water. The extreme dryness of the land in South Africa was in a large measure responsible for the want of success which wireless telegraphy had experienced in connection with the military operations in that country. A long chart of wave-lengths was exhibited by the lecturer and a special reference made to the great span in the middle of the scale, waves corresponding to which have not been discovered and investigated. As regards the books he would recommend students to read on the subject, the original memoirs of Hertz translated by Prof. Jones stood first. The treatises by Prof. J. J. Thomson should also be obtained, while Dr. Larmor's work on etheric theory was worthy of careful study. He concluded by thanking the audience for the great attention they had given his lectures, which it had been a pleasure to prepare.

Sir FREDERICK BRAMWELL then proposed a vote of thanks to Dr. J. A. Fleming for his most interesting series of lectures. He knew of no man who was able like the author to make intelligible such intricate subjects. The lectures delivered by him had the advantage that one not only thought one understood the lecture while it was being delivered, but actually was able to make it intelligible to others after the course was over.

Dr. FLEMING briefly replied to the vote of thanks.

LONDON COUNTY COUNCIL TRAMWAYS.

At Tuesday's meeting of the London County Council the Highways Committee brought two important matters before the Council. The first was an agreement with Dr. A. B. W. Kennedy with respect to his remuneration for the construction of the three sections of tramways between Westminster Bridge and Tooting, Kennington-gate and Blackfriars Bridge, and St. George's-circus and Waterloo-road. This new agreement had to be made in consequence of variations from the old agreement of Oct. 10, 1899, due to the fact that certain of the lines then mentioned cannot at present be constructed owing to the failure of the Council to get the requisite powers. The other matter which came before the meeting was that of the appointment of an electrical engineer in connection with the tramways department. In view of the large amount of work which has to be done in the construction of certain new tramways and the reconstruction of old lines for electric working, the Highways Committee rightly think that they should have an expert of their own, who would be the better able to supervise the running and maintenance of the system because he had been with the Council during the whole time that the works were going on. It will be remembered that the total length of the tramways which are to be constructed or reconstructed is about 100 miles. The salary suggested by the committee is £1,000 a year, and the gentleman selected would go in the chief engineer's department, holding a position analogous to that occupied by the mechanical engineer. A resolution to this effect was carried.

Digitized by Google

ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.*

BY W. DUDDELL, WH.SC., ASSOCIATE.

It may be thought by some that the title of this paper is rather contradictory, in that there should not be any variation in the current through a direct-current arc. I will therefore explain at once that I simply use the term "direct current" as implying that the current is supplied by cells or by a direct-current dynamo, and not as implying that the current is necessarily constant in value. It may also be as well to state that by "arc" I do not mean arc lamp, as all the effects to be described are quite apart from those produced by regulating mechanisms. The effect of varying the current through the direct-current arc very slowly, so slowly, in fact, that the carbons have time to burn into shape corresponding to each value of the current, has been investigated by many experimenters, but it is to Mrs. Ayrton that the honour belongs of giving a complete investigation of all that occurs when any of the variables in the direct-current arc are changed in any way. The other extreme—namely, very sudden changes in the current—has also been investigated by Mrs. Ayrton, thus leaving a gap in the experimental evidence as to what occurs between very slow variations and isolated sudden changes in the current.

The present paper is an attempt partly to fill this gap by giving an account of what occurs when the current is periodically varied more or less rapidly over a range which is very small compared with the mean value of the direct current. The current through a direct-current arc supplied with power from any circuit may vary either owing to changes taking place in the circuit—such as variations in E.M.F. or resistance, or owing to effects in the arc itself, such as hissing, humming. Although any variation in the current naturally entails a corresponding change in the arc itself, it will, I think, be found convenient to classify the observed effects according to whether the primary cause of the variation is in the arc or in the circuit which supplies it.

PART I.—CAUSE OF THE VARIATION OF THE CURRENT IN THE CIRCUIT SUPPLYING THE ARC.

The effects of varying the current may be divided under four heads—viz., the effect on the P.D. between the terminals of the arc, on the light emitted, on the shape of the craters, and on the vapour column. These will be considered in order. I shall assume in all cases in Part I. that the amplitude of variation of the current from the mean is small, generally much less than 10 per cent., and that the arc experimented on is neither hissing nor humming.

Effect on the Potential Difference Produced by Variations of the Current.—If the current varies very slowly, then the relation between the P.D., current, and length is that given by Mrs. Ayrton's curves. Directly the rate of variation is increased so that the carbons have not time to burn into shape, corresponding with the instantaneous values of the current, the relation will be changed, and it is conceivable that if the rate of variation were high enough and the amplitude small enough the conditions of the arc would in no way be changed, so that the ratio of the change in P.D. to the corresponding change in current would be a constant and equal to the true resistance of the arc. I shall show later that this assumption, which is the basis of several experiments on the resistance of the arc, notably those by Messrs. Frith and Rodgers, requires a much higher rate of variation of current than they employed. One of Mrs. Ayrton's curves, contained in a letter by Prof. Ayrton to the *Electrician*, illustrates very well how the connection between the P.D. and current depends on the rate of variation of the latter. This curve shows that the first effect of suddenly increasing the current through a cored-solid arc† is to cause a transient rise in the P.D. between the terminals; the effect of a slow increase of current being, as is well known, to produce a decrease in the P.D. This first transient rise in the P.D. which was obtained with a cored-solid arc was also, I believe, obtained with a cored arc, but I am unaware of its having been observed for a solid arc. Thinking that this might be due, as pointed out by Prof. Ayrton, to the extreme quickness of the phenomenon when both carbons were solid, I tried to record the transient rise in P.D. for the solid arc by means of an oscillograph, the sudden increase of the current being obtained by discharging a condenser through the arc. This experiment was successful, and a transient rise in P.D. was observed, the P.D. and current increasing together, but only for about 1/5000 second. At the end of this very short time the P.D. decreased with an increase of current in the ordinary way. If it can be assumed that during this first 1/5000 second the conditions of the arc are not changed, then the solid arc has a positive resistance, contrary to the results obtained by Messrs. Frith and Rodgers, and it is at any rate evident that, had the frequency of their superimposed alternating current been 5,000 ∼ per second instead of 250 ∼ per second, the sign of the resistance as obtained by them would have changed, though I do not say that even at that frequency its true value would have been obtained. In any method for measuring the resistance of the solid arc which depends on the change in the P.D. produced by a change of current, these changes must, therefore, take place in less than 1/5000 second in order not to allow the arc conditions to change; results to be described later indicate a still shorter time. I will not, however, pursue this subject any further, as it would unduly extend the length of this paper to include a description of a complete series of experiments on the resistance of the arc which I have recently completed.

Effect on the Light Emitted Produced by Variations of the Current.—It is well known that the light of the arc varies when the current is changed, though how small and rapid the variation in current may be and yet produce a perceptible change in the light does not seem to have been investigated. Prof. Fleming and Mr. Petavel and Mr. Burnie have determined the instantaneous values of the light and current in the case of alternate-current arcs, and have found that the variation in light roughly follows the variation of the current; the maximum luminous intensity occurring about 1/1000 second later than the maximum current. Herr Görges has also noticed that the variations in the current due to the teeth on the armature of a dynamo produced an appreciable variation in the light at the rate of 300 per second. In order to test how rapid and how small a variation of the current from the mean could be detected in the light of the direct-current arc, I arranged an arc so that its image as seen through a central slit parallel to the carbons was projected on to a rapidly falling photographic plate, the instantaneous value of the current being recorded simultaneously on the same plate by means of an oscillograph. The small quick variations of the current through the arc were produced by passing the oscillatory discharge of a condenser in series with a self-induction through it, so that the arc current consisted of a large constant part on which was superimposed a small ripple which died away after a few oscillations. By this method I find that in an eight-ampere solid arc a distinct variation is produced in the light emitted by both the + crater and the vapour column when the amplitude of the variation of the current from the mean is only 3 per cent., and the frequency of these superimposed variations is as large as 4,300 ∼ per second. At this frequency the variation in light became indistinguishable when the amplitude of the variation of the direct current was reduced to 2 per cent. Owing to the difficulty in estimating the points of maximum density in the band on the plate which represents the light emitted in consequence of the smallness of the variation of the current and therefore of the light, I was unable to be certain whether the maximum light lags behind the maximum current; but if it does, the lag is very slight, not exceeding 1/10000 second for an eight-ampere solid arc. It must be remembered that the above variations of light are those of the actinic rays which affect the photographic plate; the visual rays will probably vary in a similar manner, though possibly not to the same extent.

Effect on the Craters Produced by Variations of the Current.—Mrs. Ayrton tells me that she noticed that the variations in the current used by Messrs. Frith and Rodgers, who superimposed an alternating current of 0·5 to 1·8 ampere R.M.S. value, at frequency of 100 ∼ per second on a 10-ampere direct-current arc, so altered the shape of the ends of the carbons that she could easily distinguish them from normal carbons formed without any variation in the current. I find that if the superimposed alternating current be reduced to 0·1 ampere under the same conditions, the ends of the carbons appear unaffected.

Effect on the Vapour Column Produced by Variations of the Current.—Sounds: Corresponding with each value of the current through the arc there is probably a definite cross-section of the vapour column, so that if the current varies rapidly through an arc of fixed length, the volume of the vapour will also vary and sound-waves will be given out. This, I believe, is the generally accepted explanation of the humming of the alternate-current arc. In the case of the direct-current arc, sounds are also emitted even when the variations in the current are very slight. For example, the variation of current caused by the commutator segments of a direct-current dynamo passing under the brushes can be heard in the arc. This variation of the current, caused by the commutator segments, even when in good condition, was found by Messrs. Frith and Rodgers in the case of a 5-kw. two-pole machine to vary between 2·5 and 9 per cent. of the mean current, according to the position of the brushes. Another striking example of how sensitive the arc is to small variations in the current is furnished by the fact that a Wehnelt interrupter, working an induction coil on the direct-current street mains, will cause any arc supplied by the same mains to give out the same noise as the

* Paper read before the Institution of Electrical Engineers.

† "Solid," "solid-cored," and "cored" arc mean, respectively, arc between two solid carbons, between one solid and cored, and between two cored carbons; the top or + electrode being always placed first.

Digitized by Google

interrupter itself, even when a considerable distance intervenes between the place where the arc is connected with the mains, and where the interrupter and coil are joined on, as observed by Herr Simon, Mrs. Ayrton, and Mr. Jervis Smith. It must be clearly understood that the arcs here referred to are normal silent arcs—that is, if they were supplied with a really steady current, they would have been practically silent.* In order to determine what variation in the current was necessary to cause the arc to emit a clearly audible note, the current from a high-frequency alternator, kindly lent by Sir D. Salomons, was superimposed on the direct current by the method shown in Fig. 1. The current from the alternator passes through a condenser, F, a dynamometer, D, and the arc in series; and it is practically prevented from flowing through the cells which supply the arc by the self-induction, L. The direct current is

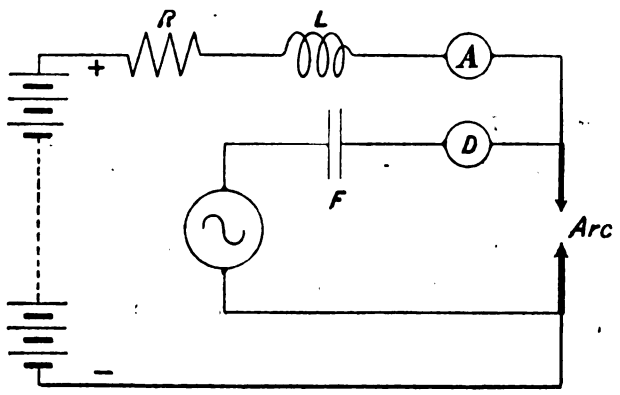


FIG. 1.

prevented from flowing through the alternator by the condenser, F. It was found by this means that a 10-ampere direct-current solid or cored arc, length 3mm. to 5mm., would produce a distinct note even if as small a R.M.S. current as 1/1000 ampere, as measured by D, was superimposed on the direct current for frequencies of the added current from a few hundred up to 8,000 ~ per second. Thus a variation of the order of 1 part in 10,000 from the mean current will alter the vapour column sufficiently to produce sound-waves. Further experiments with another alternator and R.M.S. superimposed currents of 1/20 to 1/10 ampere on a 10-ampere solid arc proved that the sounds only became inaudible at frequencies approaching 30,000 ~ per second. At these frequencies I am uncertain whether the arc had really ceased to give a note, as the ear fails to detect sounds of so high a pitch. This sensibility of the arc for very small changes in its current explains the fact that not only can rapid variations of current in any circuit supplied from the same generator as the arc be heard in the arc, but also variations of current which occur in a totally independent circuit supplied by a separate generator

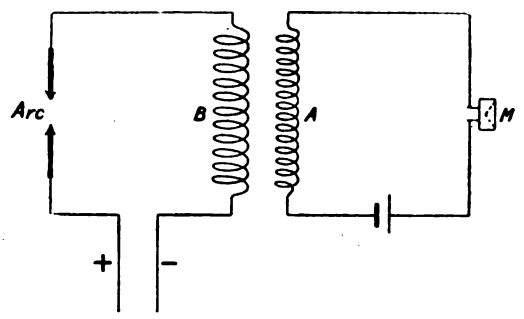


FIG. 2.

can be detected in the arc due to mutual induction between the two circuits.

Arc as a Telephone Receiver.—The fact that the arc is sensitive to such small variations in the current and over such a wide range of frequency, at once suggests that the direct-current arc might be used as a telephone receiver. This suggestion, which was made in a leader of the *Electrician* in 1899, had already been carried out by Herr Simon in 1898. The method used by Simon for superimposing a microphone current on the main arc current is shown in Fig. 2, in which A and B are two coils having mutual induction, and M, the microphone. The current through A varies when M is spoken into, and induces E.M.F.'s in B, which vary the current through the arc in such a way that it reproduces sounds and even speech distinctly. The variation of the current through the arc obtained by this method is not as large as it might be, as the E.M.F.'s induced in B have to send currents round the whole arc circuit, including any steadying resistances, and also through the self-induction in the armature, if a dynamo is used, instead of only through the arc where the varying currents are actually required. I have obtained a better result by replacing the alternator of Fig. 1 with a microphone and mutual induction, as shown in Fig. 3. A and B are the two coils of a mutual induction, F a condenser of about two or three microfarads, and L a high self-induction, the object of the self-induction being to prevent the microphone currents flowing round the cells instead of through the arc. With this arrangement and suitable arc conditions, to be explained later, the arc will speak sufficiently loudly and clearly to be heard at a distance of 10ft. to 12ft. in a quiet room. [Experiment.] The sound-waves given out by the arc are, therefore, of such an intensity that when the energy is spread over an area of 20ft. diameter, the ear placed

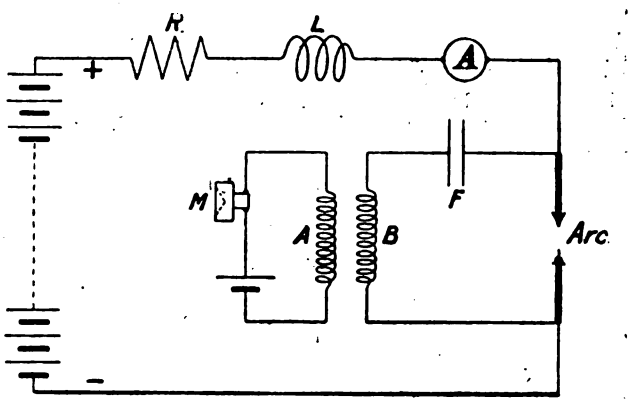


FIG. 3.

at any point can hear speech distinctly. It seems probable that if all the energy available could be collected and concentrated on the ear, very powerful sound sensations might be produced. The loudness of the sounds given out by the arc is increased by lengthening the arc, as this increases the volume of the vapour column which emits the sounds. It would also seem as if increasing the main current which increases the cross-section of the arc should also be beneficial, but experimentally I have not found any appreciable gain. The best results have generally been obtained with a current of 10 to 12 amperes, carbons 11mm. to 13mm., and an arc length of 20mm. to 30mm. To obtain these long lengths with ease it is necessary to use cored carbons or some other means of introducing foreign bodies, such as salts of potassium and sodium, into the arc, for there is not much doubt that the stability of the arc between ordinary cored carbons is due to the presence

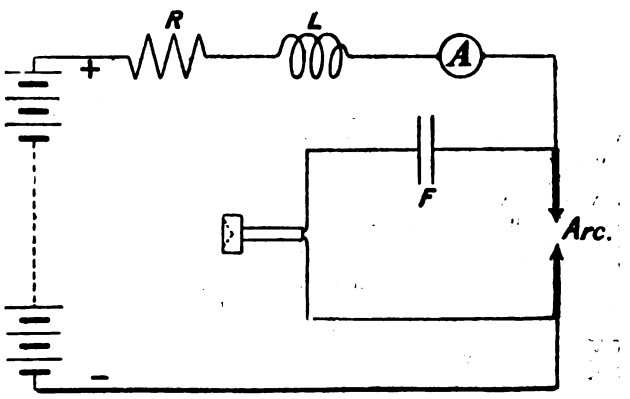


FIG. 4.

of potassium silicate in the core. These salts may be introduced either by soaking the carbons in their solution, or by using them as cores. Mr. Jervis Smith has recommended the insulator glass as a core, which I find works well.

Arc as a Telephone Transmitter.—Before leaving the subject of the use of the arc as a telephone, it will be convenient to consider its use as a telephone transmitter, though this subject strictly belongs to Part II. of this paper. Herr Simon found that if he replaced his microphone in Fig. 2 by a telephone receiver, any sounds made near the arc were heard in the receiver. In this case, as before, I find it preferable to modify his method by connecting the receiver in series with a condenser between the terminals of the arc, as in Fig. 4. A sound-wave striking the arc may affect it in two ways, either by vibrating the arc as a whole and varying its length, or the waves of condensation and rarefaction may alter the cross-section of the arc: both of these effects will tend to alter the apparent resistance of the arc, add hence vary the current through it. The sounds obtained in the telephone receiver when using the direct-current arc as a transmitter are not gene-

* Absolute silence is almost impossible, as the least want of homogeneity, or impurity in the electrodes, causes small spits and sounds.

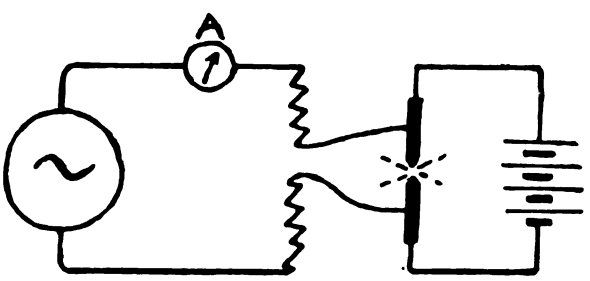
Digitized by Google

rally very satisfactory, as, besides not being very loud, they are obscured by the extraneous sounds due to the small spits and hisses which occur in the arc each time the air gets to the + crater due to any slight defect in the carbons. If a common pair of carbons be used containing cracks and impurities, the noise in the receiver is sometimes unbearable, although there is no outside source of disturbance of the current through the circuit. In all experiments on the arc as a telephone transmitter or receiver, it is essential that the current generator should be free from rapid variations, or extraneous sounds will be produced. If a dynamo has to be used, then the variations of the current produced by the commutator segments may be minimised by inserting a large self-induction in series with the arc, as in Figs. 1, 3, and 4. This self-induction serves the double purpose of keeping extraneous variations of the current out of the arc, and of preventing the variations we desire to observe from being dissipated in the source of supply. Thus we see that the direct-current arc is not only extremely sensitive to small variations in its current of almost any frequency, but also that it is affected by such small changes of outside conditions as sound-waves produce. Whether this sensibility can be turned to useful account in telegraphy or telephony remains for future experiment to decide.

(To be continued.)

Discussion.

Prof. W. E. Ayrton said the paper which they had just heard read had given him, as he was sure it must have given them, exquisite pleasure, not that he had any claim to be its author, but he had felt as pleased while hearing it read as if he had been the writer. Nor did he experience this pleasure only because he felt convinced that the experiments of that night, which were most useful for lecture purposes, would assist in the development of the electrical industry of to-morrow, but it was rather because it so rejoiced the hearts alike of professional men and of professors to find a student like Mr. Duddell, who so resembled the solid-carbon arc, for he was ever on the alert to catch at and magnify any hint which might come from nature or man. From Mr. Duddell's work—that presented some two years ago as well as the paper just read—they learnt much. Among other things, it had taught them how valuable was that research made about five years ago by Messrs. Frith and Rodgers. These experimenters, using



connections as shown in the accompanying diagram, proved that when an alternate current circuit was connected to the two electrodes of a solid-carbon arc supplied from accumulators, the alternating current was increased not only in one direction, as might have been expected, but in both directions. That investigation was made because he had pointed out to them that if they applied the methods which had been employed by various experimenters in certain conditions to an arc, they would obtain a negative answer for the resistance of the arc. Certain experiments carried out since had confirmed him in that view. Other experiments showed that whenever an arc was formed between solid carbons that $\frac{\delta V}{\delta A}$ was negative, whereas if they were cored carbons this ratio was always positive. A howl of indignant criticism followed, and if he and the experimenters had lived in the Middle Ages they would undoubtedly have been burnt. But there were other distinguished investigators who had the insight and the courage not to be drawn into this net of conventional antagonism, and among these were Prof. Gray, who is Lord Kelvin's successor, Mr. Oliver Heaviside, and the chairman of the Dublin section of the Institution (Pr. f. Fitzgerald), to all of whom they were very much indebted for so many suggestions. He did not propose that evening to consider whether or not what Messrs. Frith and Rodgers measured was the true resistance of the arc, because they would have an opportunity soon of going fully into that subject. But in justice to Messrs. Frith and Rodgers, and in virtue of the far-reaching principles which they had really brought to light, he desired to emphasise what they had obtained. Mr. Duddell had taught them what the significance of Messrs. Frith and Rodgers's work was. Dr. Hopkinson proved to them years ago that all alternators could not be run in series. Mr. Duddell had not only pointed out the importance of this result, but he had shown something further. He had demonstrated to them that the ordinary so-called perfectly silent arc supplied by the accumulators was like the mouthpiece of a flute, and that the application of a capacity in series with self-induction coils had shown some especially remarkable results. In this particular case the vibration was started and backed up when the capacity was in series with the self-induction coils. Already the author had shown them the practical result which was obtained from this. He had shown them how to improve a well-known instrument—the induction coil—and demonstrated the improvement over using a condenser joined up in the usual way, of employing a small motor so as to put the condenser across the gap immediately the break in the circuit was made. You then got a spark from five to ten times as long as was obtained by the apparatus used in the ordinary way. One other point came out in these experiments. About 10 years ago a paper read by Dr. Sumpner and himself before the Royal Society, pointing out that in the case of an alternating current arc, if they used solid carbons the true power given to the arc was considerably less than the apparent power. Subsequent to that he was pretty well convinced that in certain circumstances the direct-current arc behaved in the same way. In the case of a direct-current arc between solid carbons when hissing occurred, it was now established that the power factor was no longer unity. He was not sufficiently certain of this when he made the discovery, but now he was sure from the results of further experiments that with an arc supplied with accumulators—so called a direct-current arc—if the carbons were solid and there was a little hissing, then the power factor might vary 7 per cent. from unity. When he read this paper he thought the author had proved that a solid carbon direct-current arc was the most sympathetic soul he had ever met. But he was convinced now that this was not quite the case, for they had shown Mr. Duddell that evening that the sympathy of the arc was even exceeded by the sympathy of his audience.

Prof. J. A. Fleming thought it very difficult to decide who ought to be congratulated the more heartily that evening—the members of this Institution for having had an opportunity of hearing such a delightful paper from Mr. Duddell, or Mr. Duddell himself for having completed such a fine piece of work. This paper, he was sure, would have very important practical results in the future. The matter which had interested him most of all was the experiments with the continuous-current arc between metal electrodes, because he had been attempting something in the same direction himself, but he could not say that the result was the same as that arrived at by the author, because he had tried carbon only. Certainly, one of the most practically important parts of this paper was its final section as regarded metal switch contacts, and that would cause some heartsearchings amongst those who had been responsible for high-tension switches. It was generally believed up to now that the high-tension switch ought to have jaws which broke the arc as rapidly as possible, but according to the experiments carried out that night that was exactly what it ought not to do. He was particularly struck with the results that the author had obtained with his system of breaking the primary circuit of induction coils. One well-known fact in connection with induction coils was that they sometimes would not work well, when the number of cells used was increased. This was evidently because the current did not die away rapidly enough, and the arc was drawn out. The conclusion was that in the design of the contact breaker of induction coils, you must proceed in exactly the opposite way to what you should do in designing high-tension switches. He was sure this part of the paper would have great consequences.

The Chairman said he had intended calling upon several other gentlemen, as well as Mrs. Ayrton, to give the assembly the benefit of their views on the subject, but time did not permit of this. They wanted their remarks, however, and if they would send in what they had to say it would be published in the *Journal*. They had had extraordinary luck this session so far in having good papers to discuss, and the one they had had before them that night was almost the best.

CATALOGUES RECEIVED.

We have received from Messrs. Davies, Kent, and Stewart a list of their "flush" wall or floor sockets. These are specially constructed so that the surface of the sockets is quite flush with the floor or wall when the plug is removed. The sockets themselves are constructed in the best device entirely of porcelain, while the surface of the sockets can be varied to suit the wishes of the purchaser. We understand from the makers that they are stocking these in black or white English china, with plain surfaces for the floors, and with ornamental surfaces when the sockets have to be placed on the walls. Another type is also supplied with a brass surface, which will be most useful for floor work.

We have received from Messrs. Bergtheil and Young some illustrated leaflets concerning their "Bandy" type of electric motors. Amongst the motors illustrated is the "enclosed" motor for fixing on floors of both the two and four-pole type. They also make motors for connection to printing machinery, in which case much slower speeds are used and the number of poles in the motors increased. With the slow-running motors arrangements are also made so that they can be secured either to the floor or to the wall. In order to convince us of the large number of motors which have been supplied, the firm issue a list of the leading newspapers in the kingdom which use their system of electric motors and their control. About 35 newspapers are mentioned, from which we gather that the system must be eminently successful.

Digitized by Google

We have also received from Messrs. OFFORD and JEVONS a list of their patent time swithes, which are intended for use in arc lighting and on incandescent circuits when the lights have to be extinguished at certain predetermined times. The arrangements of the switch are such that the lights can also be switched on when required, and the whole of these operations are conducted with only one working dial. The apparatus used is a combination of an eight-day clock with mercury surfaces. The apparatus is contained in cast-iron cases, which protects it from damage, and is supplied in four different types. The operations of each of these is as follows: A, to switch on, or to switch off, only, either at fixed or variable hours; C, to switch on and off at fixed or variable hours; E, to switch on and off at variable hours, and to change over intermediately from arc to incandescent, or from full to partial light at a fixed hour; G, to switch on, change over, and switch off, all at variable hours. All the above are for circuits up to 250 volts, with specially insulated types, B, D, F, and H respectively, for use on circuits to 500 volts. As an example of the extended use that can be made of this apparatus, the firm state that the apparatus for switching "on" is suitable for making sub-circuits for lights or motors at a required (variable) moment where the mains are controlled from a centre, and the resetting done by hand; and "off" for breaking a circuit, such as for public arc or incandescent lights at daybreak; for shop window-lighting after closing hours; for burglar-proof lights to extinguish at daybreak; for public conveniences; for advertising signs; for changing over "station load" to battery sub-station without necessity for full capacity leads; for disconnecting a battery left on charge in a circuit at night-time; for cutting off current from electro-plating vats at a pre-determined moment; and for various motor-stopping requirements. The inverse operation of breaking or making respectively to be effected by ordinary means. The prices of the apparatus are reasonable, but we think objection may be taken to the use of the mercury contact switch.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

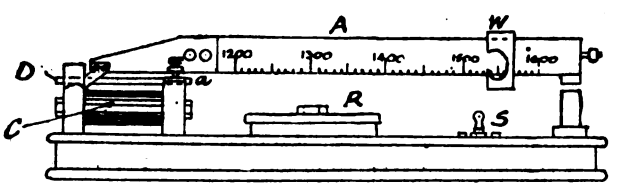
335. Explain how a shunt-wound exciter can reverse itself whilst exciting the field of an alternator. State probable causes. The alternator has claw type revolving field, and was working at light load.—E. P.

336. On switching on a motor to a single-phase alternating circuit, the volts appear to drop quite out of proportion to the increase in load. Why?—P. A.

ANSWERS.

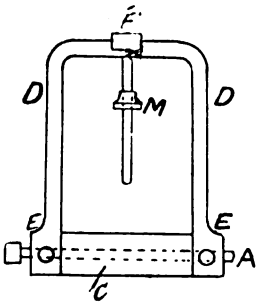
Question No. 329.—Describe and explain what you consider the best workshop method of determining the values of B and H, and for plotting B and H curves of wrought iron and steel.

Answer to No. 329 (*awarded 7s. 6d.*).—For workshop use it is only generally needful to test the permeability of different samples of wrought iron and steel with a known value of H, and the best method to do this is by using Prof. Ewing's magnetic balance. The balance consists of a graduated beam, A, pivoted at *a*, which is divided up into divisions for B, reading from 1,200 to 1,600, a sliding weight, W, for adjusting. Under one end of the beam is an electromagnet, C, which is excited by a current which gives exactly 20 C.G.S. units of magnetising force. One pole of this magnet is rounded, the other pole having a V-shaped notch cut into it. On this magnet rests the piece of iron or steel to be tested, D. This rod passes through the end of the beam, and must be turned ¼in. diameter and 4in. long. When the beam pulls the iron rod away from the rounded pole of the magnet, the other end of the rod remains in the V-shaped notch, forming what is called a magnetic hinge. R is a regulating resistance; S is a reversing switch to get rid of any residual magnetism before a test is made. A small storage battery is also



required. To measure the permeability of a sample of wrought iron or steel, the balance is first set by the standard rod which is supplied with the instrument, the current being adjusted until the tractive force corresponds to the known value of B which a force of 20 C.G.S. units produces in the standard. Remove standard and substitute sample to be tested; adjust sliding weight, W, until the beam just drops, and the value of B with a known value of H can be directly read off the graduated scale. This is a good practical method, as it has been found that if a sample is good or bad at this force it covers the whole range. The standard rod serves as an ampere-meter, and no other instruments are required.

For a practical method of determining B with different values of H, we are also indebted to Prof. Ewing, whose permeability bridge meets all the requirements. This is a method of determining the B H curve by comparison with a standard rod, whose B H curve has been previously determined by the ballistic method. The main principles of this instrument are shown in the sketch, where A is one bar



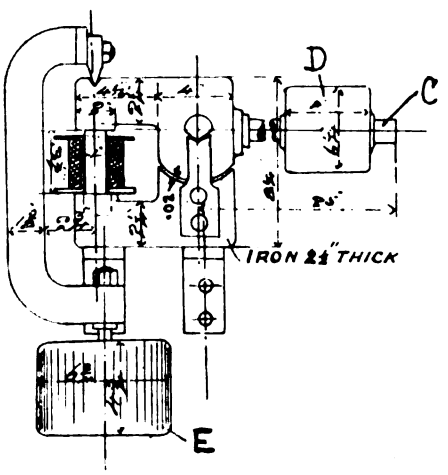
whose B H curve is known. The bar to be tested is parallel to the bar, but is not shown in the elevation. These bars must be 12·56cm. (4 π) long. These are slipped into two parallel magnetising coils, C. The ends of the rods are joined by two yokes, E E, are held tightly in position by means of set screws; from these yokes project two long iron arms, D D, which nearly meet; in the gap is a box containing a magnetic needle, F; M is a controlling magnet. The magnetic needle serves as a detector to show when the yokes are at the same magnetic potential. Such a condition will only exist when the magnetic induction in the two rods is the same. In that case the magnetic circuit will be complete in itself; the lines that got from right to left in one bar will return from left to right along the other. If the rods have the same permeability, this state of balance will be produced with equal ampere-turns for each rod; if not, balance can only be obtained by altering relative number of ampere-turns. To do this, the number of ampere-turns in the magnetising coil of sample rod is altered by means of switches, while the same current passes through both coils. To prevent the current altering while the adjustment is being made, the switches are furnished with a second set of contacts, which throw in compensating resistances as the number of magnetising coils is reduced, so that the total resistance of the circuit is unchanged. The number of turns in the magnetising coil of the standard is 100, hence the magnetising force due to this coil with a current of one ampere equals 10 C.G.S. units, so that any desired magnetising force may be supplied by means of an ampere-meter and adjustable resistance.

The number of turns on the sample bar may be increased to 210 by means of a switch provided on the instrument as before. The relation B to H is known for the standard bar, we know the current which is enough to show at

Digitized by Google

what value of the induction, B, the comparison is being made, and B is, of course, the same for both rods when the condition of balance is produced. The number of turns on the other rod gives by its ratio to 100 the ratio of magnetising force for that rod to known force applied to standard rod; hence a point in the B H curve of the rod under test is determined, and by changing the current as many points as may be wished may be obtained, from which the curve may be plotted. In cases where rod to be tested is much inferior to the standard, a switch is provided for reducing the turns on the standard rod to 50, when H becomes 5 C.G.S. units instead of 10 G.C.S. units per ampere.—W. A. J.

Answer to No. 329 (*awarded* 7*s.* 6*d.*).—There is in use at the works of Messrs. E. Scott and Mountain, Limited, Newcastle-on-Tyne, an apparatus for measuring the permeability of iron and steel used in dynamo magnets, which has given very reliable and accurate results as tested by measurements made on the actual machines from the magnets of which the test samples were cut. It is built substantially on the lines of the apparatus described in Chapter IV. of "Continuous-Current Dynamos" by J. Fisher-Hinnen, but different in a few details. It is liable to no serious errors due to external magnetic fields, is direct reading, easily calibrated, and easily used and understood. It requires only about 20 minutes to make a complete series of measurements necessary to plot the B and H curve of a sample of iron right up to the highest values of B used in ordinary dynamo work. The samples used are only 1in. in diameter and 3½in. long. A point is left on the side of a magnet casting, from which three or four of these samples are cut and turned to the above dimensions. An average of the readings from each is taken and the curve plotted from these. The dimensions of the appa-



ratus are given on the sketch. The weight of D is 14¾lb., and the weight of the balance weight, together with its suspending arm, is 49¼lb. The apparatus is constructed in accordance with the law of magnetic traction, which, stated briefly, is that a magnet of cross-section A square inches, magnetised to a density of B lines per square inch, can develop a pull of $\cdot 0000000133 \times B^2 A$. The scale on C is calibrated by hanging known weights on E and marking the position of D when balance is obtained. The arm, C, can thus be engraved to read lines per square inch directly. A second scale is engraved on C for the higher values of B. This scale is used when the weight, E, is lifted off, thus enabling the higher values of B to be measured with a shorter arm than would otherwise be possible. With the apparatus of dimensions shown in the sketch, values of B from 30,000 to 100,000 lines per square inch are read on one scale and from 80,000 to 120,000 on the other. A correction worked out for the apparatus as shown gives a number of ampere-turns per inch to be subtracted from the observed number equal to $\cdot 00012\ B''$. The ammeter used to measure the current in the magnetising coil is graduated in ampere-turns per inch length directly. In using the apparatus the weight, D, is set to a point on the scale of C, and the current gradually decreased, by means of a carbon rheostat in circuit with the coil, till the yoke breaks away from the sample. It is found to be quite impossible to get accurate readings by keeping the current constant and shifting weight D, as the disturbance caused by moving D makes the readings very inconsistent. The curves obtained from this apparatus have proved quite accurate enough for ordinary dynamo designers' requirements, and the rapidity with which they can be obtained makes it a very useful workshop method of obtaining B and H curves.—J. L.

Answer to No. 329 (*awarded* 5*s.*).—Undoubtedly the best workshop method of determining the figures for a B and H curve is by a permeametre (as designed by Prof. Silvanus P. Thompson). Fig. 1 shows the construction of this instrument. A is a block of soft iron, the centre of which is cut away and a hole about ⅞in. diameter bored through upper part; through this hole is fitted a brass tube, on which is wound a coil of wire which is connected to a battery through an ammeter and variable resistance. The iron to be tested should be turned circular and fit the brass tube.

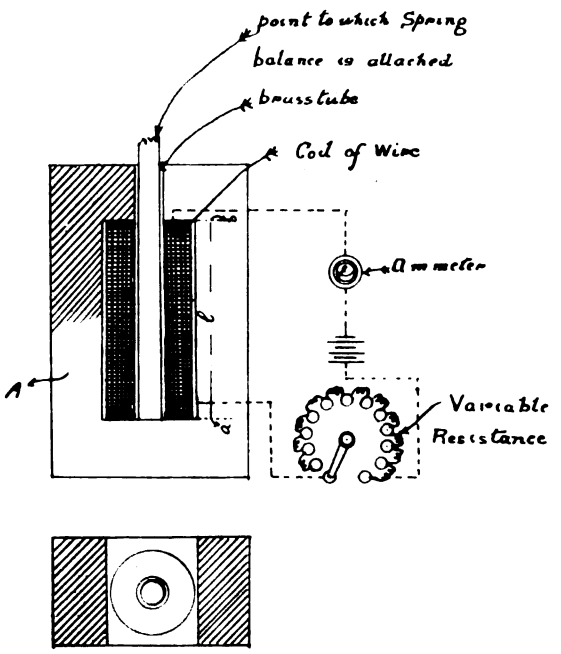


FIG. 1.

One end of the rod is attached to an ordinary spring balance, and the other rests against the inner part of iron frame. This end of the iron should be very carefully faced, as also should that part of iron frame with which it makes contact. The method of taking the readings is as follows: Lay the permeametre on its side so that the iron rod occupies a horizontal position, switch on the current, pull steadily on the spring balance till the rod breaks away from the iron frame. Note pull required. Take these readings with varying strengths of current, and we get a series of values for B of the iron rod, thus—

$$B = 1{,}317\sqrt{\frac{P}{A}}.$$

P = pull in pounds;
A = sectional area of iron rod in square inches

$$H = \frac{4\ \pi\ T\ C}{10\ \ l}.$$

l = length of iron rod between points a and b;
C = current in amperes;
T = number of turns in coil.

This is a very quick method of determining the values of B and H, and quite accurate enough for commercial purposes.

Another method, due to Fisher-Hinnen, and described in his book on "Continuous-Current Dynamos," is admirably adapted for the workshop; it possesses one slight disadvantage compared to the first method described—*i.e.*, it has to be graded. The principle of the instrument will be apparent from Fig. 2. A represents piece of iron to be tested, round which is wound a coil of wire; the ends of the test piece require very careful planing. The arched pieces, C D, are made of much larger section than the test piece, and rest on two knife-edges. The purpose of piece marked E, and weight F, is to maintain equilibrium whilst the lever, G, is adjusted, in order to use instrument

Digitized by Google

while F is fixed at a certain value of B. Then the current in the coil is reduced until armature of magnet is just released, or the exciting current may be kept constant, and

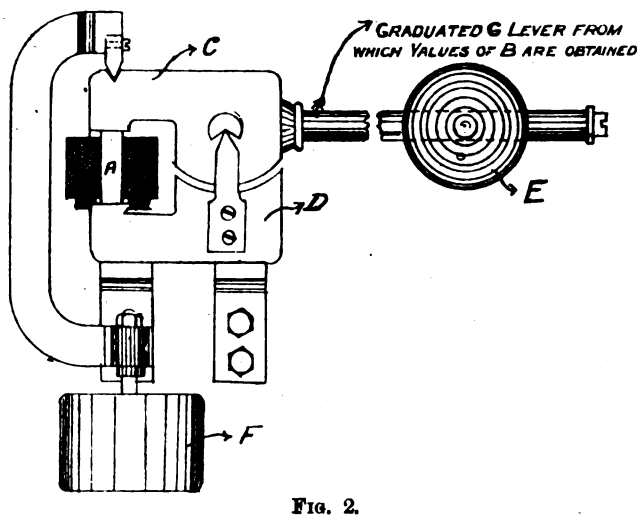


FIG. 2.

position of weight altered till the armature is released. The value of H is determined in the same manner as before described.—R. F. W.

Question No. 330.—When feeding boilers with very soft feed water, in which there is a good deal of peat acid, what kind of feed pipes would you recommend (1) taking the outlay into consideration, (2) disregarding outlay altogether?

Best Answer to No. 330 *(awarded* 10*s.)*.—The enquirer's experience with peat water must be somewhat unusual, as the writer has generally found that the water collected from a peat district is of a very satisfactory character for the purpose of feeding boilers, and is mostly free from both hardness and acidity. A notable example of this is the water from Loch Katrine, which is supplied from a peat district, and is considered to be probably the best feed water in this country. The scientific mode of procedure for dealing with boiler feed water suspected of containing deleterious matter is, first to have it analysed quantatively, and the amount of objectionable matter per gallon of water ascertained. Then, either in the feed tank or in a separate tank, and before admission into the feed tank, a substance should be introduced which will neutralise the objectionable constituent. The most general disadvantages met with in feed waters are due to hardness, arising from the presence of lime in suspension, or acidity. The hardness is usually eliminated by treating the water with lime, and the acidity by treating it with common soda. The water in question should be treated before admission to the boilers with the latter substance, and in a sufficient quantity to destroy its acidity, in which case the feed pipes could be of the ordinary material and construction, and no additional outlay would be incurred through them. It may in this or ome special case, however, occur that there is not sufficient available space adjoining the boiler plant to admit of the necessary settling tanks being put down for efficiently treating the water prior to its admission. The acidulated water would, therefore, have to be admitted through the feed pipes to the boilers and treated in the boilers to destroy the acidity; consequently the pipes would be subjected to the corrosive action of the acid, and if there is no question of outlay the best course would be to have the pipes made of copper, as this material is capable of resisting the corrosive action of acid.—E. T. J.*

Answer to No. 330 *(awarded* 5*s.)*.—When feeding boilers with soft feed water containing peat acid, the pipes through which the cold water is pumped are inclined to get choked up with a sort of growth something after the nature of green slime that one sees on stagnant ponds. To minimise this trouble I should, in the first case, where first cost is an important consideration, advise extra large feed pipes of cast or wrought iron with cleaning-out apertures arranged so that the pipes could be cleaned out periodically. In the second case, disregarding outlay altogether, I should recommend steel pipes lined with lead, as this growth will not adhere to this latter metal.—W. J. C.*

COMPANIES' MEETINGS AND REPORTS.

NERNST ELECTRIC LIGHT.

The first ordinary general meeting of the shareholders of Nernst Electric Light, Limited, was held on Wednesday last at the Westminster Palace Hotel, S.W., Sir Henry C. Mance presiding.

The **Secretary** (Mr. G. Opitz) read the notice convening the meeting, and also a notice from Mr. Zusman, one of the directors, in which he stated that he would move resolutions requiring the directors to invite the managing director to resign his office as such, to resign his office as director of the Company, and to allow Mr. Zusman to have unrestricted access at all reasonable times to the books, papers, and documents of the Company.

The **Chairman** expressed the pleasure it gave them to see Prof. Nernst with them again, and offered congratulations to him on his having been awarded the grand prix at the Paris Exhibition. He proceeded to review the balance-sheet. It must be remembered that the accounts covered a period of 19 months. At the statutory meeting of the Company, Mr. J. Swinburne had advised them not to rush the lamps on to the market, but predicted that after careful experiments to determine the best commercial form lamps should be ready for sale by this autumn. But for the fire his predictions would have been realised, and in spite of that the lamps had now reached a commercial state. He did not think the time taken to reach this stage was long considering the importance of the work to be done, and their business might have been much damaged if the lamps had been issued in a crude form, and hence had been likely to bring discredit on them. In perfecting the lamp they had not been behind the other holders of licenses. Thus Mr. Westinghouse, the General Electric Company of Berlin, and Messrs. Ganz and Co., of Budapest, had the control of these patents 12 months before they had. Messrs. Ganz say they would not be prepared to issue lamps before April or May next, and Mr. Westinghouse had refused to discuss the prices to be charged for lamps because he had not any ready for sale. The Berlin company had only just begun to rent lamps to the public. He was firmly convinced of the value of the lamps, even of the type which required preliminary heating by a spirit lamp or match. He had used these lamps in his private house, and found that on an average they lasted over 500 hours. Their own technical advisers, however, believed that it was essential to make the lamps automatic, and hence had devoted their energies to perfecting the lamps exhibited at the offices of the Company that day. They proposed to sell their lamps outright, and it might interest those present to know that the extent of lighting in the various countries they could supply appeared from report to be this: that there were 38,000 arc lamps and 5,000,000 incandescent lamps now in use. They had obtained 47 patents in various parts of the world, and applications for 14 other patents were still pending. He then referred to the good work done by their managing director, Mr. Drake, in organising their various departments, and to the disputes which had arisen between him and Mr. Zusman. He (the chairman) took the responsibility of refusing Mr. Zusman access to the books, because they were bound to exercise great secrecy over the details of the lamps. He also objected to one director interfering with the staff as likely to break discipline. At the time the objections were made, however, Mr. Zusman was informed that he could obtain copies of what he wanted after consulting the Board. At the next Board meeting Mr. Zusman submitted a protest, declaring that the past conduct of the Company had been opposed to its interests, and had been a policy of inanition, and that the managing director had been guilty of neglect and mismanagement, and had subordinated some of the best interests of the Company to those of another company. Turning to the question of a factory, they hoped to secure the English patents and thus be allowed to manufacture in this country, when they could supervise the work better than if the factory were abroad. Their right to the royalty on lamps sold in England should help them in coming to some such arrangements when the English company was established. If the directors were to leave the Company that day they would leave a valuable asset. By not establishing factories before they were actually required, and by not sending out agents prematurely to advertise an invention which spoke for itself and required no advance advertisements, they had saved the Company considerable sums. He begged to moved the adoption of the report.

Mr. Bernard Drake seconded the motion, and gave a *résumé* of the state of the technical work of the Company when it was formed by Mr. Zusman, the promoter. The lamps then shown were of large candle-power only. From these they had developed the 16-c.p. lamps exhibited at their offices that day. The time spent in so doing was well spent as it prevented them issuing lamps before they were in the best possible form, and they had now standardised what they believed would be a most successful lamp. Many difficulties had been surmounted in the process of development, such as the undue heating of the metallic connections to the glower, the heating of the holders, etc. Mr. Zusman had stated that he would bring charges against the speaker, but he had not adopted the gentlemanly method that might have been expected from him of disclosing the details beforehand, so that he (the speaker) might have had an opportunity of looking up the supposed facts. He did not therefore propose to refer to the matter until Mr. Zusman and the supporters he had recently qualified with shares had finished their attacks. When the attack was first made he had placed his resignation as managing director in the hands of his colleagues, but they had refused to accept it.

Digitized by Google

Mr. Ben Zusman then read his charges, which took over an hour. He declared his opinion that the past conduct of the undertaking by Mr. B. M. Drake had been opposed to its true interests, and that its future was foredoomed to failure if he was permitted to retain any longer the position he now occupied as managing director, or if he was allowed to remain a director at all. The detail charges related to infrequent attendance at the offices of the Company, preferential placing of contracts for materials, and undue favour shown to the Electric Resistance and Heating Company. The heaters owned by this latter company had been discovered in the Nernst Lamp Company's laboratories, and it was agreed that this latter Company should get all the heaters they required at cost price. Mr. Drake afterwards wrote a letter in which it was suggested that the preferential rate should be 15 per cent less than to other people. This letter was stopped by the chairman. Finally, Mr. Zusman said his last charge was that Mr. Drake's overbearing manners and absence of tact were continually making enemies. He had dispensed with the services of the only people who knew how to make a practicable lamp, and had brought about the resignation of Prof. Nernst as technical adviser. He had entrusted the Company's orders to incompetent contractors at 60 per cent. higher than could be obtained from competent firms elsewhere, and had placed orders of the Company with a view of benefiting another undertaking. He concluded by moving an amendment that the report should be received but not adopted.

Mr. August Cohn seconded the motion, as one who was responsible for a great proportion of the preferred shares, and expressed the opinion that if Mr. Drake remained manager of the concern they would never get a dividend He added that the fees of the directors were quite out of proportion to the position of the Company.

Mr. Ronald Power considered there was a very strong *primâ facie* case for Mr. Zusman's action, and he thought the shareholders ought to insist on the enforcement of an intelligent commercial policy. He challenged the directors to show that any practical step had been taken to establish foreign agencies in countries where they were entitled to sell these inventions.

An animated discussion followed, and a desire was expressed that Mr. Drake should be given an opportunity to reply to the charges that had been made against him.

The **Chairman** pointed out that the charges had been carefully prepared, and many of them he had never heard before. The meeting could hardly expect Mr Drake to give the necessary explanations now. Mr. Zusman had been many weeks preparing these charges, and it was not fair to ask any man to answer them at a moment's notice.

After further discussion, it was decided to adjourn the meeting for a month, and the proceedings, which had lasted for three hours, concluded.

MARCONI'S WIRELESS TELEGRAPH.

On Tuesday Major Samuel Flood Page, managing director, presided at the fourth ordinary general meeting of the Company, held at the offices in Finch lane, E.C.

In moving the adoption of the report and accounts (which we published in our last issue), the **Chairman** said the accounts covered a period of 13 months, as the directors had decided to change the date of the financial year from Aug. 31 to Sept. 30. The only change with regard to the capital was that £1,000 more ad been issued and that was part of the money included in the note which stated that of the unissued shares 12,500 were subject to the option reserved by an agreement of Aug. 30, 1900. That transaction had been closed, and the Company had received £37,500, but only £1,076 came into the present accounts. After dealing with the other items in the accounts, the Chairman referred to the German patents. Everybody who had a German patent thought he had got something of great value, and this was especially the case on the Continent. About 12 months ago it looked as if the Company was manifestly in difficulties with the German Patent Office. Dr. Fleming and he, however, went to Germany and demonstrated to the complete satisfaction of the German officials that the portions of Marconi's apparatus which they had regarded as anticipated were of no use at all to wireless telegraphy. The result was that the Company got the German patents, which were received a few days ago, accompanied by a letter from the patent agent stating that he thought the Company's further applications for patents stood a good chance indeed of being granted. The Chairman went on to state that the Board of Trade committee appointed to consider the question of introducing the German and United States system of granting patents into England had no intention whatever of making such an introduction into this country. There was no more improper power than to give paid officials the authority to reject applications for patents. Referring to the arrangement by which this Company received £100,000 fully paid shares from the International Marine Communication Company, the Chairman said it would be most disappointing to him if he or his predecessor had not some day to congratulate the shareholders of the Wireless Telegraph Company upon the great value of those shares. This was the first time they had had a profit and loss account, and this clearly showed they were actually earning money. Referring to the large sum of £5,926 for salaries and directors' remuneration, he must remind them that it was absolutely necessary that they should keep an educated technical staff in order to carry out the work and experiments, upon the success of which the fortunes of the Company very materially depended. After considerable experience of the Company, he might say that the expenditure was most moderate, and without it they could not have attained the position they now held of being prepared to undertake almost any work placed in their hands. Several members of the Belgian Cabinet were greatly interested in wireless telegraphy, and he thought their action in supporting this Company in its efforts to demonstrate the value of the invention would be the means of influencing other governments. The chief business of the year was undoubtedly the fact that they had completed the whole of the 32 sets of apparatus for her Majesty's navy. The captain of H.M.S. "Vernon" had been good enough to forward the directors a letter expressing satisfaction with the system, and with the rapidity with which it had been completed. The ships now fitted with the apparatus were moving certificates of Marconi's wireless telegraphy. He had not the slightest doubt that before long commercial companies would follow the example set by her Majesty's Government. With regard to the works at Chelmsford, they could now turn out all the apparatus required during the next 12 months. By the end of January next he hoped they would be able to prove to the Admiralty the value of the new patents, and it was his firm conviction that the business of the Company was certain to extend, and to become one of the greatest instances of the application of science to industry.

Mr. W. W. Goodbody having seconded the motion, the report was unanimously adopted without discussion.

The retiring directors, Mr Guglielmo Marconi and Mr. John Mooney, were unanimously re elected.

An extraordinary general meeting was then held for the purpose of moving a resolution that the directorate be increased from seven to ten. The **Chairman** said they wanted gentlemen who had influence with the Government, and therefore it was proposed to elect Mr. Henniker Heaton, M.P., Sir Charles Euan-Smith, and Mr. Albert Ochs to the Board.

Mr. J. F. Bannatyne seconded the resolution, which was carried unanimously.

A vote of thanks to the chairman concluded the proceedings.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

An ordinary general meeting of this Company was held this week at the Cannon-street Hotel under the presidency of the **Hon. Henry Marsham**, who said that on the present occasion the accounts were for a full period of 12 calendar months. The accounts would, he thought, be considered satisfactory. They could certainly not have come before the shareholders under such favourable conditions had they not, to meet the high price of raw material, taken the unpopular step of raising the selling price of their goods. Their customers had tacitly acknowledged the necessity of the Company's doing so by the continued support they had given it. The directors intended returning to more reasonable selling prices at the earliest opportunity. The price of indiarubber showed signs of falling; the price of guttapercha, however, maintained its high standard, and they did not anticipate lower values in that product. With regard to the Pacific cable, though they had not yet received any official reply to their tender, they must consider the matter closed so far as they were concerned. They must not, however, be despondent. The laying the Pacific cable would supply an important Imperial want, and, as especially affecting that Company, would widen the market of British cable manufacturers. He moved "that the report and accounts for the financial year ended Sept. 30 last be received and adopted, and that a dividend of 15s. per share, free of income tax, payable on the 14th inst., be now declared."

The motion was carried unanimously.

ELECTRIC RESISTANCE AND HEATING.

At the first ordinary general meeting of this Company, held at Winchester House on Tuesday last, the **Chairman** (Mr. Cyril Wanklyn), commenting upon the first annual report, said there was still some hope that their process had a future before it. The one feature of the Company's business upon which they could look with unalloyed satisfaction was that the material patent of the Company had been granted in all the countries enumerated in the prospectus except Germany, Denmark, Norway, and Russia, but though they had been unable to obtain the material patent, they had obtained a large number of apparatus patents. A great deal of work, trouble, and anxiety had been entailed in the progress of their endeavour to prove the value of their process, and they had had to meet difficulties one by one. The failure of the Company to receive payment in full in respect of 8 550 shares, relied on as part of the working capital, was really a knock-down blow to the Board. More than a third of the working capital (£6,500) had never come into the coffers of the Company. The want of the capital left them at a point at which they were almost bound to prove what the process could do. If the subscriptions for the 8,550 shares were not received, there was only one course before them, and that was liquidation, with a view to reconstruction. If they could overcome two or three of the obstacles that had appeared in the details of the manufacture, he believed there was a very good future before the Company. He moved the adoption of the report and accounts.

Captain Bax seconded the motion.

In reply to Mr. Guldalla, the **Chairman** said the vendors received from the Company £32,500 in cash and £62,500 in shares.

The report and accounts were adopted, and the chairman and Lieut.-Colonel W. T. Ellis were re-elected auditors.

Digitized by Google

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The annual meeting of the Douglas Southern Electric Tramways, Limited, was held on Tuesday at Manchester, under the chairmanship of Mr. T. J. Hutchinson. The report showed a profit on the year's working of £1,617. 14s. 9d.

The **Chairman** said efforts were being made to bring their line into more immediate touch with Douglas town, and they were hoping to make such arrangements with the Douglas Corporation as would be for the good of the people of Douglas. They regretted there was no dividend for the ordinary shareholders, but 6 per cent. was being paid to the preference shareholders, and if that were divided equally between the whole of the shareholders it would amount to nearly 4 per cent. all round. The Company was solvent, and the shares were likely to improve in value.

The report was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Asuncion (Paraguay).—The Municipality invite tenders for the installation of the electric light in the town. Tenders by Jan. 15, 1901.

Southampton.—The Tramways Committee have instructed the town clerk to arrange for tenders to be obtained for six additional cars.

Ploesti (Roumania).—The Municipality invite tenders for the installation and working of an electric tramway for 30 years. Tenders by Jan. 3, 1901.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply and erection of storage batteries. Tenders by Dec. 22. Details in our advertisement columns.

Madrid.—The Department for Agriculture, etc., invite tenders for the installation and working for 60 years of an electric tramway from Insepets to Fogas and Boranova. Tenders by Jan. 7, 1901.

Hendon.—The Urban District Council invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by Dec. 31. Details in our advertisement columns.

Swindon.—The Corporation invite tenders for three high-speed triple-expansion steam dynamos, one balancer, and one motor-generator. Tenders by Dec. 24. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the extension (about 100 lamps) of the electric lighting installation at the City Chambers. Tenders by 31st inst. Details in our advertisement columns.

Farnworth.—The Urban District Council invite tenders for eight 66 passenger tramcar bodies, motors, undertrucks, controllers, etc. Tenders by Jan. 10. Details in our advertisement columns.

Harrogate.—The Corporation invite tenders for two high-pressure 30ft. by 8ft. 6in. Lancashire boilers, with fittings complete, and economiser. Tenders by Dec. 25. Details in our advertisement columns.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Brighton.—The Council invite tenders for the supply of unarmoured and armoured lead-covered electric cables during the year ended Dec. 31, 1901. Tenders by Dec. 24. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of steam dynamos, battery-charging motor, booster, and balancer. Tenders by Jan. 7. Details in our advertisement columns.

Ayr.—The Corporation invite tenders for the work required in forming permanent way, rail-laying, roadwork, etc., of about 5¾ miles of electric tramways. Tenders by Dec. 28. Details in our advertisement columns.

Middleton.—The Corporation invite tenders for superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves, and accessories. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Rathmines.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 10, 1901. Details in our advertisement columns.

Kertch.—The Municipality invite tenders for the installation and working of an electric tramway. Particulars may be obtained from the Manager, Bank of Commerce of Azoff Don, at Kertch, Russia. The town has a population of 50,000.

Bradford.—The Corporation invite tenders for the erection of an electric tramcar shed at Duckworth-lane, Manningham. Drawings, etc., may be seen at the office of the City Architect's Department, Chapel-lane. Tenders by Dec. 24.

Worthing.—The Corporation invite tenders for the supply and erection of a main switchboard. Specifications, etc., can be obtained from Messrs. Burstall and Monkhouse, 14, Old Queen street, Westminster, S.W. Tenders by Dec. 31.

Belfast.—The Harbour Commissioners invite tenders for 10 tramway trucks, each capable of carrying a weight of 10 tons on a 3ft. gauge. Further information may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by Jan. 7.

Tooting.—The Metropolitan Asylums Board invite tenders for the execution of certain wiring and other works in connection with the proposed electric light installation at the asylum now in course of erection at Tooting Bec. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of tramway bonds. Specifications, etc., may be obtained on application to Mr. J. M. M'Elroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by Dec. 22. Details in our advertisement columns.

Thetford (Norfolk).—The Town Council invite tenders for supplying the wiring and fittings necessary for the electric lighting of the new town hall according to plan and specifications, which can be seen at the office of Mr. John Houchen, town clerk, London-road, Thetford. Tenders by Jan. 1, 1901.

Leeds.—The Lighting Committee invite tenders for electric lighting plant as follows: (Section A) two sets, each comprising engine of 2,000 b.h.p., two-phase alternator of 1,400 kw. capacity, and exciter; (B) two sets of surface-condensing plant. Specifications, etc., may be obtained from Mr. Harold Dickinson, manager of the department, 1, Whitehall-road, Leeds. Tenders by Dec. 31.

Manchester. — The Manchester Ship Canal Warehousing Company, Limited, invite tenders for the supply, delivery, and erection of 22 electric jib cranes required for work at the new transit shed, No. 8 dock, Manchester. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the company, 41, Spring-gardens, Manchester. Tenders by Jan. 4.

Winwick (near Warrington, Lancs.)—The Committee of Visitors for the County Asylum invite tenders for (Contract No. 3) wiring, etc., including ring main and feeders, sub-main, lamp circuits, switchboards, distribution boards, fittings, etc. The drawings, etc. can be inspected at Winwick Hall, and also at the offices of the architects, Messrs. Crisp and Oakley and W. S. Skinner, Edinburgh-chambers, Baldwin-street, Bristol. Tenders by Dec. 29.

Worthing.—The Electric Lighting Committee invite offers from any person, firm, or company willing to instal, equip, and maintain a system of electric tramways in the borough, with power to the Corporation to acquire the same at any specific date upon agreed terms, such offers to specify the price to be paid for current to be supplied from the central station of the Corporation electric lighting works. Tenders by Dec. 31. Details in our advertisement columns.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul-General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by Jan. 2, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in Tettenhall-road, New Hampton-road, Waterloo-road, Darlington-street, Queen-square, Lichfield-street, Fiveways, Piper's-row, Bilston street, Cleveland-road, and Bilston-road to the borough boundary, amounting to a route length of about 4½ miles, mainly double track. General conditions, etc., may be seen at the office of Mr. J. W. Bradley, M.I.M.E., borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Jan. 15.

RESULTS OF TENDERS.

Stockport.—A contract has been entered into with Dick, Kerr, and Co., London and Preston, for 20 double-deck cars.

Ilford.—The Council have accepted the tender of H. and G. Measures, Croydon, at £1. 10s. each, for lamp columns.

Bristol.—The tenders of Higginbottom and Mannock and of Ferranti, Limited, for switchboards have been accepted.

Bolton.—The Tramways Committee have accepted the tender of Mr. J. W. Witter for heating carsheds at Shiffnall-street.

Maidstone.—The Electric Lighting Committee have accepted the tender of Cole, Marchent, and Morley, Limited, at £1,209, for surface condenser and feed-pumps (Section C).

Burton.—The Corporation have accepted the tender of Geipel and Lange, Victoria-street, Westminster, for the supply of a 400 kw. alternator engine and condensing plant, at £3,335.

Heywood.—The Council have accepted the tender of W. J. Fryer and Co., Limited, London, for wiring premises in Heywood, in accordance with the wiring regulations adopted by the Council.

Portsmouth.—The Corporation have accepted the tender of Macartney, McElroy, and Co., London, at £18,280, for the overhead electrical equipment of tramways in the borough of Portsmouth, and extending to Cosham, Hants.

London County Council.—The Council have accepted the offer of Macfarlane and Co. to erect in position, at £178. 10s. 6d., the lamp standards now being manufactured by them under contract for the electric light installation for the Victoria-embankment and Westminster Bridge.

Digitized by Google

Southampton.—The Council have accepted the following tenders: Westinghouse Company, for supplying equipments for six more cars at £253. 13s. per car, being the same price as paid before; Milnes and Co., for supplying bodies for six additional cars at £290 each, being an increase of £43 on the price previously paid.

Portsmouth.—The Corporation have accepted the tender of Dick, Kerr, and Co., London and Edinburgh, at £202,409. 6s. 4d., for the permanent-way construction and underground feeders in connection with the equipment for electric traction of the tramways in the borough of Portsmouth, and extending to Cosham, Hants.

Bermondsey.—The following tenders for the supply and erection of cast-iron lamp columns, arc and incandescent lamps, switchings, and fittings have been submitted to the Electric Lighting Committee: Messrs. Oliver and Co., Plumstead, £2,848. 10s. 3d.; Johnson and Phillips, Old Charlton, £2,842. 8s. 9d.; Verity's, Covent Garden, £2,845; Crompton and Co., Mansion House-buildings, £2 595; Haydn, Harris, and Co., 11, Victoria-street, S.W., £3,292; Brockie-Pell Arc Lamp Company, £3,718.

Dartford.—The Urban District Council have received the following tenders for the erection of an electric light station at Dartford:

T. Martin, Dartford	£8,043
Leslie and Co., Kensington-square, W.	6 537
J. Lonsdale, Swanley Junction	5,935
Perry Bros., Cambridge Heath, N.E.	5,807
J. Smith and Sons, Norwood, S E.	5,619
H. Somerford and Son, Clapham, S.W. (accepted)	4 906

Brighton.—Eleven tenders have been received for the construction of tramroads and laying down wood paving in certain streets of the borough. The tenders are in two sections—viz.: (A) for the construction of the tramways and the laying of wood paving on the tracks with Jarrah wood, except where soft wood is necessary; (B) for the laying of wood paving on each side of certain of the tramway tracks. The tenders range in Section A from £68,217 to £87,013. 7s. 5d., and in Section B from £20,224 to £40,038, the quotations in the latter section varying according to the description of the wood. The totals for the two sections vary from £102,487. 14s. 5d. to £121,327. 3s. 5d. At last night's meeting of the Town Council it was recommended to accept the tender of Messrs. Macartney, McElroy, and Co., Limited, of Glasgow, to construct the permanent way of the tramways, including the paving of the tracks with Jarrah wood, except where soft wood is necessary (Section A), and to construct wood-paved carriageways on each side of, but excluding the tramway tracks, of Jarrah wood (Section B), in accordance with the specification prepared by the borough engineer and surveyor and the tramways engineer, the wood to be the quality of the sample submitted, the whole of the work to be completed on or before Aug. 31, 1901, for the sum of £102,487. 14s. 5d.

BUSINESS NOTES.

TRACTION.

Colchester.—The Town Council have sealed their application for a tramways provisional order.

Wolverhampton.—The Tramway Committee have decided that the space outside the tramway lines should be macadam or granite setts.

Newcastle.—The Corporation are negotiating with the Walker Council to run a tram service through Wallsend and Willington Quay districts.

Smethwick.—The Corporation have now agreed to grant a lease to the British Electric Traction Company of the tramways within the borough for 21 years.

Huddersfield.—Early in January a portion of the tramway service will be run by electric traction. The question of the Sunday running of cars will be considered shortly.

Esher.—The Urban District Council have declined to assent to the London United Tramways Company's application with regard to the proposed tramways so far as they might lie within the jurisdiction of the Council.

Ayr.—The Town Council have agreed to borrow £50,000 for electric tramways from the Prudential Assurance Company at 3½ per cent., the loan being repayable, principal and interest, in 80 equal half-yearly instalments of £1,166.

Glasgow.—The Corporation have passed a provisional order under which power is sought to make 10 extensions of the tramways, including lines to Renfrew, Govan, Rutherglen, and Cambuslang, the total distance being about 12 miles.

Keighley.—The Town Council at their last meeting discussed the question of purchasing the Keighley Tramway Company's lease. The line itself has for some time been the property of the Corporation. No public announcement was made of the result.

Sheffield.—The Tramways Committee have reported a profit of £12,562 for the half-year ended Sept. 29, of which £7,802 has been placed to reserve, leaving £4,760 to be placed to the accumulated net surplus. The profits since the Corporation took over the tramways shows a total of £64,000.

Bournemouth.—At the monthly meeting of the Town Council it was announced that the Poole and District Electric Traction Company had accepted the Council's offer of widening the road at Bargates or pay the Council the cost, providing in either case the cost did not exceed £500 The matter was referred to the Roads Committee, the surveyor to submit plans.

Hyde.—The Town Council have formally passed a resolution authorising the Corporation of the borough to promote a Bill in Parliament, in conjunction with the Corporations of Stalybridge, Mossley, and Dukinfield, for authority to construct and work electric tramways and to supply energy in the boroughs named. The above resolution has been confirmed at a subsequent ratepayers' meeting.

Sedgley.—At the last meeting of the Urban District Council letters were read from the British Electric Traction Company, stating that that company were just as anxious as the Council for the work of the scheme for electric trams to be proceeded with, and no unnecessary delay would take place with the construction of the line. Directly circumstances would permit, the work would be proceeded with.

Waterloo-with-Seaforth.—The Urban District Council last week received a communication from the Liverpool Corporation Tramways with reference to the proposal to construct a tramway along Seaforth road, and also a memorial from property owners, ratepayers, and residents of Seaforth protesting against the proposal, the consideration of which was deferred until the manager of the company had been interviewed.

Willington Quay.—Mr. Mertz and Mr. McClelland, engineers of the tramways company, have explained to the District Council that the laying of the proposed lines which would branch out from Wallsend, one going by the high road and the other by the riverside, will not necessitate the alteration of any roads or levels. The tramways would run past the large works, and at Willington Quay would run through the principal street.

Bolton.—The Corporation have passed the statutory resolution in regard to their Bill, under which works estimated to cost £350,000 are to be constructed. Out of that sum borrowing powers to the amount of £215,000 are asked for the cost of the new tramways and reconstruction of existing lines, and for the electric equipment of the new tramways a further sum of £15,000, the borrowed moneys to be repaid in 30 years.

Douglas.—The committee of the Tynwald Court recently discussed the question of providing facilities for conveying passengers along Ramsay Pier. Mr. Shaw showed that by an electric overhead wire a motor with two trailers could be put upon the pier, the whole to cost £850. The committee decided to recommend that Mr. Shaw's scheme should be accepted if the structure of the pier would stand the strain, and the enquiry was adjourned to Wednesday next at Douglas.

Ashton-under-Lyne.—The Town Council have resolved that application be made to the Board of Trade, under the Tramways Act, 1870, for sanction to borrow £26,570 for the purposes of the Ashton-under-Lyne Corporation Tramways Order, 1900; also that the Council adopt a memorial to the Board of Trade praying for a provisional order authorising the Corporation to construct, maintain, and work certain tramways in the township, parish, and borough of Ashton-under-Lyne, and to order the corporate seal to be affixed thereto.

Halifax.—Mr. A. P. Trotter on the 17th inst. inspected the newly-completed tramway extensions from King Cross to Tuel-lane Top, on the Hebden Bridge route, and from Boothtown to Catherine Slack, on the Queensbury route. As a result the section to Tuel-lane was opened for half-hourly service on Tuesday. With regard to the Catherine Slack section, the inspector preferred that the line should be inspected by the Board of Trade's permanent-way inspector before being opened for traffic, and the latter will visit Halifax for that purpose to-day.

Chester.—The question of the Chester tramways, upon which a poll of the citizens is to be taken during the first week in January, was the principal subject of discussion at the meeting of the Town Council. There appears to be considerable misapprehension on the part of the ratepayers as to the scheme. The Mayor said the extreme limit of the cost of the scheme, presuming all the powers to be exercised in the most expensive way, would be £150,000; but no particular scheme had as yet been adopted. It was decided that a plain statement of the facts of the case be issued to the public.

Richmond.—The report of the Tramways Committee, which was approved by the Town Council at their last meeting, dealt with the tramways proposed by the London United Tramways Company, and concluded as follows: "The committee do not at the present moment deem it necessary or desirable to submit any definite recommendation to the Council, except that the consent asked for be not accorded. The Bill will be deposited on or before the 21st inst., and they will then be in a position to consider its provisions in detail and submit recommendations as to any steps to be taken thereon."

Bradford.—The formal opening of the new electric tramway from Four Lane Ends, Bradford, to Thornton took place on the 18th inst. At a luncheon held subsequently at the Great Northern Hotel, Thornton, the chairman of the Tramways Committee (Councillor James Hill) said he considered that the opening of the Stanningley and Thornton lines would be the means of putting thousands a year into the pockets of the Bradford Tramways Company. When, however, the Corporation took over the private enterprise, both lines would prove a success, and they would be able to run right through to the city for 3d.

York.—The Corporation have agreed to purchase the tramways on the following terms—viz.: the price of the tramlines, setts,

Digitized by Google

land, and buildings to be £12,000; the price for the cars and other rolling-stock, horses, harness, tools, and effects, hay and other consumable stores to be ascertained by valuation on completion of the purchase; the purchase to be completed at the expiration of two years; pending completion the company to work the tramways on its own behalf, and to be entitled to the profits, and the Council to maintain and keep in repair the tramrails and roads. The resolution further authorised application to the Board of Trade for their consent to the purchase.

Surbiton.—At a general meeting of the local ratepayers' association last week resolutions were passed asking the Council to call a meeting of ratepayers and electors to consider whether trams should or should not be admitted to the district, and to receive a deputation on the subject. The Council, however, have decided that no useful purpose would be served by receiving a deputation at the present time. The Council have sealed the tramway company's agreement, which, we are informed, is very favourable to the company, as the Council is, we understand, to have the option to purchase the undertaking in 25 years' time at a valuation.

Cleethorpes.—At the last meeting of the Urban District Council it was agreed to ask the tramways company to place before the Council without prejudice all the contracts entered into by them for the erection and equipment of the power station, and then the Council would come to an early decision as to whether they would proceed with their electricity scheme, and serve an unconditional notice on the company to sell the site of the station and the station and plant. It was also carried that a portion of Grimsby-road, having been open more than 21 days, as specified in Clause 3 of the agreement to the Act of 1899, the Council require it to be reinstated within seven days for traffic, failing which steps be taken to carry into effect the terms of the agreement.

Leicester.—The Tramways Sub-Committee in their report recommend the adoption of the overhead trolley system of electric traction, with a central electric traction power station, to be situate on land adjoining the Lero refuse destructor in Belgrave-gate; further, that the continuous direct current system of generating plant be adopted, and designs and tenders, when required, be obtained from electric traction firms for boilers, engines, generators, switchboards, and all other electrical and mechanical equipment on a specification prepared with the advice of the consulting engineer; also that, when required, designs and tenders for overhead equipment, feeder cables, etc., be obtained under similar conditions; and that parliamentary powers be sought which should include the reconstruction and extension of the present tramways and the construction of a number of new lines over routes, most of which are covered by the existing 'bus services. Altogether the total length of the routes will be about 20 miles.

Walsall.—The Tramways Committee have agreed upon the lines to be laid down in connection with the authorised extension. The cost of construction and electrical equipment is from Park-street, along Wolverhampton-road, roughly estimated at £10,000 a mile. The committee have approved of the draft lease to the South Staffordshire Tramways (Lessee) Company, Limited, of the tramway lines from the borough boundary on the Wednesbury and Darlaston roads to the Brown Lion Inn at the Pleck for 21 years, and from the Brown Lion Inn to Bloxwich and Mellish road for three years from Jan. 1 next, in accordance with the terms of the agreement, dated Nov. 23, 1899, and scheduled to the Walsall Corporation Act, 1900, and they have sealed the conveyance from the South Staffordshire Tramways Company to the Corporation of the tramway undertaking in the borough, and to an assignment of the tramway depôt at Birchills, and also to the said lease. Various resolutions have been adopted to the effect that the repairing and maintaining of the tramways be added to the borough surveyor's department, and that a ganger and three men and the requisite plant be secured, and that the various lines agreed upon be constructed.

Cardiff.—In consequence of Mr. Ellis's report, it has been agreed that Mr. Harpur, the borough engineer, who will lay the tramway track, will meet Mr. Glenn, the engineer of the tramway company, to see if they can arrange matters so that the company's tracks, which are the lines in the centre of the town, may be got ready for electric traction when the Corporation acquire the lines in January, 1902. Work was commenced on Monday on the section—Cathedral-road to the docks—at Cowbridge-road end of Cathedral-road by a gang of 50 men. The street on either side of the track will be laid with wood blocks, and between the two sets of rails a new kind of composite block will be laid as an experiment. Similar work will be commenced shortly in Castle-road. Mr. A. Ellis has advised the Tramways Committee that they would have to consider the question of cars, seeing that the makers were so full of orders that it would take nearly a year to deliver. Mr. Ellis said they would want 120 cars—100 for actual running and 20 for standing by and emergencies. This will involve an expenditure of between £80,000 and £90,000. A resolution recommending that the committee visit certain towns to see the type of car now running, and manufacturers' sheds to see the class of material used, was carried.

British and Foreign Electrical Vehicle Co.—This Company has been registered with a share capital of £150 000, of which the vendors take 96,000 fully-paid £1 shares in part payment of the purchase consideration. The balance of 54 000 shares of £1 each is just now being issued. The Board is composed of Colonel J. F. Caldwell, J.P., and Messrs. Roger H. Fuller, Theodore G. Chambers, and Ernest W. Hart; and Sir Wm. H. Preece is the consulting engineer. The Company owns carriage depôts, works, and charging stations in Lambeth, Notting Hill-gate, Kensington, and Shoreditch, and has been formed to acquire the assets of the Leecoll Electric Battery Company, Limited, together with one-half share in the Leecoll patents in Victoria and New South Wales, France, Belgium, Italy, Hungary, and Spain, and in any other countries where it may hereafter be thought desirable to take out patents (with the exception of the United States and Canada, wherein patents have been granted; but this Company acquires no rights as to these countries) Patents have been applied for in Austria, Germany, Norway, Russia, and India. The British patents are owned by the Leecoll Electric Battery Company, Limited, who sell them to this Company, together with all their properties and contracts. From the description of the Leecoll accumulator in the prospectus, we understand that it gives 12 watt-hours per pound of cell during a five hours' discharge, and it is made on an original plan, a metallic coating being deposited on the negative when in the act of charging, and being stripped off when discharging, so that there is no active material to fall out of position, and no possible chance of buckling, the durability of the Leecoll cell is apparent. It is also stated that the cost of maintenance is extremely low, and that the cost of manufacture of the Leecoll battery is much less than that of lead plate cells, as no skilled or expensive labour is required. An interesting report on tests made by Sir William H. Preece over a period of four months is included in this document, which appears in another column. We are informed that the property acquired in Lambeth for £7,000 is the old electrical cab station, which cost originally from £30,000 to £40,000. It is a good sign that the vendors are taking all their interests in shares except in respect to properties.

Liverpool.—At the adjourned meeting of the Town Council last week the overcrowding of the tramways was discussed, and this brought to light a statement to the effect that, while when the tramways company had the tramways the cars were only licensed to carry a certain number of passengers, the present cars are not licensed to carry any certain number of passengers, and, therefore, there is no contravention of the law. This is more convenient to the authorities than the poor people who are overcrowded. In connection with this matter, we notice in the Liverpool daily Press letters complaining both of the overcrowding and of the one-class system on account of the writers having brought home from their journeys a number of involuntary contributions in the shape of unwelcome zoological specimens of various kinds. These people will hardly be satisfied at being told that their only remedy lays in trusting to their own legs, unless they can afford to hire a cab. The proceedings of the Tramways Committee, which were confirmed, contain a recommendation that the Council approve of a supplementary estimate of £15,000 on tramways ordinary account. It was explained by the gentleman who moved the acceptance of the minutes that this supplementary estimate was owing really to the increase of the traffic and passengers of the undertaking. At the beginning of the year they estimated the interest at £39,639, sinking fund and repayment of loans £40,096, and the working expenses £320,000 (the same as the year before). They found that during the year, owing to the rapid development of the system, the tramways had increased enormously. The receipts had increased over 15 per cent., the mileage about 19 per cent., and the passengers 27 per cent., so that it would be plain to the Council that with such increase of traffic the expenses must also increase. Therefore it was that this £15,000 was required. Of course the undertaking was providing for this. It was not going to be any burden upon the rates, and the committee hoped at the end of the year they would have a surplus, not a large one, he was sorry to say, but probably £5,000 or £6,000 over working expenses. This year they had had more expense than they were likely to have in the future, as they had horse cars, omnibuses, and electric cars all to provide for. By the end of the present year they would have done with horse traction, and at that moment they had done away with the whole of the horse cars, but had still omnibuses running. With only electric cars working they hoped to have a large profit at the end of next year. Facilities have now been provided for a continuous electric tramcar service from the centre of the city (South Castle-street) to the North Docks, *vid* Breck and Breckfield roads.

Southampton.—The Tramways Committee have decided to recommend that the resolution authorising the Electricity Committee to maintain the electrical equipment of the tramways be rescinded, and that the Tramways Committee be empowered to take full control of the working of the tramways and the maintenance of the equipment other than the supply of electric energy. At a subsequent meeting it was resolved that the electrical engineer be instructed to proceed with the specification for the extension works, taking the line through Canute-road. It was also decided that the Electricity Committee be informed that the Tramways Committee anticipate that 10 additional cars will be ready for use on the new tramways through Canute-road and St. Mary's-road to the Avenue in March next, and asked whether they will be prepared to supply the increased power required at that date. The assistant borough accountant submitted a return showing an income in excess of expenditure of £4,893. 18s. 2d. for the period commencing April 1 and ending on Sept. 30, 1900. In moving the adoption of the report, the Sheriff said that relative to the extension of the tramways through St. Mary's street, the committee thought it was advisable, in view of the criticisms of the public over the reconstruction of the old system, that there should be a sub-committee to look after the work, and one had been appointed. Concerning the additional cars, they were to go on the present routes. It must be patent to everyone that the committee found it utterly impossible to cater for the traffic between

Digitized by Google

five and six o'clock in the evening. They had all the cars out, and then they had not only the general traffic, but also the workmen to deal with. In wet weather the difficulty increased, because people objected to sit on damp seats, and thus a large number of customers was lost. They hoped to have the new cars ready in three months. The new cars for St. Mary's route would have garden seats, and would have a larger carrying capacity than the present ones. They would be of full size, there being no Bargate to deal with. The committee asked that six cars should receive the "never wet" sets, which had been tried with satisfactory results. With regard to the profits for the six months ending September, the sheriff said they made £4,000 in the previous half-year, and the Council had received a similar amount from the committee for the present half-year, making a total of £8,000 during the present rate. But the committee felt that that was all the Council must expect for this year. They would have more money in hand, but they had decided to build up a reserve fund, and one for depreciation, so they asked the Council to be satisfied with what had been given them on this occasion. The report was adopted.

LIGHTING AND GENERAL.

Lichfield.—The City Council have sealed their application for an electric lighting provisional order.

Ince.—The Council are obtaining a report on electric lighting from Messrs. Lacey, Clirehugh, and Sillar.

Aspull.—Messrs. Lacey, Clirehugh, and Sillar are preparing a report on electric lighting for the Council.

Ayr.—The Town Council have agreed to borrow a further sum of £25,000 for electric lighting extensions.

Warwick.—The Town Council have confirmed their resolution to apply for a provisional order for electric lighting.

Nairn.—A scheme of electric lighting for the burgh, proposed by Mr. Purves, Edinburgh, is being considered by the Lighting Committee.

South Shields.—All the principal thoroughfares in the town, and many of the residential streets, are now illuminated with the electric light.

Barnard Castle.—The Urban District Council are taking no action with regard to the Cleveland and Durham Electric Power Company's Bill.

Chelsea Electricity Supply Co.—The transfer books of the debenture stock will be closed until Dec. 31 for the preparation of interest warrants.

Upholland.—The District Council appear to be favourable to the Lancashire Electric Power Company's scheme for supplying electric energy in bulk.

Larne.—The Urban District Council have just passed plans submitted by Larne Electric Company for laying down cable and for placing transformers.

Huddersfield.—Application has now been made to the Local Government Board for a 25 years' license to provide a local municipal telephone service.

Tonbridge.—Mr. R. Hammond's electric lighting scheme has been adopted, and application will shortly be made for sanction to a loan of £20 000 for that purpose.

Stoke-on-Trent.—The Local Government Board have agreed to extend the term of repayment for the electric lighting loan of £9,900 for the workhouse from 15 to 20 years.

Improved Electric Glow Lamp Co.—We are informed by this Company that they are taking up the sole and exclusive rights of the Hammond joint boxes, recently noticed by us.

Hebburn.—The Electric Committee are making enquiries of the various electrical power companies to ascertain the conditions upon which the companies can supply energy for all purposes.

Bacup.—A deputation of the Town Council has been appointed to wait on Mr. Pelham, at the Board of Trade office, for the purpose of obtaining an extension of the electric lighting order.

King's Lynn.—The Electric Lighting Committee have been instructed to enquire and report as to the powers and means of extending public lighting to the courts and yards of the borough.

Nuneaton.—The Council have approved the plans of the proposed new buildings at the electric works as prepared by the surveyor, and tenders will now be advertised for carrying out the works.

Salford.—The Tramways Committee will recommend the Council at its next meeting to appoint Mr. E. Hatton, at present tramways engineer, as both tramways engineer and general manager of the new electric tramways system.

Battersea.—Application is to be made to the London County Council for sanction to the loan of £10,600 in respect of additional mains, etc., which it has been decided from time to time to provide in connection with the electric lighting of the borough.

Dublin.—Fifteen members of the Electric Lighting Committee, including the Lord Mayor, have been surcharged with payments made to effect necessary alterations in the electric light supply to private consumers, amounting in the aggregate to £2 000.

Share Market.—There was a little more movement in electric shares during the past week. Sales were recorded in Bromptons, British Electric Traction, City, Westminster, St. James's, Edmondson preference, Metropolitans, and in British Columbian Electric Railway.

Personal.—Mr. J. Douglas Allan has been appointed junior assistant for distribution at the Leith Corporation electricity works.—Mr. Edward Unsworth, of 8, Greenhill-street, Greenheys, Manchester, has been appointed agent for Lancashire for Mr. A. P. Lundberg, M.I.E.E.

Hunstanton.—Mr. Stevenson's report to the Urban District Council shows that the cost of providing the electric light in the Council's district would be about £4,500, and if Old Hunstanton were included there would be £500 extra. The Council have agreed to apply for a provisional order.

Burton.—At the Town Council meeting last week a return was presented stating that the quantity of electric light sold in Board of Trade units during the past month was 26,955, showing an increase of 4,291. It was resolved that the Council undertake the letting out of electric motors on the hire-purchase system.

Cardiff.—The extension of electric mains in Newport-road is to be deferred on account of the change to the continuous-current system, which is to be made as soon as possible. The recommendations in Mr. Ellis's recent report as to concentrating the plant for lighting and tramways in one place at Roath have been accepted, and Mr. Ellis is to report upon the amount of plant required.

Manchester.—At the City Council meeting on Wednesday it was decided to appoint Prof. Kennedy electrical expert, on the terms that he shall receive either 4 per cent. upon all works executed by him estimated at £400,000, or an inclusive sum of £15,000 in half yearly payments. This sum does not include the architectural work of the shell of the building at Stuart-street, which will be prepared by and at the cost of the Electricity Committee.

Stroud.—Sir William Marling presided at a meeting of the Chamber of Commerce on the 19th inst. The chief business was to consider the rates charged by the National Telephone Company, and in the course of the discussion Mr. W. G. Clissold said the National Telephone Company had been the greatest hindrance to the extension of telephonic communication. Sir William Marling undertook to draw up a memorandum on the subject to be submitted to the Associated Chambers of Commerce.

Fire.—We regret to learn that on Saturday Messrs. Hooper's telegraph, cable, and rubber works at Millwall were destroyed by fire. Some idea of the extent of these premises may be obtained by the fact that they range about 200ft. long and 100ft. wide. Over 200 men have been thrown out of employment as a result of the disaster. It is reported that the cause of the outbreak is at present unexplained. The fire broke out in a building right in the centre of the works, where spun-yarn seizings, hemp rope, and guttapercha were stored.

Appointments Vacant.—The Electric Light Committee of Salford invite applications for the post of an electrical engineer at £700 per annum.—The Corporation of Southend-on-Sea require an electrical engineering assistant. Full particulars of these vacancies appear in our advertisement columns. The Lancaster Town Council have decided to advertise for an electrical engineer able to take charge of the electric tramways as well as the electric lighting. We have referred elsewhere to the post of tramway engineer to the London County Council (£1,000) shortly to be advertised. Application for the post of a foreman, to reside at, and take charge of the machinery and staff of, the generating station in connection with the electric light installation for the Victoria embankment and Westminster Bridge will also be advertised for shortly.

Manchester Telephones.—The City Council on Wednesday agreed that the consideration of the question as to whether it should reaffirm its decision of April 14, 1897, in regard to telephones, should be adjourned till the February meeting, and that the Telephone Committee should be instructed to confer with the Salford and other urban authorities within the Manchester telephone area on the subject of telephony and report to the Council at a future meeting. Our readers may recollect that the resolution referred to expressed approval of the objects of a proposed independent competing company, subject to terms and conditions being arranged to the satisfaction of the Corporation, and reserving to the Corporation a status to communicate with and be heard before the Postmaster-General or other Government authority in reference to the subject, and as to the conditions of any license affecting the city of Manchester.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 3 a special settling day for City of London Electric Lighting Company's provisional certificates (60 per cent. paid) for 200,000 4½ per cent. second debenture stock; Mount Chalmers Copper Mines 4,053 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 917 and 20,218 to 23,353; and 10,000 ordinary shares of £1 each, fully paid, Nos. 50,001 to 56,000 and 71,001 to 75,000; and Notting Hill Electric Lighting Company's further issue of 2,200 ordinary shares of £10 each, fully paid, Nos. 10,001 to 12 200. The undermentioned securities are to be quoted in the official list: Charing Cross and Strand Electricity Supply Corporation's further issue of 30,000 4½ per cent. cumulative preference shares of £5 each, fully paid, Nos. 20 001 to 50,000; and City of London Electric Lighting Company's provisional certificates (60 per cent. paid) for £200,000 4½ per cent. second debenture stock. Applications have been made to the Stock Exchange Committee to appoint a special settling day in Kalgoorlie Electric Power and Lighting Corporation's 150 000 6 per cent. cumulative preferred shares of £1 each, 10s. paid. Nos. 1 to 150,000; Marconi's Wireless Telegraph Company's 77 083 shares of £1 each, fully paid, Nos. 1 to 40,000 and 100,001 to 137 083, and 60 000 vendors' shares of £1 each, fully paid, Nos. 40,001 to 100,000; and Motor Manufacturing Company's 246,432 shares of £1 each, fully paid, Nos. 1 to 246,432.

Digitized by Google

Ilford.—The Surveyor reported at the last meeting of the Urban District Council that the electric generating station works were progressing satisfactorily. The report of a sub-committee who had visited Kingston-on-Thames to inspect the incandescent lamps in use there, and who now recommended the Council to adopt the same, was agreed to.

Whitehaven.—The Council have decided to apply to the Local Government Board for sanction to borrow £10,000 for the purpose of carrying out the works recommended by the consulting engineers, along with the contemplated extensions to public and private mains. A detailed estimate of the cost of the proposed works has been asked for.

Alloa.—The Burgh Commissioners will make a commencement with public lighting by placing eight arc lamps in various streets. The original scheme proposed by Mr. Spence included 32 lamps, and if the trial proves successful the number of lamps will be increased. Sanction has been obtained to the borrowing of £12,000 in connection with the Alloa electric lighting order.

Walsall.—The Electric Lighting Committee are unable to accede to the request that they should extend the existing main in Bradford street along Wednesbury-road so as to supply electric light to the Wednesbury-road Congregational Church, having regard to the probable small consumption of current. The total number of consumers supplied on Nov. 30 last was 169.

Pudsey.—A petition has been presented to the Town Council by the Independent Labour party against the granting of parliamentary powers to the Electric Power Distribution Syndicate on the ground that a combination of the local authorities could do the work more effectively. The Council are taking steps to prevent any company or any person coming within the township for the purpose.

Swadlincote.—A letter from the Board of Trade was read at the last meeting of the Urban District Council enquiring whether the Council had proceeded to carry out the obligations under the electric lighting order, and elicited that the clerk had been instructed to reply that no steps had been taken, and that the time already granted should be extended for carrying out the terms of the order.

Bermondsey.—The new Borough Council have come to the very sensible conclusion to approach the Board of Trade with a view to secure the insertion in a Bill that authority proposes to introduce in Parliament in favour of making electric lighting areas coterminous with the new borough areas, provision to extend the Bermondsey electric lighting order over the whole area of the Bermondsey borough.

Rochester.—The Town Council have an offer to purchase so much of the undertaking of the Rochester, Chatham, and District Electric Lighting Company as is within the city. Mr. F. Charles Raphael has been asked to advise the Corporation as to the value of the present distributing system within the city, and the valuation of the proportion of the provisional order will be considered after this has been done.

Heywood.—At the last monthly meeting of the Town Council it was resolved to apply to the Local Government Board to sanction the appropriation of a piece of land adjoining Egerton road for the purpose of constructing electric supply works thereon. It was also resolved that a conference of local authorities interested in the acquisition of the Bury, Rochdale, and Oldham Tramway Company, Limited, should be convened.

Bristol.—The Electric Committee have asked Mr. Williams, architect, to report whether he thought the plans prepared for the Avondale works were such that he could safely assume the responsibility of carrying out the works, and, if so, whether he would be willing to prepare a specification, give an estimate of the cost, and state a probable date when he thought the works would be completed. Various short extensions of the alternating-current mains have just been authorised.

St. Austell.—The Urban District Council have formally consented to the application of the St. Austell and District Electric Light and Power Company, Limited, for a provisional order under the Electric Lighting Acts, 1882-1899, in substitution for the order now subsisting and known as the St. Austell Electric Lighting Order, 1894; and the Council waive their powers of purchase thereunder, and concur in taking such steps as may be necessary to obtain the revocation of the order of 1894.

Lytham.—The Urban District Council have obtained a report from their consulting electrical engineer, whom they had asked if he could possibly see any means of reducing the estimate of lighting Lytham. He proposes by cutting out street lighting, to bring down the price of the current to that of gas. Taking 18 lights as the average number per house, it would only require 250 houses to cover all expenses. The committee have agreed to talk the matter over with the engineer and report to the Council.

Stoke Newington.—The Electric Lighting Committee recommend the Council that any provisional order that would confer power on any private person or body to supply electricity in the borough of Stoke Newington, otherwise than by agreement with the Borough Council, should be opposed. The chairman of the General Purposes Committee is to be added to this committee. Enquiries are to be made as to the probable consumption of electricity by private consumers in this borough in the event of such supply being furnished by the Council.

Wallsend.—Regarding a communication sent by the District Council to the Walker and Wallsend Gas Company concerning the new electric mains, and pointing out that the authority would not be responsible for any damage done to the mains because of their contiguity to the sewers, a reply from the company was read at the last meeting of the Council stating that the mains had been lawfully laid, and anyone who damaged them would be liable. It was decided that a letter be sent to the company intimating that the Council had resolved to defend their position.

B.E.T. Athletic Club.—The athletic club attached to the British Electric Traction Company recently held its second general meeting, the chair being taken by Mr. J. Devonshire, who gave a short *résumé* of the summer experiences of the club. He stated that the ground at Shepherd's Bush was now being used for football, and that the team had won four matches out of the first five played. On Friday, the 14th, the club gave a very successful smoking concert at Anderton's Hotel. The concert was well attended, and the organisers provided an excellent and varied programme.

Banbury.—The Electrical Power Distribution Company, Limited, are transferring their order, with the consent of the Corporation, to a subsidiary company which has been formed under the name of the Banbury and District Electric Supply Company, Limited. The charges for light have been fixed at 7d. per unit up to 100 hours as the maximum demand, and for any further quantity supplied 2½d. per unit. The charge for energy separately metered for power is the same, with the exception that 2d. is substituted for 2½d. The undertakers propose to commence their operations in the borough at a very early date.

Islington.—At the meeting to-day the following report from the Provisional Finance Committee is to be considered: "We have had under consideration a reference from the Electric Lighting Committee approving of a proposal by the late Vestry for the provision of additional water storage by the erection of a water tower and tanks, and of a switch gallery along the engine-house, and other works at the electric lighting station in Eden grove at a total estimated cost of £7,496. We have ascertained that sanction to borrow to the extent of £6,606 was obtained by the late Vestry from the London County Council. We adopt this amount (£6,606) as our estimate of the cost of the proposed works which are covered by the sanction in question, and we recommend that the Electric Lighting Committee be authorised to carry out the works to the extent of that sanction."

Darlington.—The new electric lighting works in Haughton-road were opened on Monday. The system adopted is a three-wire continuous current of 460 volts. The works have been in progress for some months, and it is intended to light the principal thoroughfares, while there has been a large application from shops, works, and other customers. The street arc lamps are not yet in operation, but are in course of erection. The switching-on of the light was undertaken by Alderman Barron, the chairman of the Corporation Gasworks and Electric Lighting Committee, who explained that it was considered desirable at the earliest moment to give tradesmen and others who were ready with their wiring the advantage of the light. The works are capable of supplying about 7,000 8-c.p. lamps, and will be a great acquisition to the town. The total cost comes to about £25,000.

Aberdeen.—At their last meeting the Gas and Electric Committee considered the plans for the proposed new electricity station at Dee Village, and agreed meantime to defer further consideration of them until the Tramways Committee should have considered the accommodation which would be required by them at the station for repair purposes. There are eight plans, and it is proposed to erect buildings of a very substantial character. Provision is made for a battery-room, with offices; testing-room, with motor and lamp store above; for workshops, with stores above; for weigher and checker, workmen's mess-room, engine-room, boiler-house, economiser-house with water-tank above, a hot-water well underground, and a chimney stalk of a most elaborate and ornamental nature. The work of laying the electric subway which is to contain the cables from the new Dee Village electric station will also be carried out in connection with the construction of the sewer in Crown street, the subway so far running along the top of the sewer.

Taunton.—The Electric Lighting Committee in their last report recommended the Council to adopt the following scale of charges to be paid for the hire of motors from the Corporation: ½ b.h.p., 100 volts £2. 200 volts £2. 5s. per annum; 1 b.h.p., 100 volts £3, 200 volts £3. 5s.; 2 b.h.p., 200 volts, £4; 3 b.h.p., 200 volts, £5; 4 b.h.p., 200 volts, £6; 6 b.h.p, 200 volts, £8; 9 b.h.p., 200 volts, £9; and 12 b.h.p., 200 volts, £10. 10s. per annum. In the event of a hirer wishing to purchase a motor, he will be allowed to do so on payment of the cost of the motor less half the rent already paid for hire. The agreement with the Free Wiring Company has been terminated, and the committee have under consideration a scheme for free wiring by the Council similar to those adopted by other corporations. With regard to the recent breakdown of the Staplegrove cable, we learn that the accident was due to the fact that a larger number of connections have been made than were anticipated when the cable was laid down, and thus the cable was insufficient to meet the demand.

Wakefield.—At the last meeting of the Town Council, a considerable discussion arose as to the best means of street-lighting. Two committees, who apparently have jurisdiction over the same area, submitted their minutes. The principal resolution of the Electric Lighting Committee, whose minutes were adopted, embraced an instruction to the electrical engineer to prepare the specifications, etc., for the provision of a high-speed plant (recommended by the sub-committee because the same would run better in parallel than a slow-speed set) for the electric lighting works; that the town clerk advertise for tenders for supplying the same; and that Councillors Wigham (chairman), Powell (vice-chairman), Childe, Harrison, and W. H. Smith form a sub-committee to open

Digitized by Google

the tenders. The Street-Lighting Committee's minutes dealt with improved lighting in the Alverthorpe Ward in particular and the city in general. The committee recommended the erection of incandescent lamps of varied candle-power by the Wakefield Gas Company. During the discussion it was asked whether the Lighting Committee had ascertained the amount annually required for renewals in the matter of incandescent lighting, but no answer was given. Finally it was agreed that the minutes be adopted with the exception of that part dealing with the additional lighting of the old portion of Wakefield, which be referred back to the committee for reconsideration.

Leeds.—It is expected that by next Easter one of the 1,500-h.p. engines for the electric power station will be ready. Other two similar engines are to follow, and when these are set up the Corporation will be able to deal with 300 electric cars, instead of the modest 82 which the present 1,300-h.p. and 400-h.p. engines feed. The foundation for the new machinery is now being laid. By Christmas next year it is possible, therefore, that there will be no fewer than 300 motors in the streets of Leeds. Of course, special traffic arrangements are to be made to deal with this enormous addition to the already congested central thoroughfares of the city. The Town Council, in fact, has recently been considering these arrangements. According to Mr. Spaven, the traffic manager, all the electric tram routes are under carred. The Town Council at its meeting on Tuesday evening instructed Messrs. Hopkinson and Talbot to prepare specifications for the equipment of the Armley, Wortley, and Stanningley routes, which will complete the electrical tramway installation in the city. The committee also examined a new fare-collecting apparatus. The salary of Mr. Burbridge, the electrical tramway engineer, has been increased from £400 to £600. Mr. Burbridge is a comparatively young man, and has been in the service of the Leeds Corporation for about three years. At a meeting of the Lighting Committee of the Corporation it was decided to extend the electric lighting mains from Whitehall road along Spence-lane, Wellington-road, and Tong-road, as far as Wesley-road, Armley.

Swansea.—The proposed agreement between the Corporation and the National Electric Wiring Company in connection with the electric lighting scheme provides that the company shall, when required by the Corporation, provide and fix the necessary wires and fittings for using electricity for lighting purposes on the premises of any consumer, with certain exceptions. The company are to be responsible for all proper legal claim for damage or injury done by them or their agents to any premises wired or fitted by them, while the Corporation will render to the company quarterly accounts indicating the amount of electrical energy supplied to the premises to which wires and fittings have been supplied, and the amount received by the Corporation in respect thereof, "and until such wires and fittings have been paid for as hereinafter provided, the Corporation will pay to the company for the use of the installation 1d. per Board of Trade unit for the first period on a sliding scale, during which the Corporation would charge the consumer their maximum price for energy supplied, and will pay the company an amount proportionately below 1d. per unit *pro rata* with the reduction in charge made by the Corporation for periods under the sliding scale in which the consumer would be charged less than the maximum price, provided that the price per Board of Trade unit shall in no case be less than ½d., and provided that the minimum payment to the company in any year shall be 1s. 4d. per lamp installed." The Corporation, it is further provided, shall not make any payment in cases of defaulting consumers, and the sliding scale (as already reported in these columns) gives every consumer the option during the first four years of purchasing the wires and fittings at the original cost price, plus 25 per cent., and less 1½ per cent. per annum for depreciation, and so on to 22½ per cent. and 20 per cent. for the fifth and subsequent years, and such original cost shall include the costs of labour, materials, superintendence, and all expenses of general management." The Corporation also have the power of compounding for the purchase of the whole of the fittings, etc., and in both events "the company shall render to the Corporation an account of the prime cost to the company of such wires and fittings." In other clauses, a consumer, by paying the difference in cost, may have special fittings, while the company "shall not be liable for any repairs to or maintenance of the wires and fittings, all of which, including the renewal of the lamps, shall be done by the consumer at his own expense." This does not refer to defects in materials or workmanship during the first year. The agreement is terminable by six months' notice on either side.

London County Council.—At Tuesday's meeting of the Council it was agreed to lend the Battersea Borough Council £20,000 for electric lighting purposes, and the Woolwich Borough Council £20,000 for electric lighting and dust destructor works. The Highway Committee's recommendation that an electrical engineer be appointed, at a salary of £1,000, was adopted. We deal with this question in another column. The report of the Highways Committee also contained the following recommendation: "That, notwithstanding the provisions of the agreement entered into by the Council with Dr. A. B. W. Kennedy in accordance with the resolution of the Council of Oct. 10, 1899, the Council do accept the offer of Dr. Kennedy to act as electrical engineer for the reconstruction, for electrical traction, of the tramways between (*a*) Westminster Bridge and Tooting; (*b*) Kennington-gate and Blackfriars; and (*c*) St. George's-circus and Waterloo-road. That he be paid in respect of his services a commission equal to 4 per cent. on the cost of the reconstruction of the said tramways, and to 1 per cent. on the cost of buildings, and that it be referred to the solicitor to complete the arrangement." The application of the National Telephone Company for permission to lay a short length of wires underground from the corner of St. John's-road and John's-hill, Clapham Junction, to new premises of the company at 248, Lavender-hill, the object of the work being to enable it to remove its exchange from the present position in Battersea Park-road to the new premises, will be agreed to provided that the company before commencing the work obtain the consent of the Postmaster-General thereto. The Council will also grant permission to the Exchange Telegraph Company to lay two 3in. pipes underground across the Victoria-embankment upon the usual conditions. The following notices under Electric Lighting Acts and Orders were agreed to: City of London Electric Lighting Company to lay mains along a portion of Blackfriars-road; County of London and Brush Provincial Electric Light Company power, etc., to lay low-tension mains to and at Red Lion Market, and low-tension mains along both sides of Torrington street and square; also several notices from the Metropolitan Electric Supply Company to lay high-tension mains along portions of Wells-road, Albert-road, Lancaster-terrace, and along a portion of Cavendish-road, also to lay low-tension mains along Carey-street and Bell-yard. The Council have also received notices under the several orders granted to the Hammersmith, Stepney, and Lambeth local authorities (the latter being in hands of the South London Electric Lighting Company), under which the Council have no power to disapprove or approve.

PHYSICAL SOCIETY.

At the ordinary meeting held in the physical laboratory of the Royal College of Science (by invitation of Prof. Rücker) on Dec. 14, 1900, a paper "**On Electric Inertia and the Inertia of Electric Convection,**" was read by **Prof. A. Schuster.** Calculations of self-induction are based on the assumption that the currents which traverse a conductor fill it continuously, the flow being treated as that of an incompressible liquid. The assumption is generally recognised not to hold in the case of electrolytes where electricity is conveyed by a number of irregularly distributed ions. In the immediate neighbourhood of such an ion the magnetic field is many times greater than that calculated on the supposition of continuous distribution, and hence the total magnetic energy is underestimated. What is universally recognised in the case of electrolytes must also be conceded when the current is conveyed by a gas, and the idea is gaining ground that even in solid conductors the current consists of positive and negative electrons moving with different velocities. It is the object of the paper to calculate the additional terms which become necessary for the evaluation of self-induction, and to discuss the possible cases in which the corrections may effect experimental results. The mathematical investigation shows that it is necessary to add a correcting term containing a quantity which may conveniently be called electric inertia. The author has calculated the numerical value of this quantity in the case of a solid conductor, and finds it to be about 2×10^{-13} C.G.S. units. It is of the dimensions of a surface. The experiments of Hertz have proved that if electric inertia exists it must be less than 18×10^{-6}. In the case of liquids and gases, the electric inertia of the moving ions becomes much more important, and the calculation of self-induction by the ordinary processes gives erroneous results. The introduction of a term representing inertia alters the general equations of electric motion, and the author has applied his modified theory to Leyden jar discharges, the electrodeless discharges of J. J. Thomson, and the electromagnetic theory of light. In the case of electrodeless discharges in a vacuous globe, it is suggested that the absorption of energy may not only be due to the conductivity of the gas, but also to the inertia which it possesses.

A paper "**On Magnetic Precession**" was then read by the same author. The most delicate method of investigating the influence of electric inertia is based on the E.M.F.'s introduced by the motion of conductors carrying electric currents. If electricity behaves like a body possessing inertia, the rotation of a body through which currents pass should affect the flow of these currents in the same manner as the earth's rotation affects the direction of currents of air. If the earth's magnetism is due to electric currents, it is interesting to see if the affects of inertia can explain the secular variation. The investigation shows that a magnetic precession of the character of the secular variation would be produced, but that the precession would be very much slower than the variations actually observed. The subject is worked out mathematically, dealing first with the case of currents in a spherical shell and then extending the result to the case of a solid sphere. The calculated period of a cycle comes out as 7×10^{14} years If the currents are confined to a thin slice of the earth, the time would be reduced to about 14×10^{6} years. To produce the actual period of the secular change, the current sheet would have to be of molecular dimensions. This suggests the possibility of the phenomenon of secular variation being rather of a molecular than a molar character.

Prof. Rucker congratulated the author upon his attempt to solve the problem of terrestrial magnetism, and expressed the hope that further calculation would throw more light upon this difficult subject.

Mr. Blakesley asked if the time of the secular variation would be altered if the interior of the earth were liquid or solid?

The **Chairman** observed that the precession was rapid in the case of a thin layer of gas, and mentioned J. J. Thomson's notion

Digitized by Google

that the electrons were thrown off by centrifugal force and formed a molecular layer. Hertz, in his experiments on electricity, had looked for material inertia besides electromagnetic inertia. In the present theory the distinction disappears, and there is only one inertia, and that electromagnetic.

Prof. Ayrton said if the two forms of inertia were electromagnetic, he would like to know why in detecting the second form it was necessary to associate it with an absorption of energy, as in the case of an electrodeless discharge. In the case of ordinary self-induction there is no absorption of energy, and if there is absorption in the second form, and if they are both electromagnetic, he would like to know the difference between the two.

Prof. Schuster, replying to Mr. Blakesley, said that if the interior of the earth were treated as liquid the period of the cycle would be about 100 times less. In reply to Prof. Ayrton, he said he had only cited one experiment to show that a phenomenon explained by the gas being a good conductor could also be explained by its electric inertia. It was impossible to say in general whether self-induction caused an absorption of energy or not.

Prof. A. W. Rucker read a paper "**On the Magnetic Field Produced by Electric Tramways.**" Taking the case of a tramway in which the current flows along a trolley wire from the power-house and returns partly through the rails and partly as earth currents, the author has shown that the vertical disturbing force at any point is due to the currents in the feeders and rails, and that the earth currents affect the horizontal force only. Experiment shows that it is chiefly the vertical force instruments which are affected by the establishment of an electric railway, and since this disturbance is due to the wires and rails, it is impossible for an observatory to be protected by rivers or other natural features of the district. A preliminary investigation is based on the assumption that the trolley wires and rails are insulated conductors, and that a fraction of the whole current returns along the rails to the generator. The effect of the railway at a distant point is due to the difference of the current in the trolley wire and the hypothetical uniform rail current, the effect of which at the point considered is equivalent to the actual rail current, which varies from point to point. It is thus shown that the disturbance increases with the length of the tramway, and for a tramway of given length the disturbance is a maximum at points on a line perpendicular to and bisecting it. Experiments made at Stockton on the magnitude of the disturbing force gave, with the vertical force instrument, a leakage of 16·3 per cent., and with the horizontal force instrument a leakage of 15·9 per cent., a fairly close agreement. The assumption that the terminals of the line are above and below the average potential of the earth by the same amount respectively, and that the leakage at any point is proportional to the potential difference between the rail and the earth, leads to the ordinary theory of a Fourier bar. This more accurate assumption has been developed and applied to the results obtained at Stockton. The leakage as calculated from the amperes and volts comes out as 20 per cent. The calculation of the disturbing vertical force gives $10{\cdot}5 \times 10^{-5}$ C.G.S. units, which is in fair agreement with the value 7×10^{-5} actually observed. In conclusion, it is pointed out that for practical purposes it is sufficient to deal with the average return current through the rails, the formulæ for which are quite simple.

Dr. R. T. Glazebrook read some "**Notes on the Practical Application of the Theory of Magnetic Disturbances by Earth Currents.**" In this paper the author has thrown the extended formula obtained by Prof. Rücker in the previous paper into a workable form, and has tabulated numbers which show at what distances the disturbances are negligible for tramways of different lengths.

Prof. R. Threlfall exhibited a "**Quartz-Thread Gravity Balance.**" Prof. Threlfall gave a short description of this instrument, which has been described in full elsewhere. He drew attention particularly to its accuracy and portability.

Mr. Simpson asked how far the fibre had been calibrated, and if the instrument would be reliable at the freezing point of mercury.

Dr. Glazebrook asked how far the instrument was suitable for antarctic expedition work. He drew attention to the difficulty of calibrating a new fibre should one get broken in the field.

Mr. Appleyard suggested the use of a bath kept at constant temperature with a thermostat.

Prof. S. P. Thompson suggested a special meeting to discuss the physics of the antarctic expedition.

Prof. Threlfall said that there was no difficulty in measuring the relation between temperature and coefficient of stiffness down to very low temperatures. A more difficult matter is the coefficient of temperature of the instrument. Shrinkage of the instrument as a whole affects both the fibre and the spring which supports it. The difficult of a broken fibre in the field can be got over by taking two or three instruments. Working with a thermostat is useful in a laboratory, but decreases the portability in exploration work.

Mr. Watson then exhibited a set of half-seconds pendulums. In these pendulums special attention is paid to the stability of the support. They are covered by a hood from which the air can be exhausted, so that the logarithmic decrement is diminished. The motion of the pendulums is shown by rays of light reflected from right-angled prisms attached to them, and the period of oscillation is determined by the method of coincidences. For this purpose an accurate astronomical clock is used, and observations are made continuously between two time signals. An accuracy of one part in a million is attainable.

In reply to **Prof. Threlfall, Mr. Watson** said that the knife-edges were on the pendulums, and not on the supports.

The society then adjourned until Jan. 25, 1901.

PROVISIONAL PATENTS, 1900.

DECEMBER 10.

22433. Improvements in metallic conduits for electric light cables and the like. Lawrence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle street, Liverpool.

22434. Improvements in metallic conduits for electric light cables and the like. Lawrence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool.

22352. Improvements in automatic potential regulators for dynamos. Newnham Browne, 73, Cheapside, London. (The Tirrill Regulator Company, United States.)

22476. Improvements in staples for electric wires. Hermann August Litz, 72, Cannon-street, London.

22484. Improvements in prepayment electricity meters. Ernest Schattner, 55, Chancery-lane, London.

DECEMBER 11.

22503 Long quick-break spring contact switch. Fred Atkinson and William Atkinson, Brook-Lynne, Roundhay-road, Leeds.

22508. Electrical resistance switch. James Cusworth, 41, Park-road, Newcastle-on-Tyne.

22515 An automatic telling contact for electric bells. Albert Browne Mudie, Cambridge-street Works, Birmingham.

22542. Improvements in means for supporting electric lamps. August Richter, 111, Hatton-garden, London.

22546. Improvements in electrical interrupters for gas-engines. Theodor Bergmann, 72, Cannon-street, London. (Complete specification.)

22572. Improvements in or relating to electrostatic machines. Karl Schall, 8, Quality-court, Chancery-lane, London. (Reiniger, Gebbert, and Schall, Germany.) (Complete specification.)

22584. An electric furnace with two bedplates. Charles Albert Keller, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 21, 1900, being date of application in France.) (Complete specification.)

22585. Improvements in flexible supporting structures for electric lamps. William Farley Brewster, 322, High Holborn, London. (Complete specification.)

22591. Improvements in magnetic ore separators. Charles Albert Barnard, 6, Lord-street, Liverpool. (Complete specification.)

22599. Improvements in the manufacture of incandescence bodies for electric glow lamps. Alexander Just and Robert Falk, 46, Lincoln's-inn-fields, London.

22605. Improvements in and relating to plate holders for electric accumulators. Theodor Müller, 18, Buckingham-street, Strand, London. (Complete specification.)

22606. A process for chemically consolidating the active material of electric accumulators. Theodor Müller, 18, Buckingham street, Strand, London. (Complete specification.)

22607. Improvements in or relating to electric accumulator cells. Theodor Müller, 18, Buckingham-street, Strand, London. (Complete specification.)

DECEMBER 12.

22628. Improvements in electric or electro-pneumatic organs. Robert Hope Jones, 44, Grove-avenue, Norwich.

22662. Process for the manufacture and repair of electrical glow lamps. Fritz Blau, Alexander Scharf, Isidor Löti, Sandor Löti, and Rudolf Latzko, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

22665. Improvements in trolleys for electrical locomotives, tramcars, or the like. Edward James Faraday, 34, Castle-street, Liverpool.

22678. Improved means applicable for use in transmitting energy to electrically-propelled trains or tramcars. Sidney Howe Short, Clun House, Surrey-street, Strand, London.

22679. Improved means applicable for use in operating and controlling electrically-propelled trains or tramcars. Sidney Howe Short, Clun House, Surrey-street, Strand, London.

22680 Improvements in electric current switching apparatus. Reginald Page Wilson, Clun House, Surrey-street, Strand, London.

22690. Improvements relating to electrical traction. Kenric James McMullen and John Alexander McMullen, 323, High Holborn, London.

22693. Process of extracting and reducing metals by electrolysis. Hans Albert Frasch, 40, Chancery-lane, London. (Complete specification.)

22699. Process of recovering and separating metals from their ores and concentrates thereof. Hans Albert Frasch, 40, Chancery-lane, London. (Complete specification.)

Digitized by Google

DECEMBER 13.

22703. Improvements in the electrolytic refining of copper. Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

22704. Improvements in the construction of induction coils. William Edward Ayrton and William Duddell, The City and Guilds of London Central Technical College, Exhibition-road, London.

22712. Protective device for galvanometers and the like. Alfred Whalley, Ashville, Helsby, near Warrington.

22713. Improvements in electric switches and fuses. Alfred Whalley, Ashville, Helsby, near Warrington.

22731. Increasing the efficiency of high-tension induction electrical machines of the Wimshurst, Voss, etc., type. Frederick Tudsbury, Edwinstowe, Newark.

22747. Improvements in electromagnetic brakes. Francis Ludlow Clark, Westinghouse-buildings, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 14, 1900, being date of application in United States.)

22748. Improvements in electromagnetic brakes. Francis Ludlow Clark, Westinghouse-buildings, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 14, 1900, being date of application in United States.)

22775. An improved arrangement of cut-outs and apparatus for the better protection of electric cables and generators. Callender's Cable and Construction Company, Limited, and James Ormiston Callender, 24, Southampton-buildings, Chancery-lane, London.

22779. Improvements in mounting telephonic instruments and accessories so as to admit of interchanging or renewal of the various parts. Max Byng and Francis George Bell, 165, Queen Victoria-street, London. Complete Specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on Jan. 5.

1899.

22260. Electrically-operated governors chiefly designed for regulating the speed of dynamos or motors. Lake. (Millet.)

24634. Apparatus for electrically lighting railway carriages and other vehicles. Vicarino.

24718. Telephonic systems and apparatus. Kingsbury. (Western Electric Company.)

24879. Electrical conductors. Isherwood.

25281. Electrical traction on the closed conduit system. Lane.

25407. Holders for electric incandescent lamps. Phibbs.

1900.

1813. Filaments for electric incandescence lamps. Lake. (Arno.)

2232. Electricity meters. Wright and Reason Manufacturing Company, Limited.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Dec. 13	597	422	+ 174	19,894	16,950
Birmingham Trams.	,, 15	4,464	3,502	+ 962	—	—
Blackburn Corp'rat'n	,, 14	432	327	+ 104	22 341	19 902
Blackpool Corporatn.	,, 13	191	111	+ 80	27,744	20,420
Blackpool-Fleetwood	,, 15	146	96	+ 50	19,999	19,961
Bolton Corporation..	Oct. 28	1,254	—	—	42,293	—
Bradford City Trams	Dec. 16	756	302	+ 454	20,615	14,526
Bristol Tramways Co.	,, 14	3,579	2,241	+1,238	—	—
Carlisle Tr'mw'ys Co	, 15	121	—	—	4 260*f*	—
Central London Ry.	,, 15	6,006	—	—	105,433 *e*	—
City & South London	,, 16	1,874	1,151	+ 723	39,649	23,822
Cork E. T. and L. Co.	,, 13	372	302	+ 70	20,368 *c*	18,877
Dover Tramways ...	,, 15	163	126	+ 36	10,250	9 734
Dublin & Lucan E.R	Oct. 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	Dec. 14	3,355	2,729	+ 626	—	—
Dublin S.D. Electric	,, 14	794	594	+ 200	—	—
Dundee Tram Co. (*b*)	,, 6	480	352	+ 128	—	—
Glasgow Corporation	, 15	9,083	7,890	+1,192	—	—
Halifax Corporation	,, 17	643	491	+ 152	28,699	22,837
Hull Corporat'n E.S.	,, 15	1.553	644	+ 709	— *a*	—
Liverpool Corporat'n	,, 8	8,075	6,801	+1,274	388,625	337,898
Liverpool Overhead	,, 16	1,527	1,432	+ 95	39,658	38,908
St. Helens Tramways.	,, 12	—	—	+ 227	—	—
Sheffield Corporation	,, 16	2,809	—	—	—	—
Southampton Trams	,, 13	644	257	+ 387	—	—
Southport Corporat'n	,, *8	366	329	+ 37	—	—
Swansea Tramways.	Oct. 5	447	263	+ 184	7,093	4,462

a Since April 1. *b* Partly electrical. *c* Since Jan. 1. *e* From July 30. *f* From June 30. * Fortnightly returns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	5	—	10½-10⅝
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5½-6¼
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Electric Works, Ordinary, 50,001-95,000	1	..	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅞-1
—— 4½ per cent. First Mortgage Debentures	103	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5
Brush Electrical Engineering, Ordinary	2	—	1⅝-1⅞
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	108-111
—— 4½ per cent. 2nd Debenture Stock	100	—	108-106
Callender's Cable, Debentures.	100	—	111-115
—— Ordinary	5	—	12½-12¾
—— 5 per cent. Pref	5	—	5½-5¾
Crompton and Co.	3	—	3¾ 4
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	1¾-2¼
—— 5 per cent. Debentures	5	—	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	—	96-100
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-106
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-12¾
—— 4½ per cent. Preference	5	—	5½-5¾
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	11-12
—— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	12	—	38-42
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-5¾
Willans and Robinson, Ordinary. 1-20,000	5	—	10¾-11⅛
—— 6 per cent. Cum. Pref., 20,001-60,000	5	—	6¾-7⅛
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	103-105
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	12½-12¾
—— 4½ per cent. Cum. Pref.	10	—	10-11
—— Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8¾-9⅛
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¾-6⅞
Charing Cross and Strand..	5	..	9¾-10⅛
—— 4½ per cent. Cum. Pref.	5	—	5¼-6
Chelsea Electricity Supply	5	—	6¾-7
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	9-10
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	—	125-130
County of London and Brush Provincial, Ordinary	10	—	8¾-9⅛
—— 6 per cent. Cum. Pref.	10	—	11¾-12⅛
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	—	—	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¾-5
—— 4½ per cent. First Mort. Deb.	100	—	102-105
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5¾-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7¾-8¼
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10⅛
London Electric, Ordinary	2	—	1¾-2
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101 xd
Metropolitan, Ordinary	10	—	12½-12¾
—— 4½ per cent. First Mortgage Debenture Stock	100	—	113-115
—— 5 per cent. Mortgage Debenture, Red	100	—	98-101
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879....	1	—	1⅝-1¾
—— 25 Shares	5	—	7-7¼
—— 24½ Shares, New	4½	—	5¾-6¼
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	—	5¾-6¼
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	$100	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	—	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	—	2½-2¾
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	—	8¼-9⅛
—— 3½ per cent. Deb.	100	..	100-103
Westminster, Ordinary	5	—	12-13
—— 20,001-100,487	5	—	11½-12⅝
Electric Railways.—			
Central London, Ordinary	10	—	9¼-9⅝
—— Pref. Half-Shares	5	—	4¾-5⅛
—— ,, ,, deferred	5	—	4¼-4⅝
City and South London, Consolidated Ordinary	100	—	52-56
—— Ordinary	10	—	4½-5⅛
—— 6 per cent. Debenture Stock	100	—	115-120
—— 5 per cent. Pref. Stock '91	100	—	128-142
—— ,, ,, ,, '96	100	—	120-125
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	14-16
Brisbane Tramway	100	—	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	—	9¾-10⅛
British Electric Traction, Ordinary	10	—	12¾-14¼ xd
—— 6 per cent. Cm. Pf. 20,001-60,000	10	—	13-13
—— 5 per cent. Perpetual Debenture Stock	100	—	120-122
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4¼-4¾
—— 5 per cent. Deb. Stock, Red.	100	—	104-107
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	—	9¾-10⅛
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	5	—	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17
—— 5 per cent. Cum. Pref.	10	..	10¼-10⅝
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	10¼-11⅛
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	102-105
Telephones.—			
National Telephone, Ordinary	5	—	4¾-4⅝
—— 6 per cent. Cum. First Pref.	10	—	13-14
—— 6 per cent. Cum. Second Pref.	10	—	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 4 per cent. Deb. Stock, Red.	100	..	101-104
—— 3½ per cent. Deb. Stock, Red.	100	—	96-99
Oriental Telephone and Electric Company	1	—	⅜-1½

Digitized by Google

NOTES.

Street-Lighting in Paris.—We understand that street-lighting by arc lamps is making great headway in Paris, and that in consequence gaslighting is being discontinued in certain of the more important streets. Amongst these is the Rue de Rivoli, from the Louvre to the Hotel de Ville. We presume that when the municipal authorities acquire the electric lighting undertakings, as will be the case in the course of two or three years, there will be a large increase in the arc lighting of the streets of the French capital. At present the prices charged in Paris for electric lighting are excessive.

Manchester-Liverpool Electrical Express.—We understand that the new Bill of the Manchester and Liverpool Electric Express will be very different from that promoted last session. Instead of the line in the Salford district being on the viaduct principle, the whole of the three miles will be laid in a cutting. This will be covered over at intervals in a similar way to that in which the London underground was constructed, but instead of buildings being erected over the tunnels it is proposed to leave open spaces there, so that the Corporation may make gardens, and thus create a beautiful promenade a mile long through the worst slum property of the town. The capital of the company is now fixed at £2,100,000.

The Rontgen Society.—We are notified that an ordinary general meeting of the society will be held on Jan. 3, at 20, Hanover-square, W., at which Mr. A. W. Isenthal will read a paper on "Continental Progress in Practical Radiography and Apparatus." Before the paper, Dr. J. H Sequiera has kindly consented to show some cases of rodent ulcer treated with X-rays. The chair will be taken by the president (Mr. J. MacIntyre) at eight o'clock. Future arrangements include a paper upon "X-Ray Work during the Late Military Operations," by Lieutenant F. B. Bruce, R.A.M.C.; a discussion evening, the subject being "X-Ray Therapeutics," to be opened by Miss M. Sharpe, L.R.C.P.; and a paper by Mr. J. Cadett on "Some X-Ray Improvements." As in the last session, there will be an exhibition evening, and members are invited to bring skiagrams or other objects of interest.

Electric Light in Theatres.—A demand was recently made by the Licensing Committee of the Hull Corporation to force the manager of the Grand Theatre in Hull to use electric light for his projector work instead of limelight. We believe that, in accordance with the custom of the profession, we should say that the Licensing Committee tried to force the manager to use the "electric limes." The report of the city architect showed that limelight had been abolished in all the principal theatres of London, Manchester, Birmingham, and Sheffield, and that where it was still used in London the County Council required the limelight apparatus to be placed in special fireproof chambers apart from the main building. After hearing considerable evidence on the question, the committee did not feel justified in enforcing the architect's views, which is to be regretted, unless they enforced precautions to make the limelight safe.

The Bolton Tramways.—It is extremely important that the permanent way over which heavy tramcars such as are now used on electric lines should be accurately and truly laid. Any variation in the gauge causes undue wear on the wheels and also on the rails themselves. It also causes a considerable increase in the power required to move the cars. A case in point recently occurred in Bolton. It seems that when the Board of Trade inspection took place, the inspector advocated that the whole of the old tramway lines should be relaid. While it was hoped to save the big cost of this, it is now found by the borough surveyor that the gauge varies very considerably in different parts of the system. It is obviously impossible to alter the wheel tread to meet the defects, as there is a considerable difference between the gauge in the new work and certain parts of the old. The only thing, therefore, to be done is to meet the heavy expense of renewing the latter portions of the work before the wheels on the new cars are damaged by wear in passing over the lines.

Telephones in Glasgow.—The necessary underground conduits for the telephone system of Glasgow have already been mostly laid, and the work of drawing in conductors is being proceeded with. It is expected that the system will be complete and ready for working by the time the exhibition is opened next year. In view of the opposition which will thus be brought to bear on the National Telephone Company's exchange in Glasgow, the company are instituting improvements and concessions in order to hold their own if possible. Amongst the new introductions is the party line system, by which a large number of subscribers will use one line to the exchange. In Glasgow, where the houses are built to accommodate families in flats, this system can be comparatively easily employed, and the reduction in cost to the subscriber will make up to a certain degree the decreased convenience, for at busy times he may find his line to the exchange engaged. The minimum charge for such connections has been fixed by the company at 2d. per day, but payment will be made on the penny-in-the-slot system on the number of calls.

"The Journal of the Franklin Institute."—We have just received the December number of the above journal, which contains several items of interest to our readers. The first of these is a paper read in the chemical section by Prof. J. W. Richards on "The Use of Blast-Furnace Gases in Gas-Engines." As the figures given in the paper are almost all obtained from English and Continental sources, we do not propose to give an abstract of them at the present time, as all the data will shortly be given in our columns from a paper read before the Institution of Mechanical Engineers last week. Mr. W. A. Goodspeed's paper on "X-Rays and other Rays," read before the electrical section at the beginning of the year, has been referred to by us in previous issues, but it is reprinted in full in the journal before us. Another item which electrical engineers will do well to read is the report of the committee of the Franklin Institute on the Welsbach light. This report is a straightforward statement of the wonderful invention of Dr. Carl Auer von Welsbach. In consequence of this report, the Elliott Creeson medal of the Franklin Institute was awarded to this scientist.

Telegraphic Communication with the Continent We trust that the deputation recently sent to the Postmaster-General by the Liverpool Chamber of Commerce will have the effect of expediting the transmission of Continental telegrams to this country. At the present time the delays which occur in the telegraphic communications from the Continent are most serious, and in the memorial presented to Lord Londonderry the deputation name various reforms which the Chamber of Commerce consider necessary in order to render efficient the telegraph service between Liverpool and the other towns and the Continent. One of the proposals is that the French Government be urged to establish direct wires between Havre and the cotton manufacturing towns of the North and East of France. It is also suggested that new cables

Digitized by Google

to Germany, Belgium, and the Netherlands be provided. As to the means for effecting the improvement desired, it is pointed out that the Treasury, in order to provide properly for the commercial necessities of the kingdom and of a port of the rank of Liverpool, might apply some of the large profits of the Post Office and some of the increased Customs revenue derived from Liverpool to telegraph purposes.

Halifax Tramways.—It is gravely announced in one of the Halifax newspapers that the electric tramways are now being run at a loss. On looking through the paragraph underneath this heading we find that the period for which the loss is said to have been sustained is only one fortnight, and that this is due to a reduction in the number of passengers carried, which is usually found in Halifax in the winter months. Another point in connection with the loss which is worthy of note is that it is after paying interest and depreciation. In our opinion, the object of any municipal authority should be to so adjust its expenses and charges that there should be an extremely slight margin of profit after providing for the capital charges out of revenue. It seems that in the case of the Halifax tramways a profit was earned in the summer months, and that it has now, in the winter time, fallen down to a slight adverse balance. In the paragraph in question some interesting information is given as to the electricity required on the various roads. This is as follows: Highroad Well, 2·13 units per mile; King Cross, 1·54; Illingworth and Athol Mount, 1·61; Booth Town and Stump Cross, 2·08; Pellon, 1·84; and Savile Park, Salterhebble, and Skircoat Green, 1·61. The average income per car mile during the fortnight was 11d., and the cost, including interest on the sinking fund, 12·02d. per car mile.

Royal Meteorological Society.—The monthly meeting of this society was held on Wednesday evening, the 19th inst., at the Institution of Civil Engineers, Westminster, Dr. C. Theodore Williams (president) in the chair. Mr. H. Mellish read a paper on "The Seasonal Rainfall of the British Isles," which he illustrated with a number of lantern slides. He discussed the rainfall returns from 210 stations for the 25 years 1866-90, and calculated the percentage of the mean annual rainfall for each season. In winter the largest percentages of rainfall are found, as a rule, at the wet stations, and the smallest at the dry ones. Spring is everywhere the driest quarter, and the percentages are very uniform over the country—rather larger in the east than in the west. In summer the highest percentages are found in the dry districts, and the lowest in the wet ones. As the spring is everywhere dry, so is the autumn everywhere wet, and there is little difference in the proportion of the annual total which falls in the different districts. As regards the relation between the amount of rain which falls in the wettest and driest month at any station, it seems to be generally the case that the range is larger for wet stations than for dry ones. In wet districts rather more than twice as much rain falls on the average in the wettest month as in the driest, and in dry districts rather less than twice.

Electric Tramway Traction. — Last week Mr. A. W. Greatorex read a paper on "Electric Tramway Traction," the occasion being a meeting of the members of the Association of Birmingham Students of the Institution of Civil Engineers. The author first described the advantages and disadvantages of the overhead trolley wire, the conduit, the accumulator, the combined overhead and accumulator, the combined overhead and conduit, and the surface-contact systems, and illustrated his remarks with lantern slides. He expressed the opinion that the overhead trolley wire system was at present the best adapted for tramway work in the majority of towns in this country. In London, however, where tramway extension was inevitable, and where the traffic would pay for almost any capital invested, the overhead wires would probably not be admitted within a radius of three or four miles of Charing Cross, but beyond that limit trolley wires must be used. He advised municipalities to take up the tramway question, and not allow outside companies to carry on the enterprise. In his opinion the profits reaped from the tramways should be applied to a reduction of the rates. He was further of opinion that general power should be granted to local authorities to form joint boards, that corporations should have running powers over outside lines, and in the case of large towns like Birmingham the corporations should take over the control of the tramways within a certain area, and pay a rental to the smaller places. We do not agree at all with the author that the municipal authorities should make a profit out of the tramway passengers to be applied to the reduction of rates.

The Manhattan Railway.—In the derogatory remarks which were made by certain American engineers with respect to the Metropolitan District Railway Company, it is interesting to note that an experimental electrical train has recently been tried on the Manhattan Railway at New York. These gentlemen scoffed at the very idea that any experimental train was required order to prove the practicability of electric traction on the underground. In spite of this, the Manhattan Railway authorities have found it advisable to follow the example of the Metropolitan District Railway. In the train which was tried on Nov. 22 a still further similarity exists between it and the English practice. There were six cars employed, the end two being motorcars, which is the case on the Waterloo and City Railway. Eight motors were used on each train, four on each motorcar, and they were all controlled simultaneously from either end of the train. This entailed a cable running the full length of the train, as is also the case on the Waterloo and City Railway. The line voltage employed was 550 volts, and the train took a maximum current of 1,500 amperes when accelerating. The full figures of the trial are not yet available. One noteworthy fact, however, is the statement that the present average speed on the rails with steam is from 11 to 12 miles per hour, while 14 miles is expected when the electrical equipment is employed. It will be remembered that the average speeds, including stops, actually obtained on the Central London Railway is 12 miles per hour, whereas on the Metropolitan District Railway with steam locomotives the speed during the evening rush is 11 miles per hour.

Engineering Progress Abroad.—A lecture was delivered recently before the Bradford Municipal Technical College by Mr. G. F. Charnock on his visit to the Paris Exhibition and to some Continental engineering works. The lecturer is the headmaster of the college department of civil, mechanical, and electrical engineering. In the lecture it was regretted that, while all foreign nations had learnt their trade in steam-engine building and like work from Great Britain, our country should not have been more largely represented at the Paris Exhibition. This was particularly so, as our foreign competitors exhibited most largely. He thought that English manufacturers now had much to learn from what was exhibited in Paris. After referring to the few exhibits there were of English-made engines and dynamos. the lecturer went on to comment on other plant he saw when travelling through Switzerland, and the good work done by the firm of Brown

Digitized by Google

and Boveri. This led on to the question of three-phase working, in which this country was behind. He regretted that we had not done more in this direction, in spite of the fact that we had not the large water power which had made the system such a success in Switzerland. We were unable in consequence to compete with foreign firms for work in our Colonies. It was worthy of note, the lecturer thought, that Switzerland had succeeded so well as a manufacturing nation notwithstanding the high price of coal in that country. He also stated that wages were high, but in this we cannot agree. The lecturer's conclusion was that in this country draughtsmen and designers were not considered as they should be, and were not paid sufficiently well. He hoped that the advance of technical education would do much to remove the faults to which he had alluded.

The Light Cure.—We notice that the *Deutschen Medizinischen Wochenschrift* has published a communication by Dr. H. Strebel, of Munich, on the deadly effects produced by the invisible rays of the electric discharge upon bacteria. The doctor, it seems, has succeeded in proving that the invisible rays of a powerful induction spark are capable of killing strong cultures—for instance, of micrococcus prodigiosus—within the short space of, say, 20 minutes, even through a thick medium of quartz. The induction spark is naturally rich in ultra-violet rays, but by employing certain substances as electrodes and a Leyden jar as a regulator and accumulator of the electricity, the richness of the spark in ultra-violet light may be enormously increased. Dr. Strebel used electrodes of aluminium and cadmium, when the ultra-violet portion of the invisible spectrum, rendered visible to the eye by projection on to a fluorescent screen, exceeded the visible portion of the spectrum by more than four times in length. Further experiments showed that the invisible ultra-violet rays, after the passage of light rays through a system of Finsen filters, had been completely absorbed by the apparatus, and that the destructive chemical influence which the apparatus had upon bacteria was due entirely to the agency of the visible rays, especially those of the blue-violet order. But the latter rays have but little chemical effect compared with the invisible ultra-violet rays, wherefore the success of the experiment bears very largely on the improvement of the light-cure process—that is to say, the strengthening of the bacteria-killing capacity of the light—besides the simplification and cheapening of the process, for compared with the 80 amperes required by the Finsen filtering apparatus, only a very small current is involved in the case of the Röntgen apparatus. Dr. Strebel has also been engaged in investigating the permeabilities of different mediums for ultra-violet rays and their influence on different kinds of bacteria.

Electric Railway Dispute.—An action between the Great Northern Railway Company and the Great Northern and City Railway Company, recently heard in the Chancery Division of the High Court, has resulted in an important gain for the former. It would appear that the City Railway Company obtained parliamentary powers in 1892 for constructing a line to be worked by electricity in the neighbourhood of Finsbury Park Station on the Great Northern Railway. The Act provided that the City Company should use Finsbury Park Station for local traffic, and there was to be a connection near Finsbury Park Station for an interchange of through traffic. To carry out the latter scheme Sir Henry Oakley estimated that about £1,000,000 sterling would be required. Negotiations resulted in an agreement of January, 1894, and it was as to the true meaning of this document that the question turned. The plaintiffs' case was that under the agreement two substituted lines were to be made at an estimated cost of £167,000, and that they were to pay the City Company £20,000 for the transit of their traffic over the defendants' lines. The City Company, however, argued that the works to be carried out under the agreement were additional to those authorised by the Act of Parliament, but this interpretation did not find favour with Mr. Justice Buckley, who tried the case. The learned judge refused to accept the contention that it was intended to have a duplicate system of construction between the places named, and his decision, therefore, was that the connecting lines were in substitution for those in respect of which parliamentary powers were obtained in 1892. By the judgment of Mr. Justice Buckley the City Railway Company are now restrained from proceeding under certain notices to treat in respect of the first proposed line, and the Great Northern Company have secured the costs of the litigation.

Insurance Rates.—Within the past few years there has been frequent trouble between fire insurance companies and electrical engineers over the question of insurance rates. Perhaps the most attention has been attracted to the insurance rates for electricity works, which in most English offices are unduly high. The reason for this is that certain electricity works which were first established in London were put together in the early days of electric lighting, when the use of fireproof materials had not become so common as at present. In a few of these cases there have been serious fires, and the insurance companies have had to bear the brunt in consequence. It is most unfair, however, that all new electric stations in which every precaution is taken against fire, should be penalised by heavy insurance rates because the companies lost on their earlier policies. As the bulk of the English companies work on a common tariff, the only way of reducing these high premiums is to induce one of the non-tariff offices to look at the matter in the proper light. This course has been pursued with considerable advantage to all concerned. Another phase of the question of insurance rates for electrically-lighted houses has still to be solved. Thus, while it has been proved by the returns of the fire brigade department of the London County Council that electric lighting is the most safe illuminant, there has been up to the present no acknowledgement of the fact in the premiums demanded by fire insurance companies. We are now able to state that the Fine-Art and General Insurance Company, Limited, are prepared to grant reductions off the current rates for insuring private houses and business premises in which electric light is the sole illuminant. The *sine qua non*, however, is that the work should be carried out by fully qualified and experienced engineers, and we presume that the company will inspect the electric lighting arrangements before giving any reduction in the premium. If this is done, there are sound reasons for giving the reduction, and we trust that the financial results will induce other offices to compete with the above company on the reduction of rates. It is hinted in the notice before us that the reduction will probably be not less than 10 per cent. in the present premiums.

Electric Traction on Railways.—In addressing a meeting of the Cologne Association of Electrical Engineers recently, Herr Bork, director of railways, made some interesting remarks relative to the prospects of the introduction of electric traction on to the standard-gauge railways in Germany. He pointed out that railways had been projected for speeds of from 100 to 150 miles per hour, but their realisation was not in prospect, because even the estimated saving of half the time taken by a railway

Digitized by Google

train of the ordinary type to accomplish a given distance did not justify the enormous outlay which such schemes would entail. Schemes had also been devised whereby it was sought to obtain very rapid acceleration upon starting, which doubtless the question of cost had likewise upset. The directors of the State railways recognised the great advantages offered by electric traction for railway work, but could decide upon its introduction only after the working costs pertaining to the same should have proved themselves to be at least no higher than those holding for the existing system. The arguments in favour of the adoption of electric traction for very busy stretches of railway in thickly populated districts were very strong, and for this reason the directors of the Prussian State Railways had inaugurated a practical test over a section of line where such conditions prevailed—namely, the Wannsee railway between Berlin and Zehlendorf. Much had already been written about the equipment of this line. No interruptions of the service had yet occurred, though the winter with its attendant snow and ice had still to be experienced. The available figures showed a saving of over 10 per cent. in the working costs of the system as compared with the steam locomotive service, added to which the trial train ran much smoother and attained its maximum speed in the space of two minutes as against the three minutes occupied by the steam locomotive. With stations situated at four-minute intervals, this represented a shortening of the time of travel without an attendant increase of the maximum speed. The current consumed varied up to 1,200 amperes, while the energy required amounted to 32 watt-hours per ton mile. With regard to the actual cost of working, this would probably amount to 8d. per train mile, as compared with 8 12d. for the steam locomotive service.

Self-Propelled Traffic.—At a meeting of the Liverpool Self-Propelled Traffic Association recently, the report of the fourth session was presented. It stated that the judges' report on the 1899 trials of motor vehicles for heavy traffic, which had been ordered from all parts of the civilised globe, was now out of print. It was resolved to give particular attention to the matter of an increase of tare, the arguments in favour of which were chiefly: (*a*) to secure equal treatment with horse-drawn traffic; (*b*) to ensure the safety of the public; (*c*) to meet commercial requirements; (*d*) to meet foreign competition. In their report the judges of the Liverpool trials drew attention to the risks involved in attempting to work under the tare limit of the 1896 Act. They concluded that even for loads of four tons carried on the maximum tare allowed, "the strength of frames and working parts, the areas of bearing surfaces, the width of wheel types, the available platform area, the stoutness of the platform and woodwork generally, and the diameters of axles and shafts were reduced below what is compatible with a satisfactory life or the safety of the public" Whatever the risks, they are due to the fact that the present tare limit precludes the use of adequate material and strength in construction. The alternatives presented to the manufacturer at present were either to charge a prohibitive price or to reduce factors of safety to a dangerous extent. If the tare weight were increased, proper design would be possible without any concomitant disadvantage, and the means of control could be perfected in all directions. It was a hardship that Great Britain should be hindered by legislation where the Continent (particularly France and Germany) and the United States had freedom for development. If the tare limit was not increased immediately, foreigners would obtain so great a lead that Englishmen would have enormous difficulty in competing with them later. France, Germany, and America, the last-named most of all, were building motor wagons even now in much larger numbers than were being built in England, and were aiming at loads above four tons upon vehicles with tares above three tons. In regard to the 1901 trials, it was reported that a conference of manufacturers was held in Liverpool in May last, when the conditions for the third trials of motor vehicles for heavy traffic were discussed. The particulars and regulations were issued on June 13, the dates for the trials being June 3 to 7, 1901. The routes which have been selected embrace Widnes, Warrington, Manchester, Bolton, Wigan, St. Helens, Chorley, Blackburn, and Preston. The committee of the Automobile Club, we hear, have accepted the invitation of the association to arrange a tour down to Liverpool during the trials.

Street Subways.—We have again and again advocated that the great obstruction of traffic, and the expense entailed in consequence of the delay in traffic, due to the opening up of the London streets, should be avoided by the construction of subways in which all distributing systems for electricity, water, gas, and hydraulic power might be laid. It is an exceedingly difficult thing to get at the true loss caused by these obstructions, owing to the fact that the losses are indirect and involve a reduced efficiency of transport rather than a direct increase of cost. The large omnibus companies know how many journeys per day they lose owing to the streets being up, and in this loss, it must be remembered, there is no account taken of the time the omnibus drivers and conductors lose. There is one way, however, in which some idea of the value of the subways can be obtained, and it has been investigated by a writer in the *Daily Mail*. He claims to have looked into the actual outlay of the various companies in London during the past five years for excavating and making good the public streets, and the extreme accuracy of his figures makes one believe that he has actually had access to the books of the companies. For instance, he states that three large gas companies have expended no less than £3,747,152. 12s. 2d. in road work during that period. The electric light companies and local authorities are said to have spent £2,554,900, while the water companies' expenditure amounts to £2,892,188, out of which only a small proportion was due to damage caused to their pipes through frost. The telephone company is said to have spent in street work £1,369,498. 12s. 3d., so that the grand total is over 10½ millions. The contributor goes on to state that large tunnels could be constructed in the principal streets of London at an average cost of £25 per foot. If this figure be accepted as accurate, the total expenditure for equipping 75 miles of the London streets would be some 15 millions, and it will be seen that the companies would save this value in a comparatively short period. The question, however, is as to who is to bear the cost of laying down the complete new system of conduits in the subways if constructed. It must be remembered that, in addition to the 10½ millions referred to above, there is also the cost of the materials laid in the trench when excavated. Almost all this would be wasted if the present pipes and conduits had to be moved into a big tunnel down each street. It is this interference with the vested interest of private companies that makes it so difficult to act, but we trust that the construction of subways will be commenced before long. It is a great pity that they were not commenced a few years ago, for in that case the excessive obstructions at the present time, due to the simultaneous laying of telephone conductors and electric lighting mains in the City of London, might have been saved.

Digitized by Google

PRACTICAL NOTES ON ELECTRIC MAINS.

BY A MAINS ENGINEER.

(Continued from page 873.)

Bare copper systems take up much more room than any one of the foregoing, as a large concrete culvert has to be built before the copper strip is put into place. The greatest claim, perhaps, that can be made for copper strip is that it never alters its insulation value however much jointing is done on it, whereas the insulation value of a cable is lowered immediately a joint is made on it. Another thing claimed for it is the facility it offers for the connection of services. This, however, is not worth so much as it appears to be at first sight unless two or more services come within short distances of one another. It is nearly always the case that the going to a job and the general running about takes more time than the making of a service joint.

Bare copper strip has also one very great disadvantage at the time of a fault occurring. If the strip lies directly in the path of the current taken by a fault, the strips set up a swaying motion, and are often drawn together, thus making a fault which it is of no use whatever to try to burn out. This might be overcome by placing the bearing bars closer together than customary, and also seeing that the insulators and carrying caps fit better than usual, thus making a more rigid holder for each strip. Also it would be as well to place a riding insulator midway between each two bearing bars, thus making it absolutely impossible for the strips to come together. It is usual to place a cast-iron frame and lid over each bearing bar, thus making an inspection box. Into these boxes the service wires are brought. The lids and frames are not so large as they might be, as if the strip is very deep, a man cannot get at the strip to make the necessary connections. This, of course, could be altered easily. The lids should be carefully filled, and not filled too high, otherwise they form little lumps above the surrounding pavement, and so are unsightly and dangerous. When building a culvert for bare copper mains it is necessary to take levels, so that each length of culvert is drained into a manhole, which manhole is in turn drained into the nearest sewer through a non-return trap. The culverts, because they are so large, must also be ventilated. This can be accomplished at the manhole covers. Manholes are usually placed at street corners—*i.e.*, one on each side of a cross street, the cross street being crossed by cables laid on the solid system. Gas and water service pipes should never be allowed inside a culvert, and the building of a culvert is often expensive owing to such services having to be shifted, or if this cannot be done, by having to dig deep enough to allow of the culvert passing underneath the services.

After the strips have been drawn through the culvert they are tightened up by means of ratchet gear, and when tight enough are fastened by means of set screws bearing directly on the strip, these screws being placed in each manhole. If the strip is laid during winter time, it ought to be stretched tighter than if laid in summer time, as if it is not drawn tight enough in cold weather it will sag very much in the warmer weather. There is very little doubt that if bare copper could be laid everywhere throughout a town or district, and no other system used in conjunction with it, and any services taken off it were laid solid, absolute freedom from bad faults would be obtained.

Before commencing to open ground for any system, the town surveyor's maps should be consulted to ascertain the position of gas and water mains, sewers, etc.; notices should be sent to the various municipal departments to the effect that openings were intended to be made. Trial holes should be opened two or three days before a gang of men is sent on to the job, and the job should be carefully considered as to the number and size of cables required. The size of cable required can be worked out according to the value of the house property which it is intended to serve *en route*, the $C^2 R$ of the cable also being taken into account Of course, houses and shops are not always of the same value in different towns, but it will be found that the average £40 house requires about 1,000 watts and the average £60 shop requires about 2,000 watts: this is if the shop is what is known as a lock-up shop; if the house part is inhabited, of course more must be allowed It is a good plan to lay a line of, say, 4in. glazed earthenware pipes along the cable route to provide for any emergency that may arise; an extra cable could then at any time be drawn in without again disturbing the ground. Cables for street-lighting purposes are also best if they are separate cables from the distributors, and better still if they are separately controlled right from the works.

Having chosen a clear route, a gang can be sent on to the job well provided with tools, timber, rope, and other requisites according to the system to be laid. The best picks are those with iron-shod shafts, as the wood shaft wears away through the friction of the steel pick eye. The gang should consist of about 25 men to one foreman. If the number of men is doubled, then a sub-foreman should also be sent. Twenty-five men are quite enough for one man to look after properly. With a large gang, working in a large district, where many of the men come several miles to their work, it is usual to tell off one man to warm the food for the rest, to boil water for them, etc. This man during spare time can clean and trim the watch lamps for the night. The watchman should arrive at his work just before the gang knock off, and the cable-laying foreman should never leave the job until he has seen the watchman at his post. The watchman should be well provided with good lamps, guard ropes, and iron pins, as in a busy town it is necessary to rope off everything, even to the smallest heap of soil. In case an accident happens while the watchman is on duty, he should be instructed to forward to the engineer a detailed report of what has occurred at the earliest possible moment, giving the names of any witnesses, which he should always endeavour to get. The best witnesses are policemen. Where several gangs are employed in one town it is a good plan to have a foreman watchman, who goes from one job to another during the night. One watchman can easily watch about 200 yards, his cabin being placed in the centre of the length. It should always be borne in mind that people have a great knack of having accidents on municipal jobs, as the municipalities so easily pay damages: therefore everything that can be done to avoid these should be done.

When opening the trench, if it is found that gas and water lead service pipes show all along the bottom of the trench, then it is best to open again below these services, as many services are damaged by drawing in on top of them; armoured cables especially soon rub holes through. Any damage to such service pipes should be immediately reported to the department to which the pipes belong, and pending the arrival of the men to repair, the damaged service should be hammered up between the damage and the main from which it is supplied. If a gas or water main is bared for any considerable length, it should be slung with chains suspended from stiff timbers laid across the trench. The chains should be placed immediately behind the socket of the main so bared, and can be tightened by what is known as a Spanish windlass, really forming a tourniquet. The bared main might also be propped with bricks from the bottom of the trench, but these bricks are apt to be in the way.

When opening along the side of a wall, if it is found that the wall has no foundation, as is often the case with garden walls, the wall must be propped by oblique struts, the feet of the struts being let into the ground outside the trench—*i.e.*, on the side of the trench farthest away from the wall. The ends which go against the wall are cut so as to present a face parallel with the wall, vertically and horizontally; a board is then inserted between these cut faces and the wall, the end of the struts being nailed to the board. If the brick arch of a large culvert or underground brook has to be cut away, a casting should be made as shown in Fig. 4. The insertion of this casting prevents the sides of the culvert from collapsing inwards. Wrought iron would be useless, as it very soon rusts away.

As soon as a trench is opened, carts can be employed to take away some of the soil, the amount to go away being governed by the bulk of new material to go in. If only one armoured cable is to be laid direct in the ground, there will probably be no need to send any soil away. A place to tip carts must therefore be arranged for. Material should as far as possible be delivered on the job by the makers of the material, or by the railway companies who carry it. Thus much cartage expense is saved, for railway companies are bound to deliver within a fixed radius.

When drawing in cables always have as long a draw as

Digitized by Google

possible; do not flake the cable more often than can be helped. As much as possible place all the strength at the end of the cable: the cable is then kept more in a straight line than if the men were at equal distances along the cable with small concentric cables, whose conductors are formed of small wires, there is danger of the outer wires breaking and the broken ends piercing the inner dielectric if the cable is not kept straight. It is almost impossible to hurt an armoured cable by drawing it along the ground, providing it does not catch anywhere. Always draw the cable from underneath the drum; fewer accidents will happen if so drawn. See that the cable in running off the drum does not rub on the side of the drum, especially if the cable be unarmoured. Do not pull the cable too tight, especially if laid in very hot weather, as it will shrink during the next cold weather, probably causing straight joints to pull in two, thus causing a discontinuity fault. Two hundred yards are quite long enough for the smallest cables; large cables can well be shorter.

When a road has to be crossed, it often has to be opened in twice. Care should then be taken to see that no large gas or water mains come close to the end of the first opening; if so, sufficient room for bending in the remaining length of cable may not be obtained. The radius of any cable bend should not be less than ten times the diameter of the cable. If cable ends have to be buried in the ground to await jointing, the cable-laying foreman should have the ends placed in wooden boxes about 14in. long. These boxes should then be filled with bitumen. This should always be done whatever

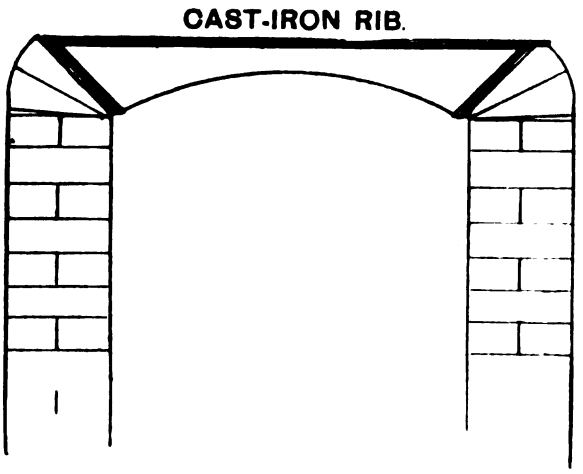


FIG. 4.—Arch Casting.

class of cable is used. The foolish plan of letting rubber insulated cable ends get wet should not be allowed. If a cable is cut, the end should immediately be dipped into hot box compound, which will effectually keep it dry, as it adheres to the cable much better than bitumen does. Cables should be lapped over not less than 2ft. 6in to allow for testing and jointing. Positions of all joints and ends should be carefully noted by the laying foreman. It is well, if it can be managed, to let a jointer follow up the gang, testing and jointing before the ground is filled in. Careful records of all cables laid as to position, as well as position of joints, should be kept, the cables being marked on the Ordnance Survey maps. This job can be undertaken by the mains engineer if the district is a small one, but is better done by a draughtsman if much work is going on. It is, however, absolutely necessary that no mistakes should be made.

Although a thin wall of insulation may stand double the working pressure of a cable, still, for mechanical reasons, no cable should be laid that has an insulation wall less than $\frac{3}{16}$in. in thickness. Rubber-insulated cables should be insulated by cross lappings of rubber in strip, and not by the two sheets of rubber, one above and one below the copper core, whose edges meet, and so unite. Very often, if they do unite, as we are told they do, they come apart again, thus giving trouble. A system which some engineers may at some time like to try is at present in the writer's mind. The suggestion is offered for what it is worth; probably the Board of Trade might not allow it. On a three-wire network a cable might be composed (in the form of a triple-concentric) of an inner copper core, an intermediate copper conductor, and the outer conductor, which would be used as the neutral wire, would be made of iron, and would serve two purposes, one as a conductor and one as a protector, really an armour. Such a cable might then be laid solid, preferably in an earthenware trough. As on a *perfectly* balanced three-wire network no current flows along the middle conductor, the greater specific resistance of the iron would not matter. The best form for the iron would be that of small iron wires braided closely.

(To be continued.)

INCREASING THE EFFICIENCY OF STEAM-ENGINES.*

The recent centennial anniversary of the Royal Technical High School at Charlottenburg was made the occasion of several important announcements concerning the work of that renowned institution, which embodies in a remarkable degree the advanced technical science which has done so much to push Germany forward into the front rank of manufacturing nations. Among these, the first rank is by common consent accorded to the paper of Prof. E. Josse, head of the mechanical laboratory, in which are described with elaborate detail the results of his experiments with an original and highly interesting process for increasing the efficiency of steam-engines by utilising the heat of the exhaust steam for evaporating another liquid having a lower boiling point than water.

It is well known that the steam boiler and engine, notwithstanding all improvements which it has undergone during the past 100 years and its incalculable services to mankind, is, nevertheless, a wasteful and extravagant device for converting the energy stored in fuel into mechanical power. The ordinary simple high-pressure engine, which after passing steam through one cylinder discharges it into the air, utilises hardly more than 5 per cent. of the value of the fuel consumed under its boiler. The compound engine, in which the steam, after passing successively through two, three, or more cylinders, is condensed, and the warm water of condensation restored to the boiler, utilises under favourable conditions 12 to 13 per cent. of the fuel energy, and there the economy appears to have stopped. An eminent American engineer has recently published an article reviewing the development of the steam engine, and closes his essay with the expressed opinion that with the compound machines and improved cut-off of recent years the practical limit of efficiency of the steam-engine has been reached. The invention described by Prof. Josse introduces a novel element into the problem, and opens a new chapter in the record of steam-engine development.

The process is the joint discovery of Mr. G. Behrend, a Hamburg engineer, and Dr. Zimmermann, of Ludwigshafen; and, although first patented in 1889, it has only recently been matured and its application perfected by the employment of an auxiliary engine, which, utilising the heat contained in the exhaust steam, gains as high as 56 per cent. additional motive power without increasing the expenditure of fuel. The principle and process involved are simple, and may be briefly described as follows:

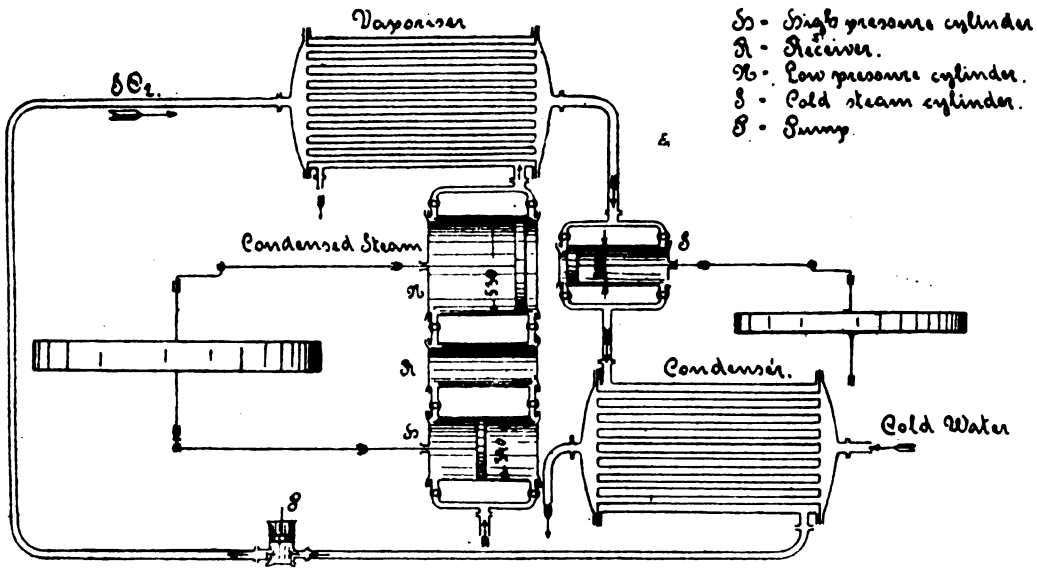
It is plain that with all progress which has hitherto been made in steam-engine practice through higher pressures, superheated steam, economical cut-offs, or successive cylinders, there is always an important and inevitable loss of heat energy when the steam, having done its work, is discharged into the open air or changed back to water by contact with cold water in a condenser. When the exhaust is into the open air, the steam has a temperature of about 100deg. Celsius (212deg. F.); when it passes into a condenser, the steam has a temperature of 60deg. to 70deg. Celsius (140deg to 160deg. F.), according to the vacuum. The corresponding latent heat of steam, given up upon change of form from steam to hot water, has hitherto run to waste in the condensing or cooling water, or in the air. Messrs. Behrend and Zimmermann attacked the problem of utilising this wasted caloric by employing it to create a new supply of steam by evaporat-

* Consular Report, U.S.A.

Digitized by Google

ing some liquid which has a lower boiling point than water, and for this purpose they chose, after many experiments, sulphurous acid (H_2SO_3), which is not only cheap and easily obtained, but has the further advantage of a viscous consistency and lubricates the inner working surfaces of the machinery without corroding them. Their demonstrations, although not practically conclusive, were so promising that Prof. Josse, as a technical authority on this subject, took up the problem, and, after several months of highly satisfactory laboratory experiment, caused to be constructed and connected with an ordinary working steam-engine of the compound type an additional condenser and auxiliary engine, the power of which could be exactly measured. The whole working apparatus is shown in the engraving herewith submitted, and the technical details will be explained by the drawing, and may be thus described.

Referring to the diagram, in which dimensions are given in millimetres, H and N represent the high and low pressure cylinders of an ordinary compound steam-engine, with a stroke of 500mm. (19·69in.) and a speed of 41·5 revolutions per minute. From the low-pressure cylinder, N, the exhaust steam passes into the surface condenser, called in the diagram the "vaporiser.' In this vaporiser, or condenser, the cooling medium used, instead of water, is liquid sulphurous acid (H_2SO_3), which has a boiling point so low that it is immediately decomposed by the heat of the exhaust steam, whereby the sulphur dioxide



gas (SO_2) is liberated, which passes over into the cylinder of the auxiliary engine, S, where its work is done as in an ordinary steam-engine. The auxiliary cylinder has a diameter of 300mm. (11·81in.) and a stroke of 500mm., with a speed of 77 revolutions per minute.

After passing through this cylinder, the sulphurous vapour enters the surface condenser, around the tubes of which cold water flows as in an ordinary steam plant. Here the sulphurous vapour is condensed to liquid and is forced by the pump, P, back into the vaporiser, where it begins its cycle again, the same SO_2 being used over and over again indefinitely. There are therefore, in fact, two condensers, the first serving, as it were, as a boiler or steam generator for the auxiliary engine; and this boiler, instead of being fired by coal, obtains all its heat from the exhaust of an ordinary steam-engine, and instead of converting water into steam, evaporates a liquid which is much more volatile—*i.e.*, has a far lower boiling point.

In the long series of recorded tests with the plant shown in the engraving herewith transmitted the following results were attained:

The steam-engine is of the compound type, of good, modern construction, and, being given a steady load, developed 34 i.h.p., with a consumption of 8·6 kg. (18·96lb.) of steam per indicated horse-power hour. The auxiliary machine working with the sulphurous vapour indicated 19 h.p.—that is, an increase of 56 per cent., and yielding, instead of 1 h.p., 1·56 h.p. for the same steam consumption and reducing the steam constmption from 8·6 kg. to 5·5 kg. (from 18·96lb. to 12·13lb.) per indicated horse-power.

The experiments showed on the average that for every 15 kg. (33·169lb.) of steam passing through the main engine, 1 h.p. could be gained in the auxiliary machine. Applied, therefore, to an ordinary single-cylinder steam-engine, exhausting into the air at high temperature, the percentage of power saved by this new device would be very much higher than the economy reached in these experiments, which, as has been shown, were made with a highly improved compound engine. From the average of these experiments, it may be broadly stated that, given a fairly economical compound engine, using 7½ kg. (16·5lb.) of steam per indicated horse-power hour, half an indicated horse-power could be produced in the auxiliary machine for every indicated horse-power developed in the main engine. Assuming an average vacuum of 60cm. (23·62in.), corresponding to a temperature of 60deg. Celsius (140deg. F.), the saving of heat must be accomplished by using a liquid which can be vaporised to a high pressure at or below that temperature. Assuming, further, the upper and lower limits of temperature within which the operation is confined to be 60deg. and 20deg. Celsius (140deg. and 67deg. F.), the pressure of the sulphurous vapour would range from 10·05 down to 2·35 atmospheres above open-air pressure. A working pressure as high as ordinary steam-boiler pressure is therefore readily obtained at a comparatively moderate temperature. Moreover, the volume of sulphurus-acid vapour necessary to contain the number of heat units corresponding to the work to be performed is much smaller than the volume of steam which would be required for the same purpose. As the saving to be effected by the auxiliary engine depends directly upon the difference between the highest and lowest temperatures involved, the greatest gain will, therefore, be made either when the water in the surface condenser is as cold as possible or when the heat of the exhaust steam from the engine is at a maximum, as is the case with a single-cylinder steam-engine without condenser, which may be anywhere up to 212deg. F.

The expense of this improvement is practically all in the construction cost of the vaporiser, condenser, and auxiliary engine itself, and its economy may be realised from the fact that the exhaust steam from a 2,000-h.p. central-station engine should furnish power to drive an additional 1,000-h.p. engine, which can be connected as an extra cylinder to the steam-engine or run independently, and thus increase by 50 per cent. the power developed without adding a pound to the quantity of fuel consumed. When in view of the present coal famine throughout Europe it is remembered that the steam-engine energy of Germany alone, afloat and ashore, is not less than 3,717,264 h.p., the commercial importance of such an improvement will be readily apparent.

FRANK H. MASON, Consul-General.

Berlin, Jan. 10, 1900.

Digitized by Google

POLYPHASE ELECTRIC TRACTION.*

BY PROF. C. A. CARUS-WILSON.

PART II.—ACCELERATION TESTS ON THE BURGDORF RAILWAY

(Concluded from page 851.)

Method of Deducing Results.—The apparent power input, obtained by multiplying together the instantaneous values of the voltmeter and ammeter readings, was plotted in kilowatts as a curve on a time base, and continued up to the point at which full speed was reached, as shown by the speed indicator readings, which were plotted on the same base. The power factor for any given watt input, being independent of the rotor resistance, is the same as when the motor is running synchronously with an equal input and with short-circuited rotor, and can be found from the curve given in Fig. 33. The true watt input was thus obtained and plotted beneath the curve of apparent watt input, the area enclosed by the curve giving the energy expenditure in watt-hours up to any given time. The weight of the train being known, the number of watt-hours per ton expended in bringing the train to full speed was then determined. In all the tests the experimental train started at the points shown in Fig. 4, and moved in the direction of Burgdorf, thus encountering successively a 300m. curve, a main-line crossing, and a second 300m. curve. After starting, the train ran for a distance of 1,700ft. on a level before reaching the grade of 1 in 47.

Criticism of the Tests.—Three sets of experiments were made with different trains—namely, one set of four tests with one motorcar and three trailers, the total weight being 68 tons; one set of three tests with one motorcar and two trailers, the total weight being 56 tons; one set of two tests with the motorcar by itself, the total weight being 32 tons. The observations obtained in two tests out of each set have been plotted and are given in Fig. 20. The automatic speed records are given in Figs. 21 and 22. At the time the tests were being conducted the automatic regulators governing the motion of the turbines in the power-house at Spiez were being overhauled, and consequently out of action, the governing being performed by hand. The result was that the speed of the generator, and hence the frequency, varied considerably, and this was shown in a variation of the speed of the train when full speed had been reached. The variations in the power input are due in part to irregularities in handling the controller, but the most important variation is caused by the large drop that takes place in the tension. The transformer stations are about two miles apart, and the tests were conducted on a portion of the line about midway between two stations, and, therefore, at a point where the drop is a maximum. The effect of the drop is shown in the diminished input and the consequent reduction of torque and acceleration at the moment of starting, resulting in an energy expenditure about 10 per cent. more than would be required if the tension were kept constant. The speeds given in Fig. 20 were obtained from the indicator readings in all cases but that of Test No. 3, where they were deduced from observations made from dropping clay balls on the track at noted time intervals and afterwards measuring up the corresponding space intervals. In Test No. 1 the motors were switched off before full speed had been reached. In Test No. 7 the trolley jumped off the overhead wire when the car struck the main crossing, causing a drop in the power input and in the acceleration.

TABLE II.—Acceleration Tests.

Railway.	Test No.	Max. speed, m. p. h.	Weight of train per motor. tons.	Acceleration f. p. s. per sec.	Time to full speed, secs.	Max. KW. input per motor.	Watt-hours per ton.	Watt-hours per motor.
Burgdorf Railway (polyphase)	3	23	17	0·48	70	53	52 6	896
" " "	6	23	14	0·60	56	53	52 8	741
" " "	8	23	8	1·20	28	53	41·5	332
" " "	9	23	8	1·08	31	53	48·8	391
" " "	8	24	8	1·17	30	53	45·1	361
" " "	9	24	8	1·07	33	53	53·2	425
Chicago Railway (continuous current)	—	23	9·5	1 12	30	75	34·7	330
" " "	—	24	9·5	0 95	37	75	39 5	375

The Results of the Tests.—The areas of the true power curves in Tests 3, 6, 8, and 9 have been calculated up to the point at which a speed of 23 miles per hour, or 33·6ft. per second, was reached, and the areas of the curves in Tests 8 and 9 have also been calculated up to 24 miles per hour, or 35·2ft. per second. The results are given in Table II. The energy expended per ton of load moved increases with the number of tons per motor. The reason of this is that the energy is proportional to the time occupied, and the time increases in a greater ratio than the load. Thus, if the load per motor is increased by 75 per cent., the time is increased 100 per cent. and energy per ton 14 per cent. This shows the importance of ample driving force, and the value of high initial acceleration in obtaining good efficiency. The best results were obtained in the tests with the motorcar alone, when each of the four motors had to move a weight of only eight tons, and of these results the lowest energy expenditure was observed in Test No. 8, where 41·5 watt-hours per ton was the energy expended in getting up a speed of 23 miles per hour. With the motorcar and two trailers, giving a weight of 14 tons per motor, the energy expenditure rose to 52·8 watt-hours per ton. In calculating these results, the power factor has been taken rather too large, so that the actual energy expenditure is somewhat lower than the values given above.

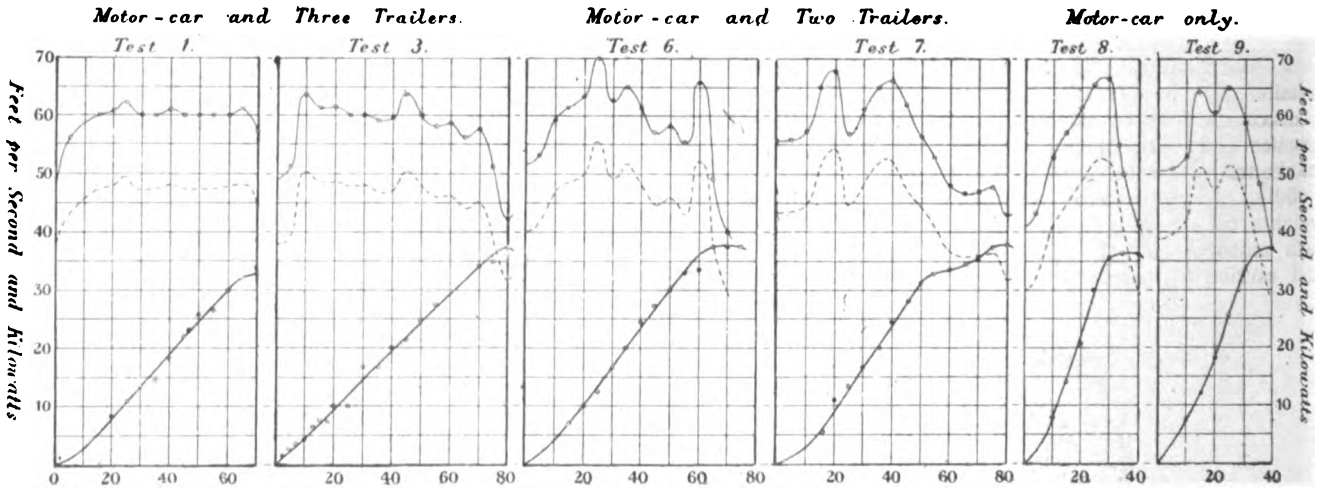
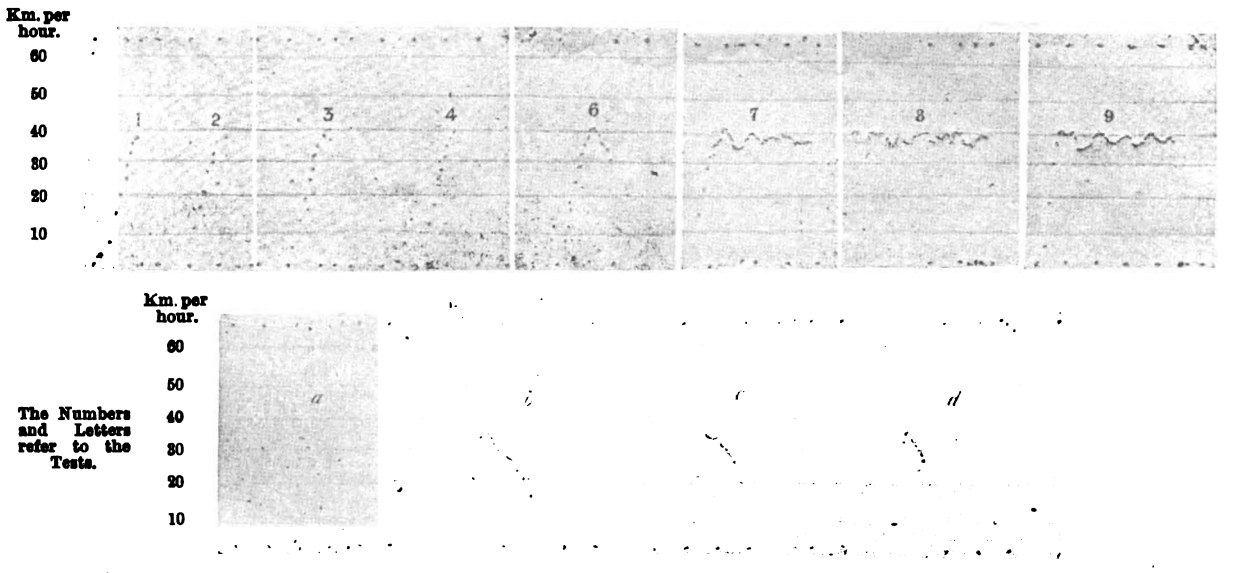


FIG. 20.—Acceleration Tests, Burgdorf-Thun Railway.

* Paper read before the Institution of Mechanical Engineers.

Digitized by Google

Comparison of these Results with those obtained with Continuous Currents.—One of the most recent continuous-current railway equipments is that installed on the South Side Elevated Railway at Chicago, a full account of which was given in a paper read by Mr. F. J. Sprague before the American Institute of Electrical Engineers on May 16, 1899. The trains on this railway are made up of motorcars operated on the Sprague multiple-unit system. Each car weighs 19 tons, and is equipped with two motors



FIGS. 21 AND 22.—Full-Size Automatic Records of Acceleration Tests.

making 9·5 tons per motor. The diameter of the driving wheel is 33in.; there are 65 teeth in the spur wheel and 22 in the pinion, making the gear ratio 2·95. The tension of the line is 650 volts at the switchboard and 600 at the cars. The motors, made and installed by the General Electric Company, are rated at a maximum output of 52 h.p. at 500 volts, though in practice they are driven considerably beyond this, the maximum horizontal tractive effort actually exerted being 1,900lb. Series-parallel control is used. To compare the weights of the cars in the two cases, we may note that each motorcar on the Burgdorf Railway weighs 32 tons and carries 66 passengers, giving 1,070lb. per passenger.

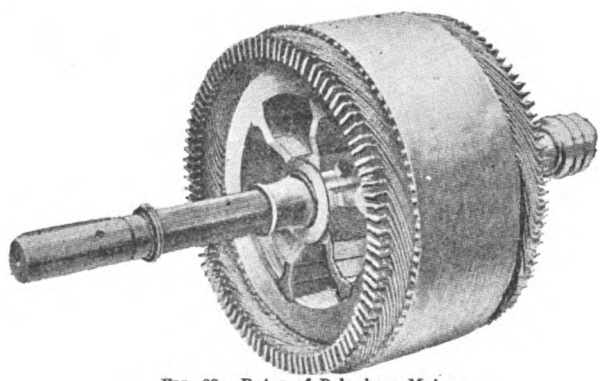


FIG. 23.—Rotor of Polyphase Motor.

Each car on the Chicago Railway weighs 18·2 tons and has seats for 40 passengers, giving 1,020lb. per passenger, so that there is but little difference between the two equipments in this respect. A complete series of tests was made at Chicago on Sept. 3, 1898, and is described fully in the paper referred to above. The results of two of these tests, which are typical of the rest, have been inserted in Table II., while the curves are given in Fig. 26 It will be seen that the continuous-current equipment can get up a speed of 23 miles per hour with 34·7 watt-hours per ton in 30 seconds, as compared with 41·5 watt-hours in 28 seconds with the three-phase equipment. Similarly, the continuous-current motors get up 24 miles per hour with 39·5 watt-hours in 37 seconds, as against 45·1 watt-hours in 30 seconds for the three-phase motors. Thus, for the lower speed, the continuous-current motors use 84 per cent. of the energy used by the three-phase motors, while for the higher speed the proportion is 87 per cent., while in the latter case the three-phase motors get up full speed in 81 per cent. of the time taken by the continuous-current motors. The reduction of energy in the continuous-current motors is due to the use of the series-parallel controller (compare Fig. 30). Comparing the maximum power input in the two cases, it will be observed that the power curves of the continuous-current equipment show a maximum of 150 kw. for two motors, or 75 kw. per motor, as against 53 kw. per motor in test No. 8 with the three-phase equipment. In some of the tests made at Chicago the maximum input reached 90 kw. per motor, but this was because the controller was not properly handled. The large majority of the tests gave 75 kw. as the maximum power input. It thus appears that the maximum power input as obtained in actual practice with the three-phase motor is only 70 per cent. of that with the continuous-current motor.

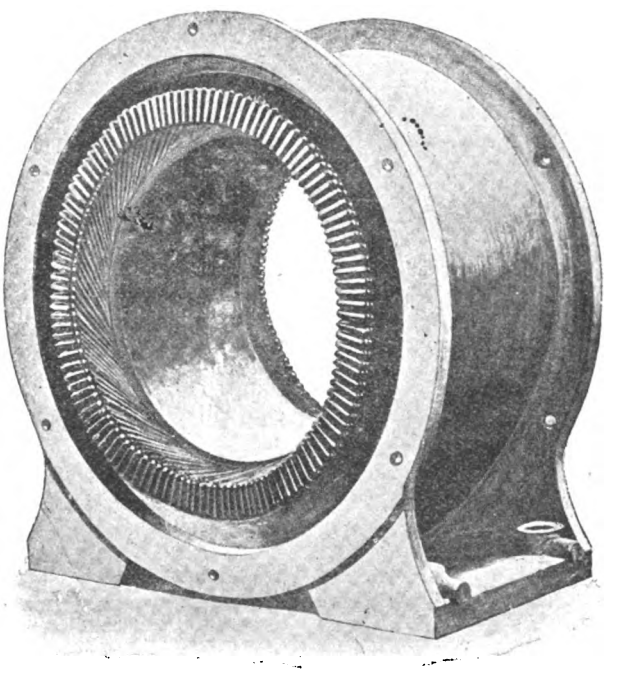


FIG. 24.—Stator of Polyphase Motor.

Conclusion.—The tests described above were made with the object of ascertaining the ability of polyphase motors to get up speed under ordinary conditions of railway service, and the economy obtainable in so doing when compared with that observed with the best continuous-current motors. The results of the tests go to show that polyphase motors are admirably adapted to getting up speed, and that the acceleration can be maintained uniform up to full speed. A comparison of the results with those obtained with one of the best and most complete continuous-current equipments shows that there is very

Digitized by Google

little difference between the two in economy of starting. The continuous-current motors have a slight advantage in the amount of energy expended, while they occupy a longer time in reaching high speeds, and require larger maximum power inputs than the polyphase motors. The author wishes to record his indebtedness to the following gentlemen for assistance rendered during the

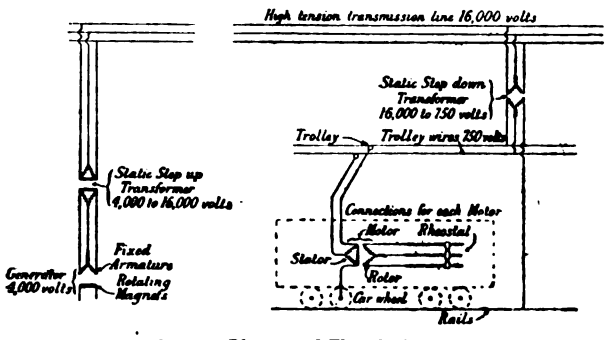


FIG. 25.—Diagram of Electric Circuits.

tests: Mr. K. Krähenbühl, engineer of the Burgdorf-Thun Railway; Dr. E. Blattner, professor at the technical college at Burgdorf; Messrs. E. Thomann, J. Landolt, H. Morgenthaler, and M. G. S. Swallow, engineers at Messrs. Brown, Boveri, and Co. He would also like to express his thanks to the firm of Messrs. Brown, Boveri, and Co. for the kind way in which they have provided him with data and information, and also to the management of the Burgdorf-Thun Railway, who afforded every facility for making the tests.

APPENDIX A.—*The Polyphase Motor.*

The action of a polyphase motor may be likened to that of a continuous-current motor, in which both the fields and the armature are capable of rotation. Supposing the fields of such a motor to be fully excited, and rotating at full speed with the armature at rest, a current of any desired

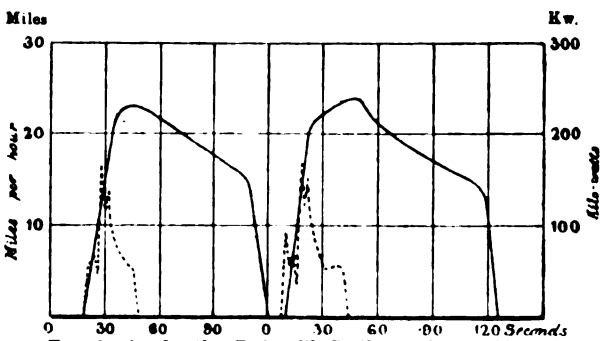
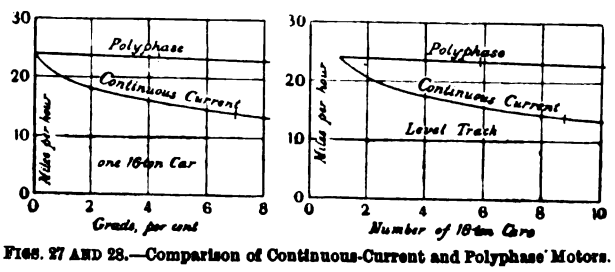


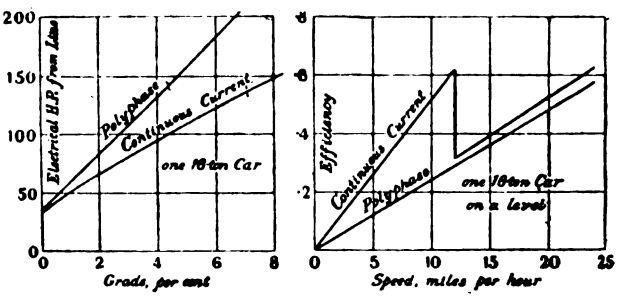
FIG. 6.—Acceleration Tests with Continuous-Current Motors.

magnitude may be induced in the armature by simply short-circuiting it, since the generation of a current depends simply on the relative motion of the fields and the armature. The torque produced by the action of the fields on the induced current will tend to turn the armature, and if the fields be kept rotating at a uniform rate, the armature will speed up until the relative motion of the fields and the armature is sufficient to generate a current that exactly balances the load; uniform speed has then been reached. The slip, or the difference between



FIGS. 27 AND 28.—Comparison of Continuous-Current and Polyphase Motors.

the speed of the armature and the speed of the fields, is generally stated in per cent. of the speed that would be reached if the load were nothing—that is, if the armature were rotating at the same speed as the fields. This speed is spoken of as the speed of synchronism. In a polyphase motor the rotation of the field is produced by magnetising the fixed part, or stator, by two or more alternating currents in such a way that the resultant magnetic field rotates at a uniform speed. In the motors used on the Burgdorf Railway three alternating currents are used, differing in phase by 120deg. One great advantage of such a motor over the continuous-current motor is found in the absence of a commutator, for the current in the armature, or, as it is called, the rotor, can



FIGS. 29 AND 30.—Comparison of Continuous-Current and Polyphase Motors.

be induced by short-circuiting its coils through a simple form of slip-ring, the current from the line being led directly into the stator without any moving contacts. Fig. 23 shows the rotor and Fig. 24 the stator of a 150-h.p. polyphase motor.

Clearance.—In a polyphase system the ratio of the current usefully employed to that generated, as measured

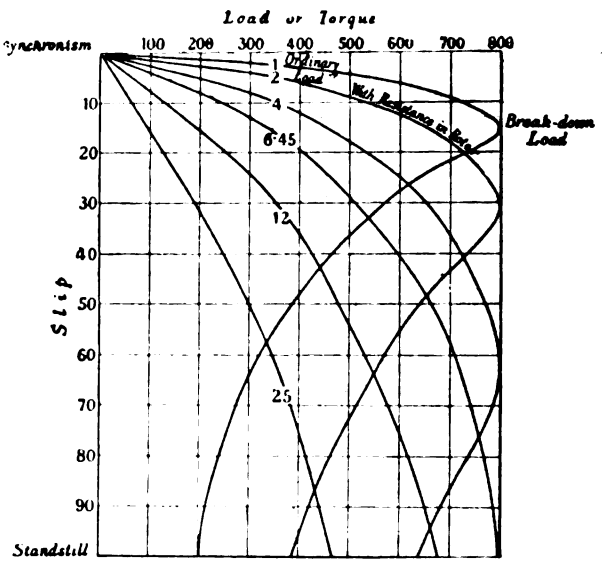


FIG. 31.—Load Curves of Polyphase Motors.

by the power factor, depends mainly upon the width of the space between the fixed and moving parts of the motor. Hence it is of great importance to reduce the clearance to the smallest limit consistent with safety. Thus the 64-h.p.

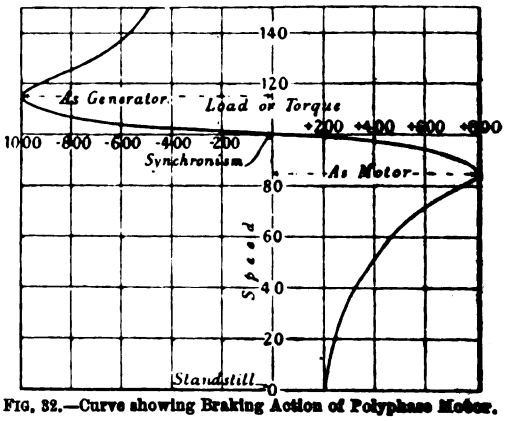


FIG. 32.—Curve showing Braking Action of Polyphase Motor.

motors on the Burgdorf Railway have a clearance of 1·5mm. on a radius and the 150-h.p. motors have a clearance of 3mm. This necessitates very careful construction, and special precautions have to be taken to prevent any chance of contact between the rotor and the stator. Figs. 6 to 9 give the details of the construction of the 150-h.p. motors on

Digitized by Google

the Burgdorf Railway. Some mechanical engineers consider the necessity of such a small clearance to be a fatal objection to the use of polyphase motors on railways, but experience shows that such motors can be constructed to run continuously without accident.

Variation of Speed with Load.—In a polyphase motor the speed is practically independent of the load. Thus the 64-h p. motors on the Burgdorf Railway run at full load with a slip of only 1·8 per cent. This is in marked contrast to the action of a continuous-current series-wound motor, such as is generally used on electrical railways, in which a reduction of speed of 40 per cent. from no load to full load is not uncommon. Figs. 27 and 28 show the speed variation of the Burgdorf motor compared with that of a standard continuous-current motor, firstly with constant load and varying grade, secondly with level track and varying load. The polyphase motor maintains the speed at the expense of a corresponding amount of power, while the continuous-current motor economises power at the expense of speed, as shown in Fig. 29.

Maximum Load.—In Fig. 31 is given the variation in speed from standstill to synchronism of a polyphase motor with different loads. Following the curve marked 1, it will be noticed that as the load increases the speed gradually decreases, until for a load of 300, for instance, the slip is 2 per cent. As the load still further increases the speed falls off in a greater ratio, until the maximum load of 800 is reached, where the slip is about 15½ per cent. This is the breakdown load. If the load be increased beyond this the motor cannot recover itself, and is brought to a standstill. In practice the maximum working load should not exceed 50 to 60 per cent. of the breakdown load.

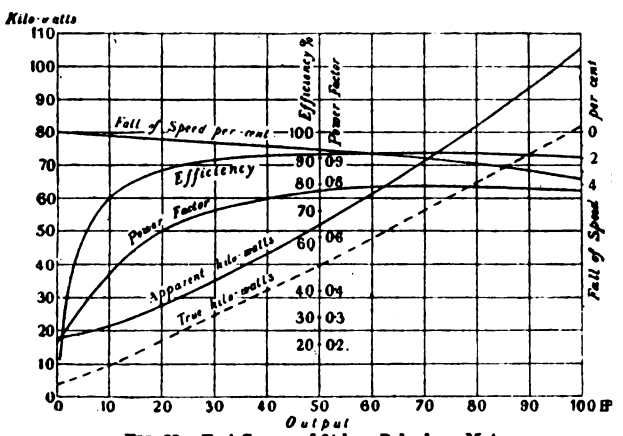


FIG. 33.—Test Curves of 64-h.p. Polyphase Motor.

Thus in the Burgdorf motors the maximum working load is 1·8 of the normal.

Speed Regulation.—If a resistance be placed in the circuit of the rotor so as to increase the total resistance, say to double it, the action of the motor will be represented by the curve lettered 2 in Fig. 31, in which the slip for equal torque is double what it was with the original resistance. The maximum torque is the same as before, but takes place with a slip of 31 per cent. instead of 15½ per cent. Thus with any load any required speed can be obtained by merely altering the rotor resistance. The polyphase motor is therefore capable of perfect speed regulations for all loads. The efficiency at reduced speed is, of course, less than that at full speed on account of the heating of the rheostats. The polyphase motor herein resembles the continuous-current motor, but it is at this disadvantage, in comparison, that it is not possible to couple two polyphase motors together in the way that two continuous-current motors can be coupled in the series-parallel method of control. The superiority of the continuous-current motor in this respect has, however, been somewhat overstated, seeing that is only for speeds less than half of full speed that the motors can be put in series. This point is illustrated by Fig. 30, which gives the comparative efficiency at equal load and different speeds of a polyphase and continuous-current equipment. For heavier loads the advantage of the latter would be reduced.

Action when Descending a Grade.—The speed curve No. 1 in Fig. 31 is reproduced in Fig. 32, and continued in order to show the action of a polyphase motor when driven above synchronism—as, for instance, when a train is descending a grade. It will be seen that as the speed increases above synchronism a negative torque is applied, and the motor acts as a generator, returning current into the line, and thereby retarding the motion precisely as if mechanical brakes were being applied. The maximum torque that can be thus applied is greater than its breakdown torque as a motor, but the slip at the maximum torque is the same. This is a feature of great importance, for not only does the polyphase motor act as an efficient brake in descending a grade, but the energy of the descent is returned into the line and is available for driving other trains. Thus, on the Engelberg Railway, which is a mountain railway worked by polyphase motors, the trains descend a 25 per cent. rack grade held only by the brake action of the motors, which keeps the speed at 4 per cent. above synchronism. Part of the current delivered into the line drives another train up a 5 per cent. grade, the remainder being used up in a rheostat.

Starting.—From Fig. 31 it will be seen that there is a certain rotor resistance corresponding to standstill with maximum torque, in this case 25 times as much as the resistance of the rotor itself. If the rotor resistance has this value at the moment when the motor is connected to the line, it will start with its maximum torque. If the resistance is taken out of the circuit as the motor speeds up, the torque can be maintained constant and equal to the maximum starting value up to full speed for that load. In other words, the torque, and therefore the acceleration, can be maintained constant practically up to full speed. It follows that the speed curve of a train driven by polyphase motors shows uniform acceleration up to full speed. Compare the speed curves given in Fig. 19.

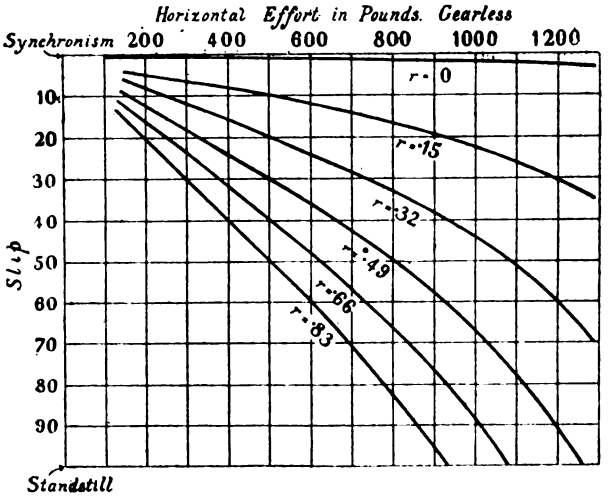


FIG. 34.—Load Curves of 64-h.p. Polyphase Motor

APPENDIX B. — *Particulars of the Motors used on the Burgdorf Railway Motorcars.*

The stator winding consists of 51 turns per phase, and is connected up in mesh. When hot, the short-circuited resistance of the winding per phase is 0·71 ohm. The rotor winding consists of eight turns per phase, and is connected up in star, the short-circuited resistance per phase being 0·0135 ohm hot. The characteristic features of the motors are well shown by the curves given in Fig. 33. These were obtained by brake tests made with motors of the same type as those used on the Burgdorf Railway, and differing from them only in the width of the clearance, which was 1·25mm., as compared with 1·50mm. in the Burgdorf Railway motors. Owing to the low internal resistance the speed is very uniform, the slip at full load being only 1·8 per cent. For the same reason the efficiency at full load is high—namely, 92 per cent. The large value of the apparent watts at no load indicates a large magnetising current, amounting to 24 amperes or, 28 per cent. of full-load current. The good efficiency at full load, however, shows that the wattless component is a more important element in the magnetising current than the hysteresis component; in other words, that the pre-

Digitized by Google

dominant factor in accounting for the large no-load current is the width of the clearance. This is further evidenced by the rapid rise of the efficiency curve, giving relatively good efficiencies at light loads. The large wattless component also influences the form of the power-factor curve, making it rise very slowly at first and reach its maximum at about full load. The wider clearance in the Burgdorf motors will, of course, influence the form of the power-factor curve, lowering it throughout its length. Hence the values of the true watts obtained by taking the power factors given in the curve sheet will be too high. This must be borne in mind when the results of the tests are considered.

APPENDIX C.—*Coasting Tests with Polyphase Motors.*

In Fig. 22 are given the automatic speed curves obtained by bringing a single motorcar up to full speed and then allowing it to coast, with the current cut off, before applying the brakes. The data of these tests are given in Table III.

TABLE III.—Coasting Tests on the Burgdorf Railway. One Motorcar of 32 Tons.

Curve letter.	a	b	c	d
Starting time	0′ 00″	0′ 00″	0′ 00″	0′ 00″
Current switched off after	0′ 25″	1′ 0′	0′ 59″	0′ 30″
Stop	1′ 00″	2′ 10″	1′ 55″	0′ 75″
Distance travelled, metres	500	1,100	900	600
Gradients	1 in 113 up	level	1 in 113 up	level
Starting current for four motors, in amperes, per phase	240	240	240	250

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

At an ordinary meeting of the above society on the 15th inst., the president, Mr. David Home Morton, M.I.C.E., in the chair, Prof. Alexr. MacLay, B.Sc., M.I.M.E., read a paper on "Technical Colleges in Germany." In the early portion of his paper Prof. MacLay outlined the preliminary training of the young German, which compared fabourably with Board schools in this country. Passing from this primary school, the student entered the middle school, and from this to real schools (Realschulen), the latter giving a higher education similar in many repects to the modern side of many of our own schools. Proceeding, the professor dealt more particularly with technical high schools, and sketched briefly the educational courses through which the student had to pass. In most cases they were modelled on lines similar to the technical colleges in our country—viz., a thorough grounding in pure science during the first and second year, gradually changing to a more specialised course. During the latter portion of a student's college career practical work in the laboratory, and such experimental work as had a direct bearing on the professional career of the student, formed the major portion of a session's work. Students generally spent 36 to 45 hours per week, starting at 8 a.m., and sometimes 7 a.m, while in this country the hours at similar institutions are 30 or 35, and fees generally for day classes 50 per cent. higher. Evening instruction was conspicuous by its absence. Not only were the necessary subjects, such as chemistry, mathematics, mechanics, steam, electricity, etc., taught, but budding engineers, chemists, and electricians attended lectures on political science, jurisprudence, hygiene, and similar subjects. These, although not entirely neglected in the technical institutions of our own country, did not form part of the recognised course of study for the diploma, although their importance was probably quite as great in producing a man of sound judgment. Proceeding to deal with the equipment and staff of these institutions, Prof. MacLay showed many slides showing the interior of the classrooms and laboratories, many of which rivalled, and not a few seemed to excel, similar institutions in our own country. Electrical engineering seemed in many of the more important colleges to have become a separate section, and great attention was devoted to it. In one of the colleges the author had seen an electric crane of 2½ tons capacity, fitted with three motors, used for lifting the heavy machines in the engineering laboratory. The teaching staffs of these colleges was remarkable, not only in respect of their professional status, but in numbers. One college had in the department of metallurgy and chemical technology no less than 41 teachers; other schools had in similar departments numbers varying from 12 to 40, depending on the size of the town and the nature of the local industries. Great attention was paid to what was being done in other countries; as an instance, the library of the school at Aachen had 250,000 specifications of English patents on its shelves.

An interesting discussion took place, at the close of which Prof. MacLay was awarded a hearty vote of thanks for his valuable paper.

PROMPT DELIVERY AND ERECTION.

English manufacturers have not a good name for prompt delivery, and it is no uncommon thing to hear of promises broken. It is, therefore, refreshing to hear of an electric lighting station in this country which placed an order for a 500-kw. steam alternator at the end of November, and had it running in time to take part of the Christmas load. This is the case of the Sheffield Corporation, who, on Nov. 28 last, acting on the advice of their chief engineer and manager, Mr. S. E. Fedden, decided to purchase one of Parsons steam turbo-alternators to help them over the Christmas load. The order was, therefore, sent off by telegram to Paris, where the machine was still standing in the position it had occupied throughout the exhibition. It was immediately taken down, packed, and dispatched to Sheffield, and on Dec. 21 it was running with 200 amperes at about 12 o'clock noon. This machine was no light weight to be taken by passenger train, as it weighed some 14 tons. It was of Messrs. C. A. Parsons and Co.'s 500-kw. capacity type.

Besides the plant, the question of steam and exhaust mains had to be promptly taken up. Thus the 16in. exhaust mains and steel riveted steam mains were ordered as soon as the drawings could be made out, and were delivered in about 17 days. When they came to be erected in the turbine, they were found to fit accurately. The steam and exhaust piping was supplied by Messrs. Tasker's Engineering Company, of Sheffield. We agree with Mr. Fedden in his opinion that great credit is due to both these firms for the smart and able way in which the whole of the work referred to has been carried out. At the same time a large share of the credit should be given to Mr. Fedden himself.

LIGHT RAILWAYS.

With regard to the proposed light railway to Arkholme, we learn that the appeal to the landowners in the county of Westmoreland to subscribe £10,000 having failed, the scheme has been practically abandoned.

At a recent private meeting of the Bridlington Town Council it was decided to oppose the application of the promoters of the proposed light railway from Bridlington to Flamborough for an extension of time for commencement of the construction of the works until March, 1902. The Council are contemplating an expenditure of about £10,000 in the widening of Clough Bridge, and the opponents of extension maintain that no practical benefit will accrue if after the widening of the thoroughfare the railway lines are laid down. It is said that the railway promoters have voluntarily offered to contribute towards the cost of widening the road.

A committee has been appointed by a recent meeting of the villagers of St. Combs and Charlestown in connection with the order obtained for the Fraserburgh and St. Combs light railway. A Treasury grant of £5,000 has been obtained. Mr. Charles Buchan, St. Combs, has been appointed convener, and Mr. Archibald Strachan secretary to the joint committee.

An application has been made to the Board of Trade to extend the limit fixed by the Ramsgate light railway order by two years as far as sections Nos. 4 and 8 are concerned.

The promoters of the Tanat light railway from Llangynog to Oswestry have received an intimation from the Treasury that the free grant will be increased by £10,000. The capital

Digitized by Google

required is not wholly made up, but there is every probability that it will be forthcoming shortly. In the case of the proposed light railway from Welshpool to Llanfair, the free grant has also been augmented by £7,500. All the capital is now guaranteed.

Last week the Lord Chancellor, Lord Macnaghten, Lord Shand, and Lord Robertson dismissed the appeal *re* Wallasey United Tramways and Omnibus Company *v.* Wallasey Urban District Council, and the *Morning Post* says that lawyers appear to be in agreement that the decision of the House of Lords in the above most important case governs the action of the Reading Tramways Company, Limited, *v.* the Corporation of the Borough.

The Commissioners have intimated to the promoters that they hope to submit the order authorising the Blackpool and Garstang light railway to the Board of Trade for confirmation before the end of this year.

We notice that the Flamborough Parish Council have received an application for an extension of time for the completion of the Flamborough and Bridlington light railways.

A public meeting of the inhabitants of Dingwall was held recently to express appreciation of the services of Mr. Arthur Bignold, of Lochrosque, M.P. for the Wick Burghs, by whose instrumentality or influence a Treasury grant of £33,000 and a loan of £4,500 have been promised towards the Dingwall and Cromarty light railway scheme.

A report has just been submitted to the Glamorgan County Council asking them to assent to a resolution which, if adopted, will commit them to a scheme of considerable magnitude. The motion reads as follows: "That in the opinion of this Council it is desirable that tramways, or light railways in the nature of tramways, upon the roads in the county, shall be owned by the County Council or by district councils, and that the Parliamentary Committee be instructed to employ skilled advisers to prepare a scheme of the lines that may be advantageously promoted for the consideration of the Council. That until the Parliamentary Committee is reconstructed, in accordance with the new standing orders, a representative of each parliamentary division that is not now represented thereon be added to it for this purpose."

The Whitehaven Town Council have appointed a committee to report on the application for the order for the West Cumberland light railway. There appears to be some difficulty on account of the proposal to take powers to supply electric light within the Council's area, and also in regard to the purchase of the undertaking.

The Spen Valley light railway order and the Spen Valley light railway order (extensions) came before the Board of Trade on the 14th inst., on objections raised to their confirmation by the Corporation of Batley and the Urban District Councils of Heckmondwike, Liversedge, and Gomersal, and the Great Northern Railway Company. The promoters of the two light railway schemes are the British Traction Company. The Spen Valley light railway proposes to run from Cleckheaton, through Liversedge and Heckmondwike, and then over the hill to Dewsbury, and from there on to Ravensthorpe. The extension scheme is to go from Liversedge up to the Pack Horse and round to Cleckheaton, making a circuit; and there is another proposed branch from Liversedge, through Gomersal to Birkenshaw, to join the Bradford tramways. Sir C. Boyle said he should advise the Board of Trade, as to the extension order, to accept the order of the Light Railway Commissioners, but to make it absolutely clear that the powers of construction given (the light railway company should not commence until the owers of the Corporation entirely lapsed. As regarded Halifax-road, he would advise the Board that the preamble was proved, and that the Spen Valley light railway should be granted. He left open the exact terms of the running powers, but said the order should authorise the construction of the Board of Trade line and its user, subject to regulations which may be approved by the Board. The matter was subsequently discussed, and finally it was agreed that the Corporation should construct the lines, with running powers to be mutually agreed upon between the light railway and the Corporation, and in case of disagreement as to the exact terms, they were to come before the Board again. The order was settled accordingly.

At the last meeting of the Loughborough Town Council the Town Clerk reported that, acting on instructions, Alderman Bumpus and himself had obtained an interview and discussed with the secretary of the Light Railway Commissioners the representations he (the town clerk) had formally lodged on behalf of the Corporation with the Light Railway Commissioners with respect to the Loughborough and district light railway order, as proposed to be issued by the Commissioners, owing to the alterations or omission therefrom of the agreed amendments and additions for the protection of the Corporation, and, as a result, a number of further alterations had been provisionally made in the proposed order, though not in every case in the manner sought by the Corporation, and a number of other points required settling. After the explanatory statement by the town clerk, it was resolved to approve of the action taken so far, and to instruct the Parliamentary Sub-Committee to continue their efforts for securing such provisions in the order as will meet the requirements of the Corporation.

The Commissioners have addressed a communication to the Middlesex County Council on the subject of the light railways joint order promoted by the Council and the Metropolitan Tramways and Omnibus Company, Limited, and the agreement between the two parties. The letter states that upon consideration of the arrangement and the various difficulties in the way of giving effect to it, and also of the advantage, as the Commissioners conceive it, of settling this order directly in accordance with the course which it is practically determined to follow as soon as the order is confirmed, the Commissioners are of opinion that the powers of the intended order should be given direct to the County Council, the agreement between the parties holding good in all other respects in the same way as with the Middlesex (No. 2) order. After due consideration of the question, and hearing the views of the company's representative, the County Council has resolved to agree to the suggestion made by the Commissioners for the order to be issued to the County Council alone, and to enter into a further agreement with the company to meet the altered position of affairs. The effect of this is to place the County Council in the same position as if it had exercised the option of purchase provided for by one of the clauses in the agreement with the company.

At the enquiry last week into the application of the Southwold Railway Company for an extension of their line from Southwold to Kessingland, and the widening of the present system between Halesworth and Southwold, the Commissioners reserved their decision.

At the last quarterly meeting of the Glamorganshire County Council a resolution was adopted to the effect that it was desirable that tramways upon the roads in the county should be owned by the County Council or by district councils, and that the Parliamentary Committee be instructed to employ skilled advisers to prepare a scheme of the lines that may be advantageously promoted for the consideration of the Council.

The Board of Trade have recently confirmed the following light railway orders: (1) Gosforth and Ponteland Light Railway Order, 1900, authorising the construction of a light railway in the county of Northumberland and Ponteland; (2) Wotton-under-Edge Light Railway Order, 1900, authorising the construction of a light railway in the county of Gloucester, between Wotton-under-Edge and Charfield; (3) Rhyl and Prestatyn Light Railways (Extensions) Order, 1900, authorising the construction of light railways in the parish and urban district of Rhyl, in the county of Flint, in extension of the light railway authorised by the Rhyl and Prestatyn Light Railway Order, 1900.

PRACTICAL COLOUR PHOTOGRAPHY.

A number of gentlemen attended at the Queen's Hall last week, by invitation of Mr. Robert Newman, to view specimens of what were called natural-colour-photograms prepared by the McDonnough process. They consisted of reproductions of landscapes, and copies of paintings, portrait studies, and various inanimate objects. The portraits especially were all that could be desired, and their colouring was, if anything, even better than that of the landscapes. Some of the latter did not show to their best advantage, as the operator was handicapped by a very inefficient lamp. The exhibition proved that these beautiful and very lifelike photographs can be obtained with extremely rapid exposures, and, according toMr. C. N. Crewdson, who explained the views taken by him at Oberammergau, the manipulation of the process is perfectly easy even to the veriest amateur. The process consists of a combination of Ive's three-colour system of Prof. Joly's diffraction grating. Owing to the labours of the late Mr. McDonnough and Mr. D. K. Tripp, the way of taking these photographs has become a very simple one. All that is necessary is to obtain a screen, which consists of a plate of glass ruled alternately with fine parallel red, green, and violet lines. Of course, the negative shows no colour, but from it a positive transparency can be obtained, which by means of the same screen will give a picture in natural colours. The practical value of the process and one which can be hardly over estimated, consists in the fact that by its means coloured prints on paper may be obtained by methods of ordinary photography, and for larger editions of books, etc., by photo mechanical means by the aid of the printing press. The architect can, therefore, obtain accurate representations of stained glass windows, and with regard to this matter we notice that the views in which windows were introduced were entirely free from halation, and consequently beautiful representations of rooms, theatres, etc., lighted by electricity ought to be obtained by it. This would be a great help to those interested in the introduction of electric lighting where its advantages are not known. It will also effect an enormous saving of time and expense to manufacturers, as the traveller in ceramic ware, or carpets, or wall paper, or any other manufactures where it is indispensable that the true colours of the material should be submitted to the purchaser, can do all his business by exhibiting these photographs, instead of the tiles, vases, or whatever he deals in.

Digitized by Google

THE
ELECTRICAL ENGINEER.

Published every Friday.

Price Threepence; Post Free, Threepence Halfpenny

Editorial and Publishing Offices:

139-140, SALISBURY COURT, FLEET STREET,

LONDON, E.C.

CONTENTS.

Notes	901	On Rapid Variations in the Current Through the Direct-Current Arc	915
Practical Notes on Electric Mains	905	Questions and Answers	918
Increasing the Efficiency of Steam-Engines	906	Legal Intelligence	922
Polyphase Electric Traction	908	Companies' Meetings and Reports	922
Glasgow and West of Scotland Technical College Scientific Society	912	New Committees	922
Prompt Delivery and Erection	912	Contracts for Electrical Supplies	922
Light Railways	912	Lighting Notes	923
Practical Colour Photography	913	Traction Notes	926
The End of the Century	914	New Companies	927
Forthcoming Events	915	Provisional Patents	927
Correspondence	915	Traffic Returns	928
		Companies' Stock and Share List	928

TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

TO ADVERTISERS.

Advertisements should be addressed to the Publisher, 139-140 Salisbury Court, Fleet Street, E.C., and should reach him not later than noon of Thursday. **Special Terms** *for a series can be arranged on application.*

SITUATIONS WANTED will be charged at three words for One Penny (prepaid and net), with a minimum charge of Sixpence.

TO SUBSCRIBERS.

"THE ELECTRICAL ENGINEER" *can be had by Order, from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 month
nited Kingdom	3s. 3d.	6s. 6d.	13s. 0d.
Other Places	5s. 6d.	10s. 6d.	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to C. H. W. BIGGS, *139-140, Salisbury Court, Flee Street, London, and be crossed "Union Bank."*

Now Ready, Vol. XXV., bound in blue cloth, gold lettered price 8s. 6d.

THE END OF THE CENTURY.

If it be asked what is the most important topic for technical discussion at the end of the century, the answer will be the same as it was at the beginning of the century—prime movers. The progress of the century is due to two causes: (1) the increased perfection in locomotion due to steam, and (2) the celerity of transmission of news due to the developments in telegraphy. No doubt a great many would object to these views, and put as the cause of progress the spread of knowledge. We prefer to agree with Buckle ("Hist. Civ.," vol. i., p. 38), that knowledge is a result, and not in the first instance a cause; later on, however, knowledge accelerates progress. The indications at the close of the century point to still greater progress due to improvements in heat engines. There is an old axiom too often forgotten, that "Necessity is the mother of invention." The pinch of necessity has made it desirable to more largely utilise natural sources of power, and to obtain a greater conversion efficiency from a given expenditure of heat energy. Why else are so many schemes presented for the transmission of power over longer distances? The reason, of course, is greater efficiency; hence a lessening of cost to the consumer of energy. In the first instance transmission schemes contemplated the more economic use of existing apparatus, but within the past few days attention has been directed to great economies to be effected by using Mond producer gas and large gas-engines in power stations. Further, according to an American consular report, a gain of from 30 to 50 per cent. efficiency can be obtained from ordinary steam-engines. The exact words are: "Its economy may be realised from the fact that the exhaust steam from a 2,000-h.p. central-station engine should furnish power to drive an additional 1,000-h.p. engine, which can be connected as an extra cylinder to the steam-engine or run independently, and thus increase by 50 per cent. the power developed without adding a pound to the quantity of fuel consumed." Let us assume for the moment these improvements to be commercially practical. It is at once seen that even under conditions involving no further improvement than this, our coalfields receive a very long increase of life. Up to the present time the best central-station working requires at least "three pounds of coal per hour per average indicated horse-power." With the addition of the sulphurous acid apparatus, this would be reduced to two pounds of coal per hour, a quantity approximating to that used in good marine-engine practice. Of course, the ordinary central station uses a good deal more than this, but whatever be the quantity, the saving is immense. The question as to initial cost of apparatus and cost of maintenance presents no difficulty, and can in any special case be compared with the amount of one-third of the annual coal bill. It is more difficult to judge the true value of producer gas, but undoubtedly while it may prove of great use in the developing of large gas-engines, it will aid rather than displace the distribution of electric energy. Lastly, a cause

Digitized by Google

more detrimental to progress than any other is as rampant at the end as it was at the beginning of the century—it is ignorant legislation. Henry Bell devised the steamboat, he told his plans to Fulton, and with the latter carried out his plans in America, subsequently coming back to Glasgow and building the "Comet." The work of Bell in this direction is well recognised, but it is not so well known that he designed to introduce steam traction on common roads. His designs came to naught, and automobilism was retarded for a whole century because an ignorant Legislature would not permit the necessary high-pressure engines to be used. Perhaps, had the Legislature been wiser, railways would have developed differently—whether for the better is no use now to discuss.

To all Readers,

A HAPPY AND PROSPEROUS NEW CENTURY.

FORTHCOMING EVENTS.

SATURDAY, DEC. 29.

Royal Institution of Great Britain.—At 3 p.m., lecture on "The Earth and its Heat," by Sir Robert Ball.

TUESDAY, JAN. 1.

Royal Institution of Great Britain.—At 3 p.m., lecture on "The Evidence from the Stars," by Sir Robert Ball.

WEDNESDAY, JAN. 2.

Society of Arts.—Juvenile lecture in the afternoon by Mr. E. Walter Maunder, F.R.A.S., superintendent of the Solar Department, Greenwich Observatory, on "Eclipses."

THURSDAY, JAN. 3.

Civil and Mechanical Engineers' Society.—"The Case for Electrical Power Distribution," by Mr. W. B. Esson, M.I.C.E., M.I.E.E.

Rontgen Society.—At 8 p.m., ordinary meeting at 20, Hanover-square, W. Dr. J. H. Sequiera will show some cases of Rodent Ulcer treated with X Rays. Afterwards a paper on "Continental Progress in Practical Radiography and Apparatus," by Mr. A. W. Isenthal, will be read.

Royal Institution of Great Britain.—Lecture by Sir Robert Ball on "The Significance of Planetary Movements," at 3.

SATURDAY, JAN. 5.

Royal Institution of Great Britain.—"The Evolution of the Moon," by Sir Robert Ball, at 3.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

NERNST ELECTRIC LIGHT COMPANY.

SIR,—The criticisms made by Mr. Zusman at the recent meeting of the Nernst Electric Light Company, Limited, on me in my capacity as managing director of that company, have not unnaturally attracted interest and attention amongst my friends. It was arranged at the meeting that I would deal in detail at the adjourned meeting, in a month's time, with all these allegations, but in view of the interest which these remarks have created, as above mentioned, I would like to state that there is absolutely no foundation for any of the allegations, and that at the adjourned meeting of the company I shall have no difficulty in refuting them in the most complete and ample manner.—Yours faithfully,

BERNARD M. DRAKE.

82, Victoria-street, S.W., Dec. 20.

The above letter was also sent to the *Financial News*, which paper has received the following letter on the same subject:

"Sir,—My attention has been drawn to a letter in your issue of to-day from Mr. Bernard Drake, stating that it was arranged at the recent meeting of the company that Mr. Drake should deal with the allegations of Mr. Zusman at the adjourned meeting in a month's time. I was present at the meeting in question, representing a large number of shareholders, and I would remind Mr. Drake that it was distinctly arranged at that meeting that he should, without delay, lay his explanations before the shareholders by circular, so that they might have ample opportunity to consider them, and not wait until the holding of the adjourned meeting, as he now appears to contemplate.—Yours faithfully, AUGUST COHN.

15, Throgmorton-avenue, E.C., Dec. 22."

ON RAPID VARIATIONS IN THE CURRENT THROUGH THE DIRECT-CURRENT ARC.*

BY W. DUDDELL, WH.SC., ASSOCIATE.

(Continued from page 888.)

PART II.—CURRENT CAUSED TO VARY BY THE ARC.

Humming.—Mr. Trotter discovered that the direct-current humming arc rotates, including a coma-like appearance at the + crater, and he also found that the current through the arc varied periodically, the frequency of these variations being the same as the pitch of the humming sound produced and as the speed of rotation of the arc. In order further to investigate the connection between the variation of the light P.D. and the current, I have recorded the P.D. and current by means of an oscillograph, the humming arc experimented on being used as the source of light to illuminate the oscillograph mirrors. The arc was so inclined that only the light from the + crater and a small part of the vapour column reached the mirrors, so that the density at any point of the lines represents the photographic intensity of the light emitted at that instant in the direction of the mirrors by the + crater and part of the vapour column, and the distance of the point from this zero line measures the P.D. or the current as the case may be.† A typical example of the variations observed in the humming arc is given in Fig. 5, from which it will be seen that the P.D., current, and light emitted in a fixed direction vary in a regular periodic manner with the same frequency. The variation of the current, which is about 6 per cent. from the mean, is not sufficient to account for the large variation in the light emitted in the direction of the mirrors. This periodic variation of the light is most probably due to the fact that the arc rotates, so that the + crater alternately either supplies light to the oscillograph mirrors, or is prevented from doing so by being on the other side of the + carbon. The periodic time of the variations of the light will, of course, be unaffected by a change in the position from which the arc is observed, but the times at which the light maxima occur relatively to the times at which the current is a maximum will depend on this position. Thus, besides the rotation of the humming arc and the variation of the current observed by Mr. Trotter, I find that the light and P.D. vary with the same frequency, so that in the humming arc the frequencies of the rotation of the arc, and of the variations in the P.D., current, and light emitted in a given direction, are identical with the pitch of the note given out.

Hissing.—It has been shown by Messrs. Frith and Rodgers, and by Messrs. Duddell and Marchant, that when a direct-current arc supplied from a constant source hisses, the current through it and the P.D. between its terminals vary rapidly, and M. Blondel and Mr. Brown have also found that the light emitted varies. If the current through the humming arc be increased until the arc hisses, the variations in P.D., current, and light change, I find, in a most striking manner from the regular periodic variations of Fig. 5 to the very irregular variations shown in Figs. 6 and 7. In spite of the very irregular nature of the variations, which irregularity is not surprising in view of Mrs. Ayrton's explanation of the cause of hissing given before this Institution last year, I think that they can be separated into two kinds—a large comparatively slow variation, and a rapid superimposed one. The light given out is alternately bright, with rapid variations in intensity, *a* to *b* (Fig. 6), and dull with hardly any variations, *b* to *c*; the slow variation of the light corresponding with the larger variation of the current; the maximum light and current do not, however, occur simultaneously. In view of the explanation given in the case of the humming arc that the large variations of the light is due to its rotation, and in view of the fact that the hissing arc is also probably rotating, as pointed out by Mrs. Ayrton, I think that the larger variations of P.D., current, and light in the hissing arc must also be due to the rotation of the arc. If this is the case, then the brighter parts

* Paper read before the Institution of Electrical Engineers.

† In Figs. 5, 6, and 7 the centre line is not the zero line, but represents 20 amperes and 40 volts.

Digitized by Google

of the curves are produced by light from the + crater and the rapid variations of density chiefly present in these parts of the lines are due to the rapid variation of this light from the + crater. [Experiment.] Now, these rapid variations in the light correspond with the small rapid changes in the current and the P.D., so that the rapid variations of P.D. and current correspond with the variations of the light emitted by the + crater, and the large slow variations with the rotation of the arc as a whole. Considering one of the larger light maxima, say from *a* to *b*, or *c* to *d*, Fig. 6, during which the oscillograph mirrors receive the light from the + crater without being obstructed by the carbon, it will be seen that in many cases the maximum light and minimum P.D. occur practically at the same instant, whilst the maximum current occurs later than the

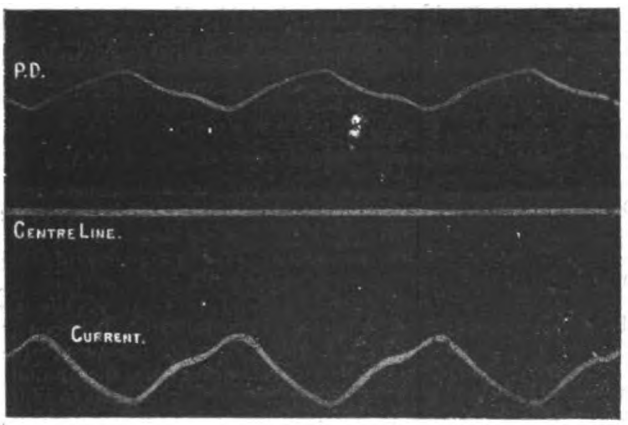


FIG. 5.—Humming Arc. Carbons +11 and −9 mm. Solid "Apostle." Mean P.D. = 50·5 volts. Mean current = 15·2 amperes. Scales: 1mm. = 0·5 volt = 0·186 ampere = $\frac{1}{640}$ second. Centre line = 40 volts = 20 amperes.

light maximum. This is the opposite to what occurs when the current through the arc is varied by any change in the circuit, for in this latter case the maximum current occurs before the light maximum. The periodically recurring sequence of events in the hissing arc is thus probably as follows, putting aside the rotation of the arc as a whole. Owing to the crater becoming too large for the end of the + carbon, the air obtains access to the crater surface as found by Mrs. Ayrton, the oxygen of the air there combines with the carbon, causing a rise of temperature, an increase of brilliancy, a drop in the P.D., followed very slightly later by a rise in the current. I think that the above observations on hissing and humming are explained by, and confirm, the fundamental nature of Mrs. Ayrton's discovery of the cause of the hissing of the arc.

Sounds Emitted by Very Short Arcs.—A very short hissing arc, so short that practically no light can get out from between the carbons, sometimes produces a shrill whistling sound, accompanied by a small tongue of green flame. The variation of P.D. and current for such an arc are given in Fig. 8, in which the current and P.D. have varied between two limits—viz., 22·5 amperes at 24 volts and 28 amperes at 9·5 volts—the former of which would produce a hissing arc, while the later values of the current and P.D. can only be explained on the assumption that the arc is short-circuited by a bad contact, such as a loose piece of carbon. The whistling sound is probably due to the periodical short-circuiting and relighting of the arc.

Sounds Emitted by Very Long Arcs.—The frying sounds emitted by very long arcs, noticed by Mrs. Ayrton, are probably due to the fact that long arcs are very sensitive as telephone receivers, as mentioned in Part I., so that very slight variations in the current will cause them to give out sounds. In confirmation of this it may be mentioned that a very long silent arc can be obtained if the arc is supplied with current from accumulators which are not in use for any other purpose, and if the arc circuit be so arranged that no variations of the current can be induced, or produced, in it by causes outside the arc. If, on the other hand, the direct-current arc be supplied by a dynamo, or if the arc circuit be placed so that there is mutual induction between it and leads carrying a dynamo current, then the long arc will give out a sound corresponding with rate at which the dynamo segments pass the brushes. This explanation was, I believe, first suggested by Prof. Ayrton and Mr. Mather.

Intermittent Arcs.—If a direct or alternate current arc be blown out by means of a jet of air or CO_2, or by means of a transverse magnetic field, it will, under suitable conditions, relight itself; and if the blowing be continued, the arc will be extinguished and relight itself again and again with great rapidity, giving out a harsh sound. The rapidity of these intermittances may be very great; M. Blondel has found them to be as high as 3,000 to 4,000 per second in the case of the alternate-current arc, and M. Abrahams has obtained 100,000 per second in the case of the same discharge. It was suggested by Prof. Fitzgerald that this intermittance of the arc might be used to produce some high-frequency alternating current which I required. I therefore tried rendering a direct-current carbon arc in series with a self-induction intermittent by means of a magnet. With this arrangement the rate of intermittance was irregular and not very high, probably owing to the E.M.F. of my source of supply being too low, although E.M.F.'s up to 300 volts were employed. In order to try and overcome this irregularity, I connected a condenser (about five microfarads) between the terminals of the arc, when to my surprise I found that the direct-current arc was intermittent even when not blown in any apparent way either by a stream of gas or by a magnetic field, and, further, that no self-induction in series with the arc was necessary. Here, then, was a puzzle—a direct-current solid arc burning under ordinary conditions with resistance in series, and supplied with current from accumulators, became intermittent and gave out a musical note on simply shunting the arc with a condenser. Leads were, of course, employed to connect the condenser as a shunt to the arc, and on twisting these leads together so as to destroy the small amount of self-induction which they possessed, I found that the musical note stopped, to be started again on separating the leads; and on interposing in the condenser circuit a loose coil of wire, the sound was greatly magnified. Hence the true statement of the facts is that given below.

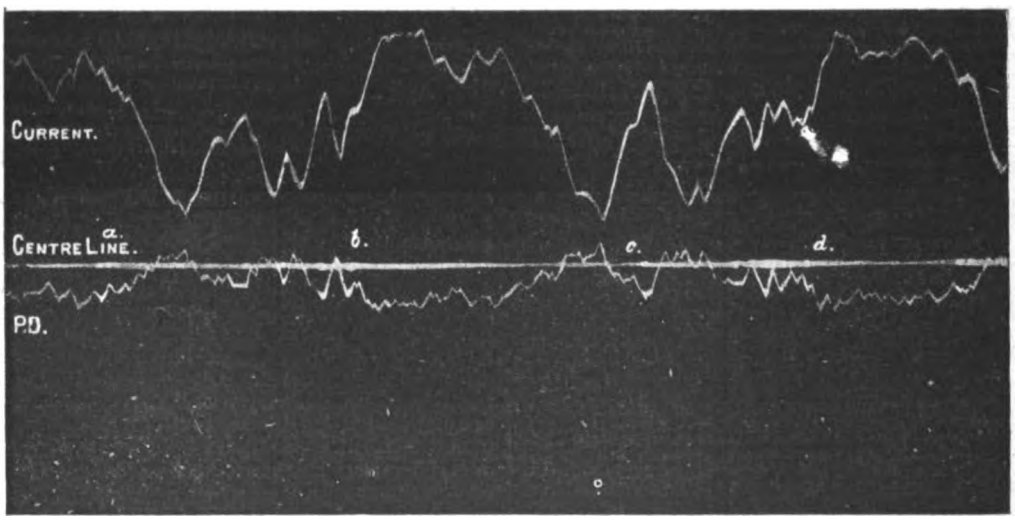


FIG. 6.—Hissing Arc. Carbons +11 and −9 mm. Solid "Apostle." Mean P.D. = 38 volts. Mean current = 22·3 amperes. Scales: 1mm. = 0·5 volt = 0·1 ampere = $\frac{1}{640}$ second. Centre line = 40 volts = 20 amperes.

Musical Arc.—A direct-current arc of suitable length and current, between solid carbons, will give out a musical note if it be shunted with a condenser in series with a self-induction, as in Fig. 9, even though the source of supply of the current be perfectly constant and the arc be protected as far as possible from any outside cause of disturbance. [Experiment.] I find that the musical note is produced by oscillatory currents flowing in the circuit composed of the condenser, F, the self-induction, L, and the arc (Fig. 9), and its pitch is determined

Digitized by Google

by the periodic time of this circuit—that is, on the relation between the capacity, self-induction, and effective resistance of the circuit. Neglecting the resistance, which it will be shown later must be small, the periodic time of the circuit $\tau = 2\pi\sqrt{L.F.}$, and this has been found, by judging the pitch of the note by ear, to be approximately correct, so that for lecture purposes Kelvin's law can by this means be easily demonstrated. It must be remembered that, although we have an alternate current through the condenser and self-induction, the source of supply is not an alternating one, and that it is the arc itself which is acting as a converter and transforming a part of the direct current into alternating, the frequency of which can be varied between very wide limits by altering the self-induction and capacity. The upper limit I find to be about 10,000 ~ per second, and the lower limit, if such exists, is well below 500 ~ per second. It has long been known that a train of oscillations of almost any frequency can be obtained on discharging a condenser through a suitable inductive resistance, but, of course, these oscillations have a rapidly decreasing amplitude; and the means of supplying energy to such a circuit so as to maintain the amplitude of the swings constant, other than by means of a varying source of power having the same periodic time as the circuit, has been wanting. It is, therefore, necessary to enquire under what conditions it is possible for the arc to cause the source of direct current to supply the energy necessary to maintain the oscillations in the condenser circuit when once they have been started. If the resistance in the main circuit in series with the arc is large, and if the δ V be a small instantaneous change in the P.D. between the terminals of the arc, δ A the corresponding small change in the current through it, and r the resistance of the condenser circuit, not including the condenser; then, during the time this small change lasts, sufficient energy may be supplied to the condenser circuit to make up for the energy dissipated there, in ohmic loss, if the following conditions are fulfilled:

1. $\frac{\delta V}{\delta A}$, negative.
2. $\frac{\delta V}{\delta A}$, numerically greater than r.

The question is, Can the arc fulfil these two conditions? Messrs. Frith and Rodgers have experimentally determined the value of $\frac{\delta V}{\delta A}$, which they call the resistance of the arc, for various arcs, and they found that while $\frac{\delta V}{\delta A}$ was always + when both carbons were cored, it was, on the contrary, always − when both carbons were solid; and that it was as small as −2 ohms for a four-ampere solid arc. Now the resistance of the condenser circuit, r, external to the condenser can easily be made less than two ohms, so that the arc can fulfil both the necessary conditions. I will now describe some observations on the musical arc which tend to confirm the above conclusions. Arcs between solid carbons for which $\frac{\delta V}{\delta A}$ is always negative work well, while those between cored carbons for which $\frac{\delta V}{\delta A}$ is positive I find will not work under any conditions. [Experiment.] The largest negative value of $\frac{\delta V}{\delta A}$ given by Messrs. Frith and Rodgers is two ohms for a four-ampere solid arc, and it is probable that it did not exceed 2·5 ohms, for the smaller currents—viz., 3 to 3·5 amperes—which I used. According to the above conditions, 2·5 ohms should be the limiting resistance of the condenser circuit. By experiment it was found that when the resistance of this circuit was increased to 2·4 ohms, the oscillations stopped and could not be restarted. [Experiment.] It is evident that besides the resistance there are other causes, such as hysteresis, which tend to dissipate the energy in the condenser circuit and stop the arc giving its note. The hysteresis in an iron-wire core introduced into the self-induction will instantly stop the note. [Experiment.] Any complete circuit such as a ring of wire placed near the self-induction has the same effect. [Experiment.] On several occasions before the importance of these causes of the dissipation of the energy were realised, considerable trouble was experienced in tracing the reason of the arc failing to give its note. As examples, in one case it was traced to an ammeter and in another to the tinfoil in the condenser which were acting as short-circuited secondaries to the self-induction coil, which had been placed too near them. [Experiment.] The relation between the self-induction, capacity, and frequency can be very easily demonstrated by playing a tune on the arc by varying either the capacity or the self-induction by means of a keyboard. [Experiment.] Another method of varying the self-induction is by separating or bringing closer together the turns of the coil, as

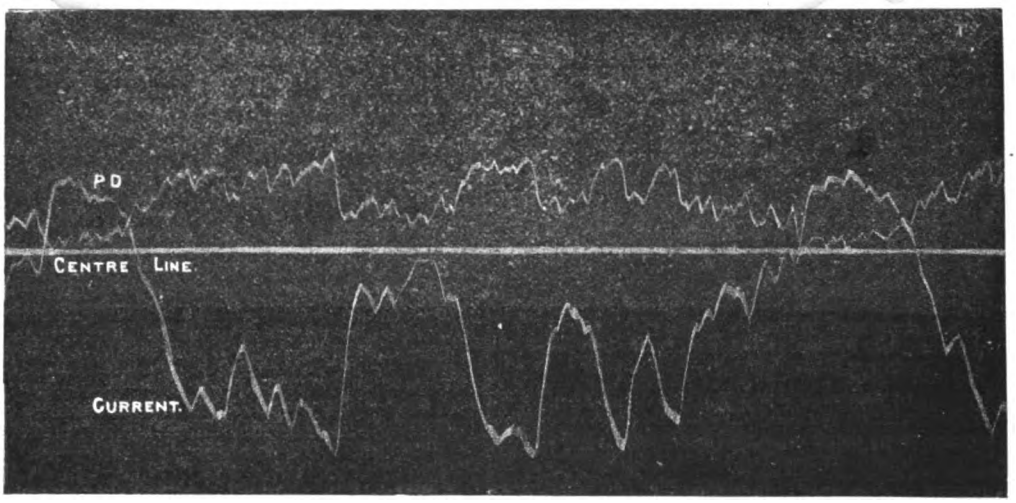


FIG. 7.—Hissing Arc. Carbons +11 and −9 mm. Solid "Apostle." Mean P.D. = 44·5 volts. Mean current = 19·5 amperes. Scale: 1mm. = 0·5 volt = 0·1 ampere = $\frac{1}{500}$ second. Centre line = 40 volts = 20 amperes.

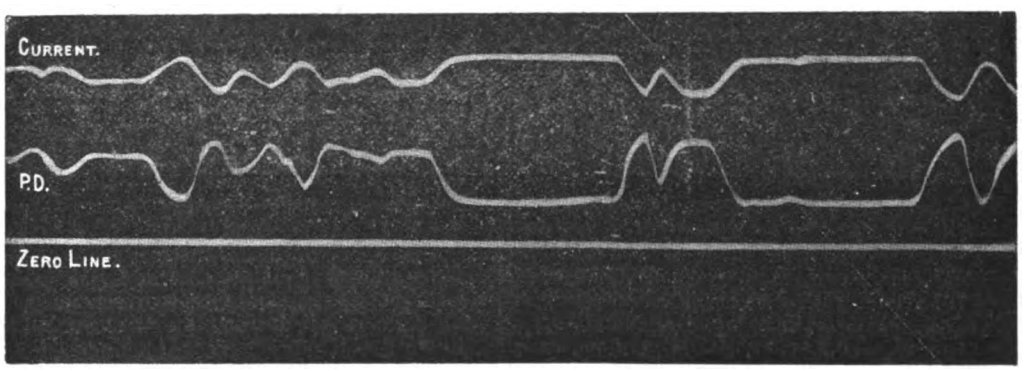


FIG. 8.—Very Short Hissing Arc. Carbons +11mm. cored "Apostle," −9mm. solid "Apostle." Scales: 1mm. = 1·5 volt = 1·0 ampere = $\frac{1}{500}$ second.

Digitized by Google

if playing on a concertina, the relative positions of the turns determining the self-induction and the pitch of the note. The musical arc can be used as a means of comparing self-inductions or capacities by comparing the pitch of the notes produced. The "enclosed arc" will work equally as well as the open arc, though the note given out is not so audible owing

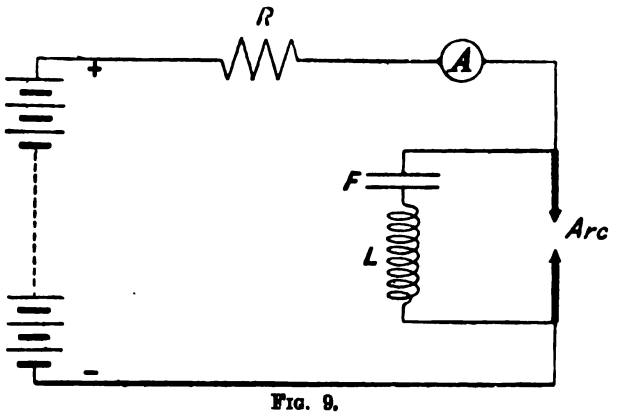


FIG. 9.

to the globe; but it can easily be made so by taking advantage of some of the telephoning effects mentioned in Part I.

(*To be continued.*)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers.

QUESTIONS.

337. In a combined alternating and three-wire continuous-current station it is intended to couple the two systems by connecting an alternator direct to two continuous-current machines, which will be required to balance the three-wire system, supply the whole of the system on light load, or to drive the alternator and supply the alternating system at times of light load. Note.—The alternator is of the slow-speed type. Give diagram of connections.—L. B.

338. What are the requirements for a lightning arrester for overhead cables, and how far are these requirements fulfilled in the present instruments?—M.

ANSWERS.

Question No. 331.—Give method employed in calculating resistances for motor starters so as to get a certain number of amperes per contact. In liquid starters what is the usual current allowed per square inch of surface of iron plate electrode? Also give way of calculating resistance of liquid, say 5 per cent. soda solution.

Best Answer to No. 331 (*awarded* 10*s.*).—A resistance for a motor-starting segment switch is correctly designed when, at the starting up of the motor, the momentary rush of current over and above the normal as each section of the resistance is cut out must be the same.

To comply with these conditions, the values of the starting resistance in circuit with the armature must decrease at each step according to a proportional scale, or, in other words, the value of the resistance must decrease in geometrical progression. This difficulty is not met with in the design of liquid starters, as the resistance is decreased in perfect uniformity. In addition to the above requirements necessary for starting resistances, we very often find that a corporation or a supply company will demand that when motors are being put on to the mains, the current taken by the motor when the arm of the switch is on the first stop must not exceed, say, 10 amperes; so that if the normal current of the motor exceeds 10 amperes, we have to make the total starting resistance equal to $\frac{\text{volts on mains}}{10}$.

So that the portion of the resistance preceding the point at which the motor will take its normal working current is divided up into such sections that the value of the *current* increases in geometrical progression until it reaches the normal, and for the remainder of the resistance the current is constant, except for a momentary jump as each section is cut out.

It will probably make the above remarks more explicit if we take an actual case and deal with the design. For example, suppose we require a starting resistance for a 11½-b.h.p. motor, 220 volts and 1,080 revolutions per minute, the resistance being so arranged that the current when the switch arm is at the first stop is 10 amperes, and also that the jump of the current while switching on does never exceed 10 amperes (approximately).

Let us say the efficiency of our motor is 93 per cent. at full load, then the normal working current is—

$$\text{Normal current of motor} = \frac{11{\cdot}5 \times 746}{{\cdot}93 \times 220} = 42 \text{ (approx.)}.$$

We must also note that the resistance of the motor armature is ·153 ohm.

Then total starting resistance, including that of the armature,

$$= \frac{220 \text{ volts}}{10 \text{ amperes}} = 22 \text{ ohms}.$$

A portion of this 22 ohms is used to bring the current from 10 amperes up to the normal 42 amperes; the motor armature then commences to rotate (unless in special cases where a very large starting torque is needed), and the remainder of the resistance is cut out in bringing the motor up to its full speed.

Resistance required to give the normal current

$$= \frac{220 \text{ volts}}{42 \text{ amperes}} = 5{\cdot}5 \text{ ohms}.$$

Therefore 22 − 5·5 = 16·5 ohms. This part of the resistance is divided up into steps, so as to give the *current* increasing in geometrical progression, while the *resistance*, 5·5 ohms, is divided up in geometrical progression.

1. Current increasing in geometrical progression—

	Value of current.	Value of resistance in each step.	Steps.
1st point	10		
		$\frac{220}{20}$ = 11 ohms	1st
2nd point	20		
		$\frac{220}{30}$ = 7·33 ohms	2nd
3rd point	30		
		$\frac{220}{40}$ = 5·5 ohms	3rd
4th point	40		

The problem now is to divide 5·5 ohms up in decreasing geometrical progression so as to give the limiting jump in the current of 10 amperes. Let us say that the jump in the current can be kept low enough by cutting out the resistance in 16 steps. Now we commence by having a resistance of 5 5 ohms, and this is reduced in 16 steps down to the armature resistance, ·153 ohm. Therefore, we have to insert 15 geometrical means between 5 5 ohms and ·153 ohm, this being a simple problem in algebra.

Let r = the common ratio;

the 17th term = ·153 ohm—*i.e.*, the armature resistance;

$$\therefore \cdot 153 = 5\,5 \times r^{16}$$

$$\therefore r^{16} = \frac{\cdot 153}{5{\cdot}5} = {\cdot}002725$$

$$\therefore 16 \log r = \log {\cdot}002725.$$

$$16 \log r = \bar{3}{\cdot}436$$

$$\log r = \frac{\bar{16} + 13{\cdot}436}{16} = \bar{1}{\cdot}9 \text{ (approximate)},$$

from which $r = {\cdot}8$ (approximate).

Therefore, our resistances decrease as follows:

$$5{\cdot}5,\quad r\,5{\cdot}5,\quad r^2\,5{\cdot}5,\quad r^3\,5{\cdot}5\ \ .\ .\ .\ \ r^{17}\,5{\cdot}5,$$

Digitized by Google

and the value of the resistances in each step thus:

$5{\cdot}5 - r\ 5{\cdot}5 =$ 1st step;

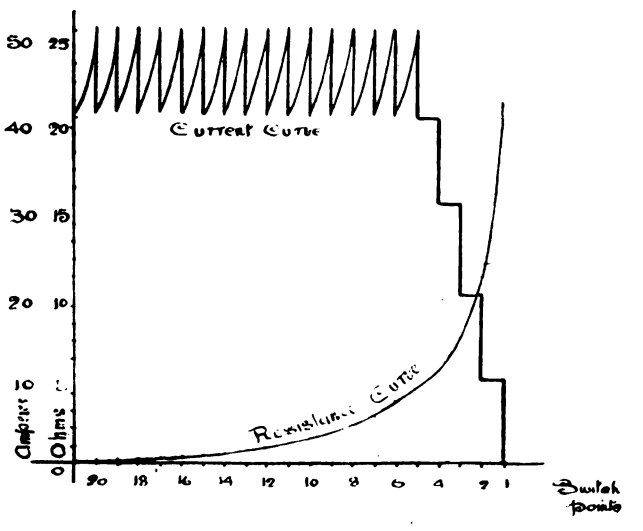
$5{\cdot}5\ r - r^2\ 5{\cdot}5 =$ 2nd step, etc.;

$r^{16}\ 5{\cdot}5 - r^{17}\ 5{\cdot}5 =$ 16th step.

We can now tabulate our complete results:

Back E.M.F. of motor. $C = E - c(R_a + R)$	Drop of volts in armature and resistance. $C(R_a + R)$	Total resistance at any position of switch arm	Current.	Value current, momentary increases to.	Momentary jump of current	Switch points.
0	220	22	10	—	—	1
0	220	11	20	—	—	2
0	220	7 33	30	—	—	3
0	220	5·5	40	50	10	4
34	186	4 4	42	53	11	5
71	149	3 52	42	52·8	10·8	6
101	119	2 825	42	52 8	10 8	7
124·8	95 2	2 26	42	52 8	10 8	8
143·5	76 5	1 81	42	53	11	9
159	61	1 44	42	53	11	10
171 4	48·6	1·15	42	53	11	11
181	39	92	42	53	11	12
188·8	31·2	735	42	53	11	13
195·2	24·8	·588	42	52 5	10 5	14
200 1	19 9	·47	42	53	11	15
204·1	15 9	376	42	53	11	16
209·2	12 8	302	42	53	11	17
209·8	10·2	242	42	53	11	18
211·88	8 12	·192	42	53	11	19
213·52	6 48	·153	42			20

These tabulated results may now be plotted in the form of two curves, as below.



Current curve shows the rate of increase in the motor current on the first four points of switch, and also the momentary increases in the current as further steps are cut out, the armature having commenced to revolve.

The resistance curve shows the rate of decrease of the starting resistance with reference to the number of points on switch.

The above description, I think, covers any information required for the design of starting resistances, with the exception of fixing allowable sizes of wire for a given current, and as this can always be furnished by the maker of the particular kind of wire which you may decide to use, it is, I think, hardly necessary to touch on here. I may note that starting resistances may be graduated direct from the proportional scale of a slide rule. This will probably suggest itself to the reader.

With regard to liquid starters, the writer has found that a current density of 6 to 10 amperes per square inch of iron electrode surface to be a fair allowance for starting purposes. With reference to the resistance of a 5 per cent. soda solution, the writer does not know of any reliable method of calculating such a quantity. The usual way is to fix your current density and also your maximum distance between the plates, and then make up the percentage solution to suit your particular requirements.

The following figure is approximately correct for a 5 per cent. soda solution: two iron plates one square inch in sectional area and 1in. apart; resistance = 10 ohms (approximate).—H. P.

Answer to No. 331 (*awarded* 5*s.* 0*d.*).—The determination of the resistances between the successive contacts of a starting switch, so arranged as to preclude more than a certain sudden increase of current per step, falls into two parts dependent on different conditions and involving different considerations.

The first of these conditions obtains until sufficient current has been switched on to produce rotation. During this stage the resistances are in series with a circuit containing no counter E.M.F., and the current flowing is simply the supply voltage divided by the total resistance. In a shunt-wound motor the first contact or contacts will put in the exciting current, and the following steps augment that through the armature until sufficient torque to overcome the load and static friction flows. This quantity is somewhat greater than required whence once motion has begun. In a series motor, field strength and armature current, of course, increase together until the same torque is obtained. Let now V denote the supply voltage, C′ the current which may be suddenly drawn from the mains, and R_1 the total resistance of the switch and shunt. Then we must have

$$\frac{V}{R_1} = V\left(\frac{1}{R_2} - \frac{1}{R_1}\right) = V\left(\frac{1}{R_3} - \frac{1}{R_2}\right) = \text{etc.} = C'.$$

and consequently

R_1
$R_2 = \frac{1}{2} R_1$ } $\frac{1}{2} R_1$ = resistance between 1st and 2nd contacts
$R_3 = \frac{1}{3} R_1$ } $\frac{1}{6} R_1$ = " " 2nd " 3rd "
$R_4 = \frac{1}{4} R_1$ } $\frac{1}{12} R_1$ = " " 3rd " 4th "

$R_n = \frac{1}{n} R_1$, and generally resistance between the n-th and $(n \times 1)$-th contacts $= \frac{R_1}{(n \times 1)\, n}$.

This arrangement of resistances disposes of that portion of the switch connected with the shunt. The calculation now goes on at that point, where in the case of a series motor it begins, to the resistances in series with the armature. Until the machine begins to speed up the method of calculation is identical with the foregoing, the armature, or armature and series coils, resistance being taken in place of that of the shunt.

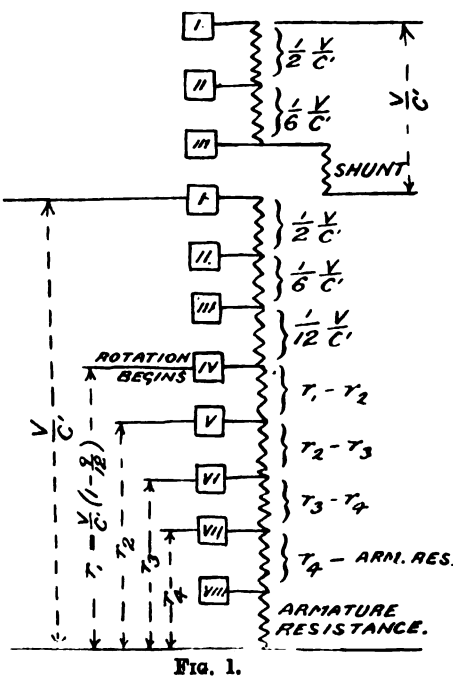


FIG. 1.

Let C denote the normal current for the load under which the motor starts up and runs, and let C_1 denote the starting current ($> C_1$, see above) reached at the n-th contact of this portion of the resistance. The second state of affairs mentioned is now reached. If, starting onward from this n-th contact, we denote the total resistances succes-

Digitized by Google

sively in circuit by r_1, r_2, r_3, etc., we have $r_1 = \frac{V}{C_1}$. The armature, however, now speeds up, producing a back E.M.F., v_1, and so reducing the current to C. The next step must, therefore, make r_2 such that $(V - v_1)\left(\frac{1}{r_2} - \frac{1}{r_1}\right) = C'$, or $\frac{V - v_1}{r_2} = C + C'$. The speed now again increases, bringing v_1 to some value, v_2, and thus $(V - v_2)\left(\frac{1}{r_3} - \frac{1}{r_2}\right) = C'$, and so on until after cutting out all the switch resistance the back E.M.F. has its full normal value. The point to be noted is that with a constant retarding torque, the motor will always speed up until its current is reduced to give an equal driving torque. Hence, if at the n-th contact a current, C_2, equal to or greater than C_1 was flowing, we find that:

At the n-th contact $r_1 = \frac{V}{C_2}$;

" $(n+1)$-th " $r_2 = \frac{V}{C + C'} - \frac{C_2 - C}{C + C'} r_1$;

" $(n+2)$-th " $r_3 = \frac{V}{C + C'} - \frac{C_2 - C}{C + C'} r' - \frac{C'}{C + C'} r_2 = \frac{C}{C + C'} r_2$;

" $(n+3)$-th " $r_4 = \text{etc.}, = \frac{C}{C + C'} r_3$;

" $(n+m)$-th " $r_{m+1} = \text{etc.}, = \frac{C}{C + C'} r_m$.

Thus $r_1 - r_2$, $r_2 - r_3$, etc., are the resistances between successive contacts (see Fig. 1).

As an example, let a shunt motor of ·17 ohm armature resistance, taking 50 amperes at its constant load, be considered. Starting current 55 amperes, supply at 200 volts, maximum sudden current increase 20 amperes. Here the shunt current would be well under the limit, and would be put on fully at the first contact. The second contact would start the armature current, and total resistance in must be $\frac{200}{20} = 10$ ohms. Thus

Resistance between 2nd and 3rd contacts $= \frac{1}{6}(10) = 5$ ohms.

" " 3rd and 4th " $= \frac{1}{6}(10) = 1{\cdot}56$ ohms.

The resistance in at the 4th contact is $10 - 6{\cdot}56 = 3{\cdot}44$ ohms, so that a current (C_2) of 58 amperes flows and rotation begins.

At the—

n-th contact, here the fourth, then		$r_1 = 3{\cdot}44$	1·97
5th	constant resistance in	$= \frac{200}{70} - \frac{58 - 50}{70} r_1 = 2{\cdot}47$	·7
6th	" " "	$= \frac{50}{70} \times 2{\cdot}47 = 1{\cdot}76$	·5
7th	" " "	$= \frac{50}{70} \times 1{\cdot}76 = 1{\cdot}26$	·35
8th	" " "	= etc. = 9	·25
9th	" " "	" = ·65	·19
10th	" " "	" = ·46	·13
11th	" " "	" = ·33	·09
12th	" " "	" = ·24	·07
13th	" " "	" = ·17	

Thus, since the armature resistance is ·17 at the 13th and last contact, the whole switch resistance is cut out. The resistances between successive contacts are given by the column on the right (calculated approximately).

As to the current density in a liquid starting resistance, the writer has found about four amperes per square inch work satisfactorily with the electrolyte mentioned (5 per cent. sodium carbonate). The limiting density depends upon either the rush of evolved gas being excessive, or upon the heating of the liquid. As ordinarily arranged, the latter limit is reached first, the electrolyte soon boiling and frothing over with a greater density than four amperes. Exact calculations for electrolytic starting resistances are almost impossible, however, as the permissible density in the liquid depends upon the length of time occupied in the machine's speeding up; also because the resistance varies enormously with the temperature, falling at 100deg. C. to less than half its value at 15deg. C., in the case of the soda solution.

The resistance of the quantity of liquid between two plates of the resistance is, supposing that the sectional area of liquid is not much greater than the area of the plate, equal to the (specific resistance × distance in inches plates are apart) divided by 2·54 (sectional area in square inches). The specific resistance—*i.e.*, the resistance in ohms per centimetre length of a column having one square centimetre sectional area—can in the case of a few solutions be found from tables. (Munro and Jamieson, however, give nothing, and there is more difficulty than there should be in getting this information.) In the case of the 5 per cent. soda—*i.e.*, 5lb. common washing soda ($Na_2CO_3.10H_2O$) in 100lb. of water—the specific resistance, as just determined by one in whom I put reliance, is 55 ohms at 15deg. C. There is, however, no simple rule for finding from this what it would be at another temperature or another percentage strength. The simplest rough method of ascertaining the resistance per inch length per square inch area is to fill a trough, b inches wide, to a depth c inches; place two electrodes a considerable distance a inches apart; send a current C amperes through, and measure the volts, V, across the electrodes. Then, neglecting polarisation, etc., we have

$$\text{Resistance per inch, etc.} = \frac{V}{C} \frac{bc}{a} \text{ ohms,}$$

A result sufficiently accurate for practical work—indeed, better than an accurate one, as it is determined under the working conditions for which the information is required.

In conclusion, one may perhaps suggest the desirability of placing under different numbers such distinct questions as are included under No. 331.—ZERO.

Answer to No. 331 (*awarded* 5*s.*).—The starting of a motor may be divided into two processes: (1) increasing its current by steps till it starts from rest; (2) increasing the volts on the armature till it reaches full speed. The first part is only necessary if the motor is on a lighting circuit, when pressure variations must be prevented at all costs; and as the resistance in each step can be at once determined by Ohm's law, we need not consider this part in detail. We will suppose that the motor is to start on full load, and that the torque to overcome that load is independent of the speed, as is usually the case; also that the full-load current passes when the switch is on the first stop.

Let C = full-load current;
Let R_1, R_2, R_3, etc. = total resistance in circuit (including the armature) when switch is on points 1, 2, 3, etc.;
Let E = supplied volts;
Let n = number of stops on starter;
Let R_a = resistance of armature;

$$R_1 = \frac{E}{C}.$$

$R_n = R_a$ = total resistance when switch is on last stop.

Now let switch be put on first point; the motor starts very slowly, so that its back E.M.F. is negligible; then

$$E = C R_1.$$

Now put switch on second point; then for an instant, before the armature can increase its speed and its back E.M.F., the total voltage round the circuit is $C R_1$, and the total resistance is R_2.

$$\therefore \text{current rises to } \frac{C R_1}{R_2},$$

falling again to C as the speed rises.

Then $E = C R_2 + \text{back E.M.F.}$

Now put switch on third point. For an instant the net forward E.M.F. is $C R_2$, and resistance is R_3.

$$\therefore \text{current rises to } \frac{C R_2}{R_3},$$

falling again to C as the speed rises.

Similarly, on stop 4, the current rises to $\frac{C R_3}{R_4}$. But our hypothesis is that the current is to rise to the same value on each stop.

Digitized by Google

$$\therefore \frac{C R_1}{R_2} = \frac{C R_2}{R_3} = \frac{C R_3}{R_4}, \text{ etc.};$$

that is, R_1, R_2, R_3, etc., are in geometrical progression. Our problem then resolves itself into finding n numbers in geometrical progression, the first being R_1 and the n th R_a.

$$\text{The common ratio } (r) = n\sqrt{\frac{R_a}{R_1}}.$$

This can easily be worked out with the help of logarithms; then R_1 being known, $R_2 = r R_1$, $R_3 = r^2 R_1$, etc. There is a simple mechanical method of getting these values by the aid of a slide rule almost without any calculation. The top scale of a 10in. rule is used, and it may be necessary to extend this scale to 15in. by means of the slide. We then have three similar 5in. scales, and figures on the first scale represent numbers one-tenth of those on the second scale and one-hundredth of those on the third scale.

Mark the armature resistance, R_a, on the first scale and the value of R_1 on the second or third scale as it happens to come. Now divide the distance between them into $n-1$ equal parts, and read off the figures at each point; these will be the values R_1, R_2, R_3, etc.

Resistance in first gap $= R_1 - R_2$.
Resistance in second gap $= R_2 - R_3$, and so on.

Starters are seldom made which really follow the law of geometrical progression described above, but the smoothness of starting thereby obtained, even with a comparatively small number of stops, is well worth a little arrangement.

In liquid starters a fixed current density at the surface of the iron plate should not be aimed out. One size starter will start one size motor, whether its voltage be 50 or 400. The difference should be made, not in area of plate, but in concentration of solution. The horse-power of the motor is the factor which determines the dimensions of the starter. One containing three gallons of suitable solution will start a 15-h.p. motor on full load without trouble.

It is not possible to calculate the resistance of a solution of stated concentration, because the resistance is no definable function of the concentration. The only way is to determine the resistance experimentally with varying strengths of solution, and plot a curve of specific resistance against percentage of solution. In a liquid starter, however, the best way is for the man who sets it up to add soda till he gets the most satisfactory result. Thus we get the most suitable arrangement for the actual working conditions, which can never be exactly foreseen, and this is one of the great advantages of liquid starters.—J. W.

Question No. 332.—In transmitting power to a distance, how does the load factor of the supply influence the commercial result?

Answer to No. 332 (*awarded* 7*s.* 6*d.*).—The commercial result of a transmission of power undertaking depends on the relation between the total annual income and the total annual expenditure. Taking the percentage dividend as the measure of the commercial result, we have

$$\text{D per cent.} = \frac{\text{Profits (annual)}}{\text{Capital}} \times 100.$$

Now, the capital does not in the least depend on the load factor, and may be taken as constant. It is therefore the profits with which we have to concern ourselves. The annual profits from a supply undertaking are equal to I – E, where I denotes the total annual income and E the total annual expenditure. Now, let F denote the load factor, which is the ratio between the total number of Board of Trade units generated in a given time to the maximum number of units which the whole of the generating plant could produce during that time. Let N denote the total possible output of the plant for a year in Board of Trade units; then

$$\text{I} = \text{price obtained per unit} \times \text{N} \times \text{F}.$$

The price obtained per unit, P, does not depend on F, but depends on the prices charged for steam, gas, or water power in the district supplied, as these competitive prices would determine the charge which could be obtained for electric power.

Now,
$$\text{E} = \text{cost of production per unit} \times \text{N} \times \text{F};$$
$$= \frac{\text{S} + (\text{G} \times \text{N} \times \text{F})}{\text{N} \times \text{F}} \times \text{N} \times \text{F};$$
$$= \text{S} + (\text{G} \times \text{N} \times \text{F});$$

where S = total standing charges per annum, consisting of interest on capital, depreciation, sinking fund, rents, rates, and taxes, salaries of officials, and all sundry expenses which do not vary with the number of units generated in the station. S is not dependent on the load factor. G denotes generating cost per unit, and may be taken as independent of F. Of course, in the case of long-distance transmission the loss in the line would be greater with a high load factor, as the cables would be working up to nearly their full capacity, and G would thus be increased. This cable loss would vary as F^2 (approximately). Although G would be increased owing to a loss of efficiency in the cables it would be decreased to an almost equal extent by increased efficiency of boilers, engines, dynamos, and station attendance, so for all practical purposes we may consider G independent of F, but of course dependent on the cost of coal (or whatever source of power is used), oil, repairs, maintenance, and attendance at generating station, and for distribution, if the latter is done at the supply undertaking's expense. We have, therefore,

$$\text{D per cent.} = \frac{\text{I} - \text{E}}{\text{capital}} \times 100$$
$$= \frac{(\text{P} \times \text{N} \times \text{F}) - \{\text{S} + (\text{G} \times \text{N} \times \text{F})\}}{\text{capital}} \times 100.$$

This formula denotes how the commercial result depends on the load factor. Of course, N × F is simply the total number of units sold per annum (F being calculated for a period of one year in above case), and it will be seen that this number varies directly as the load factor.—R. M. W.

Answer to No. 332 (*awarded* 5*s.*).—The cost of working a generating station consists chiefly of the following items: interest on outlay, coal, water, oil, waste, and stores, management expenses (salaries, etc.) and wages. These items may be divided into three classes: (1) those which are directly proportional to the maximum load on the station; (2) those which are directly proportional to the total yearly output; and (3) those which fall in between, being influenced both by the maximum load and by the total output. We will consider each item individually.

Interest on Outlay.—Seeing that the generating plant, the buildings to contain it, and the supply mains have to be put down for the maximum output, this item will be the same whatever the total output, and clearly belongs to case 1. It is sometimes supposed that this can be reduced by the use of accumulators, but as a battery for a given discharge rate costs more than a complete generating set for the same output, this is a mistake.

Coal.—This belongs to class 3. When the load is about to come on, fresh boilers have to get up steam, and a considerable amount of coal is wasted in the process; and when the load goes off again, these boilers are left full of hot water, representing wasted energy.

This may be minimised by the use of water-tube boilers, which hold only a small quantity of water and get up steam very rapidly. Another cause of poor economy of coal is that when the load is rising or falling, it is not possible to keep all the generators on full load, and their efficiency falls. This loss can be reduced by the use of accumulators, which permit all running plant to be kept on full load. Another partial remedy is the use of small units, but this partly defeats its own end, as small units are less efficient than large ones.

Water.—The question of reduced efficiency also affects the water bill, and it must therefore come under case 3, although it approaches more nearly to case 2 than does the coal.

Management.—The responsibility of managing a station of a certain size is independent of the total output; if anything, it is greater with a varying load, as the station hands need more supervision. The salaries of the manager and his assistants, therefore, come under case 1.

Wages.—If the station is a very large one the number of stokers, drivers, labourers, etc., will always be propor-

Digitized by Google

tional to the number of engines running. If the station is small, this will not be so, as one stoker, one driver, etc., must be present during the hours of light load, although not fully occupied. However, for the sake of argument, we will put it under case 2.

The most conclusive way of showing the influence of the load factor on the commercial results will be to take a reliable estimate of the cost per unit for a large station supplying a constant load day and night, and to apply the above considerations to determine the cost per unit with a given load factor. Let us take as a basis the figures given by Mr. Langdon in his paper before the Institution of Electrical Engineers, published in this journal last month. We will take a load factor of ·15, this being a fairly good figure for an English lighting station with a considerable motor load. The output of the station is 5,000 kw. The outlay includes mains and step-down transformers, and as the question gives no details, we can take this as being a typical scheme, but we will omit salaries of sub-station engineers and outdoor service men.

Column 1 gives the total cost per annum, and column 2 the cost per kilowatt-hour when working at a constant load of 5,000 kw., and columns 3 and 4 give the same when working at an average load of $5{,}000 \times \cdot 15 = 750$ kw.

Details of charges.	1. Per annum.	2. Per kilo-watt-hour.	3. Per annum.	4. Per kilo-watt-hour.
1. Capital outlay, £470,000.	£	d.	£	d.
Interest at 3½ per cent.	16,450 ...	·0901 ...	16,450 ...	·6000
2. Generating station :				
Salaries	1,320 ...	·0072 ..	1,320 ...	·0482
Wages	3.159 ...	·0173 ..	473 ...	0173
3. Coal	23,345 ...	·1279 ...	3 840 .. (say)	·1410 (say)
4. Water	913 ...	·0050 ...	144 ... (say)	·0052 (say)
5. Oil, waste, and stores...	2,000 ...	·0109 ...	300 ...	·0109
Total	47,187 ...	·2584 ...	22,527 ...	·8226

This shows in a very striking manner the disadvantage of working with a small load factor, and it also shows where the disadvantage principally occurs—namely, in the money lying idle in machinery which is standing for a large number of hours in the 24.—J. W.

LEGAL INTELLIGENCE.

THE WOLVERHAMPTON TRAMWAYS.

The case of the Mayor and Corporation of Wolverhampton *v.* the British Electric Traction Company was down on last week's list to be mentioned in the Chancery Division of the High Court before Mr. Justice Joyce.

Mr. Hughes, Q.C., who appeared on behalf of the Corporation, said his lordship would remember that this action was brought to enforce specific performance of a contract contained in an Act of Parliament for the sale of defendants' tramway undertaking in the borough of Wolverhampton to the Corporation, and was argued some few weeks ago. His lordship's decision was that the Corporation was entitled to specific performance, and that, in fact, was not really in dispute in the trial. The defendants, however, contended that they were entitled to running powers, and the question which now arose was as to whether interest was payable from the dates upon which the contract was to have been completed. The learned Registrar had stated that the question of interest could not be left open, owing to the form in which the judgment had been entered. He therefore asked his lordship to fix a day on which this point could be discussed.

Mr. Justice Joyce said he would hear the arguments on the following Thursday.

On the Thursday **Mr. Hughes, Q.C.**, for the Corporation, read at length the correspondence which had passed between the parties in reference to the sale, for the purpose of showing that they were entitled to 5 per cent. interest on £4 250, the amount of the purchase money. The Corporation forwarded a cheque for £4,250, and in reply a letter, written on behalf of the defendant company, was received, acknowledging the receipt of the letter and the enclosed cheque, and stating that the transfer would be executed without delay. Subsequently, the solicitor for the company telegraphed to the town clerk withdrawing the acceptance, but the Corporation insisted on the completion of the contract. The Registrar found some difficulty in drawing up the order and in dealing with the question of interest, which counsel said was a substantial sum. The statement of claim asked for an enquiry as to profits, but his friend, Mr. Freeman, had said that there had been no profits, and it was obvious that the enquiry would be a difficult one. He agreed that they could not have both profits and interest at the same time, and they preferred to take the interest and leave the profits alone.

Mr. Thompson, for the other side, contended that there had been no proper tender made.

His Lordship said he thought Mr. Hughes's clients were entitled to an enquiry.

After the argument, **His Lordship** made an order to the effect that the Corporation was entitled to 5 per cent. interest in lieu of compensation for the non-completion of the purchase from the date that the purchase money was tendered.—*Midland Counties Express.*

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL, ST. ANNES, AND LYTHAM TRAMWAYS COMPANY.

The second ordinary general meeting of the shareholders was held on the 19th inst., at Manchester, Mr. A. W. Carrington (Lytham) presiding over a large attendance.

The directors recommended a present dividend of 3 per cent. on the preference shares, leaving the payment of a further dividend of 2 per cent. on these shares over.

Mr. J. Fell (director) said he wished to explain that he objected to the payment of dividend on preference shares, because it had not, in his opinion, been earned.

Mr. Hengler (Hoylake) moved an amendment that the balance-sheet be referred to a future meeting to allow shareholders an opportunity of studying it in detail, but this was defeated on a vote, and the balance-sheet was adopted.

LONDON ELECTRIC OMNIBUS.

The report for the period of Nov. 30 states that the efforts of the present Board have been entirely devoted to the object of placing the Company in such a position so that a definite and feasible working scheme could be submitted to the shareholders. The future existence of the Company now depends upon the response received to the circular dated 18th inst. This circular states that, in the opinion of the directors, electricity as applied to street traction (except as regards tramways) has not been developed sufficiently to warrant their advising the shareholders to experiment further with it, but they consider that a system of street cars capable of carrying 14 passengers could be made a success. If a sufficient number of shareholders agree, it is proposed to reconstruct the Company, the shareholders receiving one £1 share in the new Company for every share held in the old Company, the new shares having a liability of 5s. per share.

NEW COMMITTEES.

The following appointments have been made :

BATH.—*Electric Lighting* : Alderman Taylor, chairman.

BERMONDSEY.—*Electric Lighting* : Councillor Cox, chairman.

HAMMERSMITH —*Electricity and Lighting* : Alderman Glasier, chairman ; Councillor Bendon, vice-chairman.

HEYWOOD.—*Electric Lighting* : Alderman Maden, chairman.

KING'S LYNN (NORFOLK).—*Electric Lighting* : The Mayor ; Aldermen Miles and Jermyn ; Councillors Affleck, Carpenter, Chatterton, Floyd (chairman), and Miles.

KINGSTON.—*Electric Lighting* : Alderman Collings, chairman.

NEWBURY – *Electric Lighting* : Mr. J. Rankin (mayor), chairman.

STRATFORD UPON AVON.—*Electric Lighting* : Councillor Holtom, chairman.

WALSALL – *Tramways* : The Mayor (Councillor W. J. Pearman-Smith) chairman ; Councillor Powell, vice chairman. *Electric Lighting* : Councillor Brownhill, chairman ; Councillor Noake, vice-chairman.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Asuncion (Paraguay).—The Municipality invite tenders for the installation of the electric light in the town. Tenders by Jan. 15, 1901.

Madrid.—The Department for Agriculture, etc., invite tenders for the installation and working for 60 years of an electric tramway from Insepets to Fogas and Boranova. Tenders by Jan. 7, 1901.

Hendon.—The Urban District Council invite tenders for the supply and erection of various plant for the municipal electricity works. Tenders by Dec. 31. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the extension (about 100 lamps) of the electric lighting installation at the City Chambers. Tenders by 31st inst.

Ayr.—The Corporation invite tenders for the work required in forming permanent way, rail-laying, roadwork, etc., of about 5¾ miles of electric tramways. Tenders by 10 a.m. on Jan. 4.

Southampton.—The Corporation invite tenders for the overhead electrical equipment of about 1¾ miles of tramway route. Tenders by Jan. 7, 1901. Details in our advertisement columns.

Digitized by Google

Farnworth.—The Urban District Council invite tenders for eight 66 passenger tramcar bodies, motors, undertrucks, controllers, etc. Tenders by Jan. 10. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of telephone apparatus in connection with the Glasgow Corporation tramways. Tenders by Jan. 18, 1901. Details in our advertisement columns.

Salford.—The Tramways Committee invite tenders for tie-bars, fishplate bolts, etc. Specifications, etc., may be obtained from Mr. Ernest Hatton, tramways engineer, Town Hall, Salford. Tenders by Dec. 31.

Battersea.—The Council invite tenders for the supply of ordinary and prepayment electricity meters, in accordance with specification No. 10. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of steam dynamos, battery-charging motor, booster, and balancer. Tenders by Jan. 7. Details in our advertisement columns.

Middleton.—The Corporation invite tenders for superheaters, economisers, feed pumps and pipes, tanks, steam and exhaust pipes, valves, and accessories. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Rathmines.—The Electric Lighting Committee invite tenders for the supply and erection of various plant for the extension of the municipal electricity works. Tenders by Jan. 10, 1901. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of condensing plant and cooling tower, secondary battery, mains switchboard, and travelling crane. Tenders by Feb. 1, 1901. Details in our advertisement columns.

Farnworth (Lancs.).—The Urban District Council invite tenders for steel girder tramrails, fishplates, etc. Drawings may be seen from the engineer, Mr. W. J. Lomax, A.M.I.C.E., 11, Fold-street, Bolton. Tenders by Jan. 8, 1901.

Worthing.—The Corporation invite tenders for the supply and erection of a main switchboard. Specifications, etc., can be obtained from Messrs. Burstall and Monkhouse, 14, Old Queen street, Westminster, S.W. Tenders by Dec. 31.

Whitby.—The Urban District Council invite tenders for erection of an electric light station and destructor. General conditions, etc., can be obtained on and after Jan. 1 from the Clerk at the offices of the Council, Whitby. Tenders by Jan. 8.

Belfast.—The Harbour Commissioners invite tenders for 10 tramway trucks, each capable of carrying a weight of 10 tons on a 3ft. gauge. Further information may be obtained from the harbour engineer, Mr. G. F. L. Giles. Tenders by Jan. 7.

Turin (Italy).—The Public Works and Artillery Department in this town require tenders for 20 tons of copper ingots, to be delivered within 40 days of acceptance of tender. The provisional deposit is £1,840, the final deposit being 10 per cent. of the total. Tenders by Jan. 7.

Tooting.—The Metropolitan Asylums Board invite tenders for the execution of certain wiring and other works in connection with the proposed electric light installation at the asylum now in course of erection at Tooting Bec. Tenders by Jan. 2, 1901. Details in our advertisement columns.

Rotherham.—Tenders are invited for the supply of electricity meters of sizes for maximum currents of 5, 10, 20, 25, and 35 amperes. The supply pressure is 230 volts, continuous current. Tenders should be sent to Mr. H. Hampton Copnall, town clerk, Council Hall, Rotherham, by Jan. 19, 1901.

Thetford (Norfolk).—The Town Council invite tenders for supplying the wiring and fittings necessary for the electric lighting of the new town hall according to plan and specifications, which can be seen at the office of Mr. John Houchen, town clerk, London-road, Thetford. Tenders by Jan. 1, 1901.

Poplar.—The Borough Council invite tenders for the supply of an electric crane to lift a maximum load of five tons, with a return block, the electricity supply being continuous current at 460 volts. Specification, etc., may be obtained from the Borough Electrical Engineer, at the Electricity Works, Glaucus-street, Bromley-by-Bow, E. Tenders by Jan. 16, 1901.

Leeds.—The Lighting Committee invite tenders for electric lighting plant as follows: (Section A) two sets, each comprising engine of 2,000 b.h.p., two-phase alternator of 1,400 kw. capacity, and exciter; (B) two sets of surface-condensing plant. Specifications, etc, may be obtained from Mr. Harold Dickinson, manager of the department, 1, Whitehall-road, Leeds. Tenders by Dec. 31.

Manchester.—The Manchester Ship Canal Warehousing Company, Limited, invite tenders for the supply, delivery, and erection of 22 electric jib cranes required for work at the new transit shed, No. 8 dock, Manchester. Specification, etc., can be obtained at the office of Mr. W. H. Hunter, M.I.C.E., chief engineer to the company, 41, Spring-gardens, Manchester. Tenders by Jan. 4.

Winwick (near Warrington, Lancs.).—The Committee of Visitors for the County Asylum invite tenders for (Contract No. 3) wiring, etc., including ring main and feeders, sub-main, lamp circuits, switchboards, distribution boards, fittings, etc. The drawings, etc. can be inspected at Winwick Hall, and also at the offices of the architects, Messrs. Crisp and Oatley and W. S. Skinner, Edinburgh-chambers, Baldwin-street, Bristol. Tenders by Dec. 29.

Worthing.—The Electric Lighting Committee invite offers from any person, firm, or company willing to instal, equip, and maintain a system of electric tramways in the borough, with power to the Corporation to acquire the same at any specific date upon agreed terms, such offers to specify the price to be paid for current to be supplied from the central station of the Corporation electric lighting works. Tenders by Dec. 31.

Norway.—The Secretary for Foreign Affairs has received a dispatch from her Majesty's Consul General at Christiania stating that tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Scholen. Tenders must be received by Jan. 15, 1901. Further information may be obtained on application to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Wolverhampton.—The Tramways Committee invite tenders for the supply of the necessary materials and labour for the construction of tramway track and contingent works in Tettenhall-road, New Hampton-road, Waterloo-road, Darlington-street, Queen-square, Lichfield-street, Fiveways, Piper's-row, Bilston-street, Cleveland road, and Bilston-road to the borough boundary, amounting to a route length of about 4½ miles, mainly double track. General conditions, etc., may be seen at the office of Mr. J. W. Bradley, M.I.M.E., borough engineer and surveyor, Town Hall, Wolverhampton. Tenders by Jan. 15.

RESULTS OF TENDERS.

Aldershot.—The tender of Messrs. Parker, of Wolverhampton, at £14 466, has been accepted for the laying down of an installation of the electric light for Aldershot.

Brighton.—The Council have accepted the tender of Messrs. Macartney, McElroy and Co., Glasgow, at £102,487. 14s. 5d., for the construction of the tramroads, and the laying of certain routes with wood.

Hampstead.—A contract has been entered into with Messrs. W. Neil and Co. for construction of boiler foundations, flues, and enclosure to economiser in north boiler-house at the electric station extension at £3,094. 4s. 6d.

Swansea.—Eight tenders have been received for the supply of meters, etc., and the resident engineer has been authorised to order supplies from Venner and Co., the General Electric Company, and the British Thomson-Houston Company.

St. Pancras.—The Guardians have received 18 tenders for the installation of electric lighting in the Cook's-terrace infirmary. The estimated cost was £500. 6s. The whole of the tenders, which ranged from £471 up to £1 600, have been referred to the Housing Committee for consideration, consultation, and report.

Croydon.—The tender of the Wheeler Condenser Company, Limited, for an additional Bernard cooling tower, at £758, is recommended for acceptance. The Tramways Committee have accepted the tender of Messrs. James Smith and Sons, Limited, for the erection of the Brighton-road car shed, at £3,145.

Greenwich.—The Guardians have received the following tenders for electric lighting at Grove Park Workhouse:

Pearson and Co., London	£7,550
F. Troy and Co., London	7,374
National Electric Wiring Company, London	7,350
Hampton and Sons, London	6,598
Barlow Bros. and Co., London	6,400
Drake and Gorham, London	6,380
Geipel and Lange, London	6,278
S. G. Cozens, Brockley	6,140
Collins Bros., Blackheath	5,921
Foote and Milne, London	5,763
Johnson and Phillips, Charlton	5,550
H. F. Joel and Co., London	5,456
R. Dawson and Co., Stalybridge	5 014
Lea and Warren, Kettering	4 910
G. F. Cook and Co., Lightcliffe	4,338

BUSINESS NOTES.

LIGHTING AND GENERAL.

Hastings.—The Town Council intend to apply for sanction to borrow £276 for extension of mains.

Bath.—Claverton-street is to be lighted by electricity at a cost of £150 for cable and £240 for six arc lamps.

Stratford upon-Avon.—Application has been made to the Board of Trade for an electric lighting provisional order.

Dorchester.—The Town Council have sealed the memorial to the Board of Trade relative to the electric lighting of the borough.

Ludlow.—Mr. Enright will shortly visit the town to confer with the Electric Light Committee on the plant supplied by him for electric lighting.

Hampstead.—Additional mains for the supply of electric current to private consumers are to be laid in Cannon-hill, Platt's-lane, and Belsize-park-gardens.

Teddington.—The District Council have sealed a memorial to the Board of Trade in support of the application for an electric lighting provisional order.

Shildon.—The Urban District Council last week sealed the agreement with the Northern Counties Electrical Supply Company for the electric lighting of the district.

Digitized by Google

Share Market.—There was little doing in electric shares during the past week, but the tone kept good; almost the only bargains consisted of the squaring up of the account.

Mitcham.—The Croydon Rural District Council have applied for a provisional order to supply electricity for all public and private purposes throughout the parish of Mitcham.

Ripon.—In their application for an electric lighting provisional order the Corporation seek powers to establish electrical works and supply their own electricity at a capital outlay of £15 000

Epsom.—The Urban District Council have decided to apply for sanction to borrow £2,793 as an extension of the loan of £16 100 already obtained for carrying out the electric lighting installation.

Reduced Tariffs.—The Eastern Telegraph Company have given notice that reduced tariffs will be brought into operation on Jan. 1 for Cape Colony, Natal, the Transvaal, Orange River Colony, and Rhodesia.

Eccleston.—The Chester Corporation are conferring with the agent of the Duke of Westminster as to the question of the laying of mains for supplying Eccleston with electric light, the estimated cost being £3,480.

Retford Hospital.—Preliminary steps are being taken for the erection of the proposed new wing at a cost of from £500 to £600. An offer of £150 has been received for an accident ward and Röntgen-ray room.

Woolwich.—The London County Council have approved a loan of £20,000 (first instalment of £86 658), repayable within 42 years, for electric lighting and dust destructor works within the borough upon certain terms.

Wireless Telegraphy.—Trials of the wireless telegraph are to be made at Inishtrabull, Ireland, to report vessels. Arrangements have also been made for night as well as day signalling at Kildonan, Arran, Scotland.

Aldershot.—The District Council have decided to lay down an installation of electric light at an estimated cost of £20,000. Application is to be made to the Local Government Board for sanction to borrow this sum.

Indiarubber Culture.—It is stated that the Department of Agriculture have set aside the islands of Panay and Panitani in the Iolo Islands for the cultivation of indiarubber, as the American supply of the gum is failing.

Dover.—The electric light company being prepared to negotiate for purchase by agreement, the Corporation have now resolved not to proceed with their Bill, but have asked Mr. Manville to report with a view to the negotiations.

Bingley.—At the meeting of the District Council last week it was decided to dissent from the proposed Electric Power (Yorkshire) Bill, 1901. A statutory meeting of ratepayers is to be held to approve or otherwise of the Bingley Bill.

Handsworth (Staffs).—At the ordinary meeting of the Town Council, held on Dec. 12, permission was granted to the National Telephone Company to lay pipes for underground wires along Birchfield-road and World's End-road under agreement with the Council.

Obituary.—As we go to press we regret to hear of the death of Lord Armstrong, C.B., LL.D., D.C.L., F.R.S. This occurred shortly after one o'clock yesterday morning at Craigside, Rothbury. A full notice of the work done by the deceased engineer will appear in our next issue.

Luton.—The Reason Manufacture Company, Limited, have approved the draft contract for the supply of Wright's patent demand indicators. The draft contract for the supply of Aron meters has been forwarded to the General Electric Company, Limited, for approval.

New Firm.—We are informed that the combined businesses of Laing, Wharton, and Down, Limited (acquired from the Receiver), and J. S. Cunnington and Co., will henceforth be carried on by them at 93, St. Martin's-lane, W.C., under the style of Laing, Wharton, and Cunnington.

Aylesbury.—At a special meeting of the Urban District Council it was resolved to apply to the Board of Trade for an extension of time, and in the meantime to treat for land and ascertain companies willing to undertake the work in connection with the electric lighting of the town.

St. Austell.—The Council have consented to the application of the St. Austell and District Electric Lighting and Power Company, Limited, for a provisional order under the Electric Lighting Acts in place of the order now subsisting and known as the St. Austell Electric Lighting Order, 1894.

Removal.—Messrs. Doherty and Donat, engineers, licensees for Zschocke's patent water-cooling towers, and agents for Blake and Knowles's pumps, etc., have removed to larger premises at 82 and 83, Deansgate-arcade, Deansgate, Manchester, where they will keep samples of their specialities.

Gloucester.—The Corporation have decided to enter into an agreement with Messrs. Sisson and Co. for granting them facilities for carrying out specified tests of engines and generating plant, and as to affording a supply of electricity at the works of Messrs. Sisson for power purposes.

Coventry.—The Corporation have now fixed upon the following scale of charges for electrical energy for motive power: for any quantity up to 100 units per quarter per kilowatt demanded, 6d. per unit; for any quantity consumed beyond such 100 units per quarter per kilowatt demanded, 1d. per unit.

London Gazette.—A first and final dividend of 1s. 7½d. per pound has been declared in the estate of W. Haines, 261, Bury New road, Whitefield (Lancs.), payable at Official Receiver's Offices, Exchange-street, Bolton, from Dec. 27.

Ham.—The Richmond (Surrey) Electric Lighting Supply Company have decided to charge consumers 6d. per unit, and in consequence the District Council have agreed that part of the resolution which makes the consent of the Council as conditional on the maximum price being fixed at 6d. be rescinded.

Newbury.—At the last meeting of the Council the Mayor reported that the Board of Trade had revoked the electric lighting order granted to the borough, and a committee was appointed to confer with the Urban Electric Supply Company (Edmundson's Electric Corporation, Limited), who have just deposited an application for a provisional order.

Hammersmith.—Extensions of mains in Rylett-crescent and Girdlers-road, to cost £201 have been agreed to. Since the last meeting of the committee 36 additional consumers have been connected, representing a maximum of 888 8-c.p. lamps; these added to the number previously reported, show a total of 746 consumers taking current from the mains.

Nantwich.—The Urban District Council have approved the appointment of Mr. W. H. Trentham, of Victoria-street, Westminster, and Mr. G. R. Peers, of Manchester, as joint engineers in connection with the proposed electric light installation and refuse destructor, the terms of such appointment to be embodied in an agreement to be prepared.

Aberdeen.—At the Town Council meeting recently it was reported that in the central part of the city great improvement had been effected in regard to electric lighting. A report of the Watching, Lighting, and Fires Committee recommended that 18 electric lamps should be erected in Powis-terrace at an estimated cost of £650. The report was adopted.

Hull.—The Electric Light Committee of the Corporation have decided to increase the salary of their electrical engineer (Mr. A. S. Barnard) by £50 per annum. We learn that it is probable that the Tramways Committee will also make a further addition to this amount in respect of his services in connection with the electrical installation of the tramways.

Electric and General Investment Co.—The directors have declared an interim dividend of 10 per cent. on the capital paid up on the ordinary shares of the Company, being 2s. per share, less income tax. The dividend is for the six months ended the 30th ult., and will be payable on Jan. 2, 1901, to those shareholders registered on the books of the Company on Nov. 30, 1900.

Sleaford.—The Local Government Board have followed the granting of an electric lighting provisional order by sanctioning a loan of £7,000 to carry out the project, the money to be repayable in 25 years. There is considerable indignation on the part of the majority of the ratepayers at the action of the Local Government Board, for it is urged by experts that whereas only a two-wire system is to be laid at present, larger works and the three-wire system will have to be substituted should the town continue to increase in size, thereby greatly adding to the outlay and placing an unnecessary burden upon the ratepayers.

Stock Exchange.—The Stock Exchange Committee have appointed Jan. 3 a special day for Kalgoorlie Electric Power and Lighting Corporation's 150,000 6 per cent. cumulative preferred shares of £1 each, 10s. paid, Nos. 1 to 150,000; and Marconi's Wireless Telegraph Company's 77,083 shares of £1 each, fully paid, Nos. 1 to 40,000 and 100,001 to 137,083, and 60,000 vendor's shares of £1 each, fully paid, Nos. 40,001 to 100,000. Applications have been made to the committee to appoint a special settling day in British Motor Traction Company's 205,557 5 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 205,557, and to allow Dick, Kerr, and Co.'s 24,000 5 per cent. cumulative preference shares of £5 each fully paid, to be quoted in the official list.

Appointments Vacant.—A large Continental works, manufacturing generators, motors, and electrical apparatus of every description, require a manager and engineer to take charge of business in the United Kingdom and Colonies. Machinery already well introduced in Great Britain.—The Council for the Foreign Community of Shanghai require a municipal electrical engineer. Salary at present rate of exchange, about £510 per annum, with quarters, coal, gas, and medical attendance. Full particulars of these vacancies appear in our advertisement columns.—The Corporation of Rotherham invite applications for the post of borough electrical engineer. Salary, £200 per annum. Applications must be received at the office of Mr. H. Hampton Copnall, Rotherham, endorsed "Electrical Engineer," before noon on Jan. 14.

Bolton.—On Friday night the last laid portion of the Corporation electric tramways to Deane and the Hulton district was first utilised since its completion, the members of the Tramways Committee, with their general manager (Mr. H. England), and the borough electrical engineer (Mr. A. A. Day), taking a trial trip over the new route, the opening of which for traffic this week will prove a boon to a large residential district. The Brush Electrical Engineering Company are supplying portion of the cars required by the Corporation, and the first of these delivered, which is a vehicle on the bogie principle, with a carrying capacity for 71 passengers, was utilised, and ran very satisfactorily. With a view to further extending the tramways, reconstructing the old lines, and widening the streets of the town, the Corporation has resolved in the next session of Parliament to obtain borrowing powers to the extent of over £500,000.

Digitized by Google

Bath.—The Electric Lighting Committee have recommended an application to the Local Government Board for sanction to borrow £4,000 to cover the cost of purchasing land lying between the Great Western Railway Station and the old bridge.

Long Eaton.—The District Council decided to send the electrical engineer's plans and specifications for an electric lighting scheme for the town to the Board of Trade for approval. It was also resolved to apply to the Local Government Board for sanction to borrow £15,000 for carrying out the scheme.

Bexhill.—At the recent enquiry Mr. Le Feuvre, electrical engineer to the Council, described the electric lighting plant. The Council had not decided what the price should be for lighting, and the minimum cost now was 2·4d. per unit. At the present time extra money was being borrowed to extend the machinery.

Pollak-Virag Telegraph.—When Mr. Pollak first brought out his system of rapid telegraphy great objection was taken to the wavy signals of the siphon recorder. The Austrian papers now mention that under the improved Pollak-Virag system this has been overcome, and that recently a message was printed in Latin characters at a rate of 1,000 words a minute—which we doubt.

Openshaw.—At the Manchester City Council meeting on Wednesday attention was drawn to a memorial from Openshaw and district, signed by a large number of business firms, complaining of insufficient telephonic accommodation, and asking that it should be rendered efficient by the coupling up of certain connections and extensions. The matter was referred to the Telephone Committee.

Middlesex.—The County Council have adopted the recommendations of the Parliamentary Committee that the Hampton, the Heston and Isleworth, the Teddington, Hampton, Hampton Wick, and Ham, and the Teddington Urban District Council electric lighting orders be opposed, unless the promoters are prepared to undertake to insert a clause in it providing that the works shall be underground.

Mine-Lighting.—We learn that the Collingwood Goldfields, Limited, Golden Bay, New Zealand, will in all probability shortly light their extensive workings by electricity. The power will be obtained from the water of a neighbouring lake, an unlimited quantity being available at a head of some 200ft. The transmission line will be about half a mile long. Messrs. Adams and Williams are the consulting engineers, and are reporting to the company on the matter.

Barry.—The negotiations between the District Council and the Thompson-street Syndicate, Limited, for the purchase by the former of the railway siding and land belonging to the syndicate at the rear of Thompson-street, Barry Dock, for the purposes of the contemplated extension of the gasworks and the erection of an electric generating station have fallen through, the Barry Railway Company having made a more favourable offer for the acquisition of the property.

Union Light and Power Co.—The Reorganisation Committee of the Union Light and Power Company have announced that on and after Jan. 1 next the National Provincial Bank of England, Limited, will pay to the depositors of bonds under the scheme of reorganisation £5 in respect of each 1,000dol. first mortgage 5 per cent. gold bond deposited, and £2 in respect of each 1,000dol. consolidated mortgage bond deposited. Certificates of deposit must be left with the bank for examination.

Croydon.—The County Council have adopted the Lighting and Electricity Committee's report as follows: "That the borough electrical engineer be authorised to arrange for the laying of tubes to receive the telephone cables of the General Post Office Department in the trenches he excavates for electric light mains along routes where the department desire to go; that the committee have approved form of free wiring agreement; that a low-tension main be laid in Wellesley-road, which will obviate the necessity of supplying transformers from the high-tension main, which is now done; and that the main now in use should afterwards be used for supplying street-lighting by nine arc lamps."

Brighton.—At the last meeting of the Town Council exception was taken to the Lighting Committee's refusal to light Chesham-road and Rock street, Kemp Town, with arc lamps. It was pointed out that the provision of these arc lamps would mean a capital expense of £2 000. The exception was carried by a large majority. The Lighting Committee have resolved to inform the Tramways Committee that they would undertake the supply of electricity to the wattmeter on the tramway switchboard, including the provision and control of sub-station battery, transformer, and tramway switchboard. Mr. Wright is to report upon the rate of charge to be made, and the surveyor is to report as to the cost of constructing an underground sub-station, 80ft. by 30ft. by 14ft., at the bottom of Ditchling-road.

Electric Lighting in London.—At the meeting of the Court of Common Council, held at the Guildhall last Thursday week, Mr. A. C. Morton asked if the City of London Electric Lighting Company had approached the City Lands Committee, and the other committees of the Corporation having the control of electric lighting, with a view to obtaining consent to an increase of the standard pressure in the mains from 100 volts to 200 volts. Was it estimated that the change of pressure from 100 to 200 volts would result in an estimated increased cost of about 25 per cent. to the users of the electric light in the City? Mr. Pryke, chairman of the City Lands Committee, replied that that committee had been approached by the company, and after consideration and advice had decided not to give the required consent. It was estimated that the change of voltage or pressure from 100 to 200 volts would result in an estimated increase of cost to the extent of 20 to 25 per cent. consequent upon the higher voltage and the inefficiency of the lamps.

Catalogue.—The Pond Machine Tool Company have forwarded us a copy of their catalogue compiled especially for the Paris Exhibition. From this it appears that the firm turn their attention chiefly to the manufacture of engine lathes, planing machines, radial drills, boring and turning mills, and railroad machinery for wheels and axles, and a full and interesting description of each of these is given in a separate chapter. The machine tools manufactured by the firm are of the most modern design, massive and substantial in construction, and every convenience is provided for facilitating work. The company have a name for heavy and powerful tools, and those turned out by them are now in use in many of the leading concerns, both in this country and in Europe. The catalogue itself, which is in book form, is handsomely got up, and the important information it contains is in three languages—English, French, and German. It may be mentioned that the company's exhibit at the Paris Exposition secured the grand prix and two gold medals.

Swansea.—The County Council at its last meeting adopted the recommendations of the Lighting Committee, that the town clerk be instructed to undertake, on behalf of the Corporation, to supply the Trustees with current for lighting the harbour at a price per unit equal to the present actual cost to the Trustees, and that the engineer be authorised to expend a sum not exceeding £55 in extending the mains to supply the Grand Theatre. The Electrical Committee's report, adopted at the last meeting of the Council, contained the following resolution: "The question of supplying electricity for the lighting of the harbour was considered, and your committee recommend that the town clerk be authorised and instructed to undertake, on behalf of the Corporation, to supply the Trustees with current for lighting purposes at a price per unit equal to the present actual cost to the Trustees, and, in the event of disagreement as to what the actual present cost per unit to the Trustees is, that the question be referred to a third person, to be agreed upon between the parties." An amendment providing for the addition of the words, "provided that the resident engineer is satisfied that the price covers the cost of production, taking into account the capital which will be expended in new plant necessary for this purpose," was negatived.

Kingston.—The Town Council have amended their application for an electric lighting loan by adding £2,800 required for an additional exciting dynamo and engine and an extra arc lighting dynamo and engine at the electric lighting works. The total sum, therefore, amounts to £17,800. The Hampton Wick District Council have informed the committee that they have agreed to the terms of a company, as those terms seemed more advantageous than those of the Corporation. The electrical engineer has been asked by the Teddington Urban District Council to submit a report to them in regard to their proposed application to the Board of Trade for a provisional order for powers in regard to the electric lighting of their district. The committee have consented to this, and when their report came up for discussion at the Council meeting last week someone remarked that if the engineer, instead of attending smoking concerts or enjoying his leisure in a hundred other ways, chose to spend his time in preparing the Teddington report, the Corporation would gain rather than lose by the preparation of that report, because it took the engineer away from the daily routine of detail duties, and gave him the opportunity of looking at a lighting scheme as a whole from its inception to its completion.

Derbyshire and Nottinghamshire Electric Power Co.—We have now received particulars of the Bill deposited in the Private Bill Office of the House of Commons to incorporate and confer powers on a company to be known as the Derbyshire and Nottinghamshire Electric Power Company. The Company is to be established for the purpose of producing and supplying electrical energy within the whole of the county of Nottingham and the county of Derby, except that part of Derbyshire which lies to the south of the River Trent and to the north-west of the boundary between the unions of Bakewell and Chapel en-le-Frith. The share and loan capital of the proposed company is fixed at £2,400,000, of which £600 000 may be raised by the issue of debenture stock, and £1,800 000 by the issue of £1 shares, but with the right to divide these shares into preferred half shares and deferred half-shares. The Company ask for powers to proceed to acquire the lands authorised to be taken under this Bill as soon as £100,000 of the capital of the Company shall have been subscribed under contract binding the parties. The promoters named in the Bill are Sir Edward Hamer Carbutt, Bart., Mr. F. Faithfull Begg, Mr. F. Carver, Mr. F. Clench, Mr. Duke Fox, Mr. Archibald Grove, Mr. M. H. Mills, Mr. W. O. Plowright, and Mr. J. W. Thonkerey.

Large Power Scheme.—The Westinghouse Companies' power works at Messena, on the St. Lawrence River, which it is hoped will commence the supply of electricity in about July next year, is to be of larger capacity even than the world famed Niagara plant. Since 1895 there have been installed at Niagara 10 Westinghouse electric generators of 5,000 h.p. capacity each. For the St. Lawrence Power Company 15 Westinghouse generators, of 5,000 h.p, each, are under construction. The power-house is being built on the bed-rock of the Grasse River, and will be about 700ft. long by 150ft. wide. Each of the turbines will consist of a set of six wheels, produce 6 000 h p., and be directly coupled to one generator. The town of Messena is situated between the St. Lawrence and Grasse rivers, which at this point are almost parallel streams, separated by a distance of less than three miles, and with the St. Lawrence about 36ft. higher than the Grasse.

Digitized by Google

The canal conveying the water from the St. Lawrence to the power-house is large enough to accommodate large lake vessels, and in the future a lock will probably be constructed to pass these vessels to and from the canal and the Grasse River. The deepening of the latter would make Messena both a lake port and a seaport. To develop 75,000 h.p. the canal will need to be widened to a width of 263ft., and the Grasse River will have to be deepened. It is expected that a part of the plant will be in operation supplying the surrounding neighbourhood with electric power during the coming summer.

Sunderland.—At a recent meeting of the Chamber of Commerce an interesting discussion took place as to the proposed municipalisation of telephones. Mr. Heaviside, who had charge of this district on behalf of the Post Office and who attended by request, said that the Postmaster-General was offering in Sunderland to establish an exchange circuit in accordance with the new terms recently adopted. The Post Office applied in the middle of February for wayleaves to cover the whole of the town with a service of telephones, but from that time to the present the Government had not got that sanction from the Corporation, and the matter was further complicated owing to the Corporation not having decided whether or not they would apply for a license for the municipalisation of the system. If that license were granted, of course, the Government would enter into competition in Sunderland, but, on the other hand, the Government were not justified in making any great expenditure if a license were to be granted to Sunderland. If the Post Office established a large centre in Sunderland the communication with the trunk calls would be more rapid than through other systems, because two connections would be obviated which would otherwise have to be made. He added that Halifax, Portsmouth, Brighton, and Glasgow had already applied for licenses, but none had yet done anything in the matter further than that. It was a very big question, and a matter in which expert knowledge of a very special kind was wanted. It was very different to working with heavy currents, for the currents were microscopic, and the apparatus extremely delicate, and it required almost infinite knowledge of details to make it successful. The Government were unable to do anything until the Corporation had decided what they would do in the matter.

TRACTION.

Colchester.—The Corporation have sealed their application for a tramways provisional order.

Rawmarsh.—The tramway negotiations are proceeding. No definite answer has been arrived at.

Folkestone.—The Town Council have formally confirmed their resolution to apply for a tramways provisional order.

Cleveland and Durham Electric Power Co.—A conference has been arranged of councils affected by this company's Bill.

Brighton.—The Tramways Committee have approved the plan of the proposed electric tramways subject to certain amendments.

Gloucester.—A deadlock has arisen between the Corporation and the tramways company with regard to the proposed tramways.

Maryport.—The District Council recently appointed representatives to attend a conference of local authorities concerned in the roads over which it is proposed to run electric trams.

Bristol.—Colonel von Donop, R.E., inspected the permanent way and the general equipment of the Bristol electric tramways on Thursday and Friday. There are now 30 miles open.

Huddersfield.—Mr. H. N. Thomas, the resident engineer and clerk of the works at the electrical power station, has been appointed electrical engineer at a salary of £300 per annum.

Grimsby.—On Thursday last week the first trial car was run on the new tramway line diverting the up traffic in Victoria-street round by George-street, Osborne-street, and Bethlehem street.

Falkirk.—The Town Council last week agreed to the draft tramways provisional order which the Roads Committee had approved of subject to certain proposed amendments being given effect to.

British Columbia Electric Railway.—The directors have declared an interim dividend on the ordinary shares at the rate of 4 per cent. per annum, free of income tax, for the six months to Sept. 30 last.

Hull.—The city engineer is now engaged on the preparatory work in connection with the wood paving and the laying down of tramlines in the Market-place and Queen-street. The actual work will probably commence shortly after Christmas.

Elgin.—The County Council have received a petition from the villagers of Hopeman asking the Council not to consent to the provisional order which it is proposed to apply for to authorise the construction of a tramway between Clash Quarry and the village of Hopeman.

Twerton (near Bath).—The Parish Council has expressed its satisfaction of the plan of the proposed route and extension of the electric tramways from Twerton Station to Lower Mills, and the clerk has been instructed to write the company and the Rural District Council on the subject.

Birkenshaw.—At the monthly meeting of the District Council last week, the clerk was empowered to take the necessary steps to purchase, at the expense of the British Electric Traction Company, the portion of the Dewsbury, Batley, and Birstall Tramway within the Birkenshaw township.

Aberdeen.—The Tramways Committee have agreed to recommend the Council not to take the ground at Dee Village for tramway car sheds. The following committee has been appointed to define the duties of the manager of the tramways and the electrical engineer: Lord Provost Fleming, Councillor Wilkie (the convener), Treasurer Bisset, Councillors Johnston, Geo. Brown, Kemp, and Glass. The question of widening Park-street is being considered by a sub committee.

Liverpool.—The proposed line of the Manchester and Liverpool Electric Express Railway is to be laid in a cutting, instead of being on the viaduct principle, as previously proposed. This will be covered over at intervals in a similar way to that in which the London underground was constructed, and it is proposed to leave open spaces over the tunnels so that the Corporation may make gardens, and thus create a beautiful promenade a mile long through the worst slum property of the town. The capital of the company is now fixed at £2,100,000.

Greenwich.—At the last meeting of the Borough Council a letter was received from the South-Eastern Metropolitan Tramways Company, whose lines run from Greenwich to Catford, informing the Council that they had applied to the Board of Trade for their approval to the reconstruction and electrical equipment of the company's tramways upon the Schuckert surface-contact system, and that the Board in their reply stated that they desired to learn the views of the several local and road authorities concerned. The matter was referred to the Highways Committee.

Charing Cross, Euston, and Hampstead Railway Extension Bill.—The committee of the Hampstead Heath Protection Society have passed the following with regard to this Bill: "That this society objects strongly to the proposed extension on the grounds that tunnelling under the heath may injure it, and that the threatened erection of a station on the summit of the Hampstead hill, or on or adjacent to any part of the heath, would be a substantial injury to the heath. The society will therefore use every effort to oppose the proposed extension as shown on the deposited plans."

Middlesex.—The County Council, on the recommendation of the Parliamentary Committee, have agreed to oppose the Kingston Corporation Tramways Bill and the London United Tramways Bill with the view to the protection of county interests. The Parliamentary Committee's recommendation that the County of Middlesex Light Railways (Joint Order) be granted to the County Council alone, and, further that a supplemental agreement be come to with the Metropolitan Omnibus and Tramways Company accordingly, was adopted last week. The County Council have appointed a Light Railways and Tramways Committee to take charge of the construction, control, and management of light railways and tramways which may belong to the County Council.

Scarborough.—The Streets and Buildings Committee have recommended the Corporation to withhold for the present their sanction to the proposed scheme of the electric tramways company. Two clauses in the proposed Bill are strongly objected to. One is in reference to the period of purchase and the other the levying of toll for transit over the Marine Drive. The company proposes 50 years as the period of purchase, but the committee favour 21 years. The company also proposes to pay half tolls for trams running over the drive, and in return to illuminate the drive by electricity. The committee contend that this would not be fair to the owners of other vehicles who use the roadway. The committee's recommendation will, it is anticipated, be unanimously agreed to at the full Council meeting.

Oldham.—The Middleton-road section of the new electric tramways was opened on Saturday. The centre under-running overhead trolley system has been adopted. The steel standards are of the side bracket type, with cast-iron ornamental bases and ornamental wrought iron scrollwork and collars designed by the borough engineer. The electrical energy is being supplied by the Electricity Committee of the Corporation from their present power station. A new generating station is under construction, and will, when completed, be capable of supplying about 20 000 h.p. In addition to the section just opened, seven miles of track is already completed, and the electrical equipment is being pushed rapidly forward. The total estimated cost of the whole system, with 25 miles of track, excluding the new power station, but including permanent way, electrical equipment, cars, and car depôts, £400,000.

Proposed Metropolitan Railways.—The particulars of the powers sought under the 13 Bills deposited for promotion in the next session of Parliament show a total capital outlay of £24,020,000, made up as follows: City and South London Company, £300,000; Charing Cross, Hampstead, and Highgate, first Bill £1,800,000, second Bill £1,800,000; Central London, £600 000; Brompton and Piccadilly Circus, £1,800,000; Piccadilly and City Railway Company, £1,500,000; line from New King's-road to Buckingham Palace-road, £1,250,000; line commencing in Islington and terminating at a point under Drummond-street, St. Pancras, £420,000; line from near Charing Cross to Park lane, Kensington, and Hammersmith, £2,250 000; from Victoria to City, £2,100,000; from City to Peckham, £3,300,000; line from City to Tottenham, Walthamstow, and Leyton, £4,500,000; and from City to Waltham Abbey, £2,400,000.

Tube Railways and Householders.—A meeting of the Court of Common Council was held at Guildhall on Thursday week, the Lord Mayor presiding. Sir Prior Goldney, the Remembrancer, replying to a question by Mr. Deputy Johnson, said he was aware that a great deal of public attention was being directed to the construction and working of what were called "tube railways" in London. Some half dozen Bills had been deposited in Parliament

Digitized by Google

in connection with new railways of the kind, but until the middle of January, or, perhaps, until the commencement of the session, it would not be known which of them would be proceeded with. Householders who were apprehensive that their buildings would be damaged by the vibration caused by the running of the trains ought to ascertain all necessary data in anticipation of the Bill being prosecuted. There might be questions whether the powers of the railway companies had been exceeded or not in the manner in which the lines had been constructed. The Board of Trade had taken exceptional steps to estimate the facts for themselves by appointing a committee of experts to ascertain the causes and the extent of the damage, and persons seriously injured should lay their evidence before the Board, and no doubt it would be satisfactorily dealt with. It was anticipated that the committee would report in time to get a stock clause inserted in all future Bills for the protection of the public.

Wolverhampton.—We notice that "Perplexed" writes to the *Financial Times*, giving his experience of the "so-called voluntary winding-up" of the Wolverhampton Tramways Company. He states that "In the month of April last the Wolverhampton Company sold its tramway, with its cars and stock, to the Corporation of that town, but only in so far as the tramway was included in the town boundary. The Corporation paid the tramway company the sum of £22,500, but to this day no record of the transaction have the shareholders received, neither has a fraction been paid to them. Enquiries have elicited the remarkable reason, given by the secretary of the tramway company—viz., that a separate sale of the tramway property outside the town of Wolverhampton to the British Electric Traction Company has not been completed in consequence of a dispute having arisen months ago as to the terms on which this outside property should be taken over, and arbitration was agreed upon. If this arbitration has commenced it is high time it was completed, but as to why the large sum of money already long since paid by the Corporation to the tramway company has not been distributed to shareholders I can obtain no explanation" "Perplexed" goes on to express the opinion that had the High Court officials had this business placed in their hands shareholders would months ago have received a large proportion of their money, and probably would have settled the alleged dispute that had arisen. The writer, in conclusion, contends that shareholders should have been called together and the delay explained why money had been so long locked up by the directors of the tramway company, and why they had not been furnished with a detailed account showing the actual position of affairs.

Kingston-on-Thames.—We understand that the Corporation and the London United Tramways Company are still disputing over the question of the ownership of the lines to be run through the borough. The Corporation are endeavouring to obtain a provisional order to become the tramway authority for the borough, and are warmly opposing the company's Bill. A committee of burgesses has been formed to support the Corporation in their effort to obtain this provisional order, and it would seem from certain correspondence which has been forwarded to us that there is a good deal of excitement in the locality over the question. It is stated that by the terms offered by the company, Kingston would get ½ per cent. on the estimated outlay of the line, nothing definite for track maintenance, and the power of purchase at market value at the end of 25 years. These terms do not please the Council, who say they do not accord with the interests of the borough, and cannot be accepted. The Council will, therefore, persevere in their opposition to the company's Bill and with the promotion of their own. The Tramways Special Committee's report states that the actual proposals are more prohibitive of eventual purchase than ever. The company seek to abrogate Section 43 of the Tramways Act, 1870, and, in addition, require that the right of purchase shall be deferred from 21 to 25 years, and shall only then be exercised on payment of a "going concern" price. The committee, however, say that before any local authority in the Surrey portion of the company's scheme can exercise the power of purchase, each of such authorities must agree to purchase the portion of the undertaking situate in the district of such authority. Barnes District Council is one of these authorities, and the proposed line in that district is unconnected with the others; so that, if it should not at one and the same time suit the purposes of Barnes to purchase, none of the other authorities could do so. Any proposal more preposterous, the report goes on to state, it would be difficult to imagine. The company's conditions, contrary to the interests of the borough as they previously were, are now, as contained in their Bill, still worse.

NEW COMPANIES.

The following new companies have been registered:

British and Foreign Electrical Vehicle Company, Limited.—Capital of £150,000 in £1 shares. Object: to acquire the assets of the Leecoll Electric Battery Company, Limited, together with one-half share in the Leecoll patents in various countries. The notice of the present issue of capital appeared in our last issue.

Elden Engineering Company, Limited.—Capital of £2,000. Object: to adopt an agreement with R. Hancock, and to carry on the business of consulting, mechanical, and electrical engineers, etc.

Electrical Navigation Protection Company, Limited.—Object: to carry on the business of electrical engineers, constructors of cables, wires, lines, and works, generators and distributors of electricity, electric light contractors, electricians, etc.

L. Gardner and Sons, Limited.—Capital of £50,000 in £1 shares. Object: to acquire the business carried on at Barton Hall Engine Works, Patricroft, Lancashire, as L. Gardner and Sons, and to carry on the business of mechanical, electrical, and general engineers, etc.

Hillgrove and Armidale Electrical Corporation, Limited.—Capital of £70,000 in £1 shares. Objects: to adopt an agreement with the International Railway Corporation, Limited, for the sale of the undertaking described as the Hillgrove and Armidale Water Power Electric Company, and an assignment between the said two parties and Crompton and Co., Limited, of an agreement providing for the local management thereof, to acquire the benefit of certain powers granted by the Legislature of New South Wales, to carry on in the county of Sandon and elsewhere in Australia the business of an electric light and power company, to facilitate the navigation of the River Gyra, and to carry on the business of electricians, mechanical and electrical engineers, to construct and maintain rail, tram, and omnibus systems, to lay down cables, wires, lines, accumulators, dynamos, etc.

Kapunda Copper Mine, Limited.—Capital of £120,000 in £1 shares. Object: to acquire a mine and other property at or near Kapunda, South Australia, and to carry on the business of miners, explorers, smelters, and refiners of ores, metals, and mineral substances, engineers, etc.

W. T. Kent and Co., Limited.—Capital of £250 in £1 shares. Object: to acquire W. T. Kent's patents for improved cup and ball joints for gas pendants and the like, and apparatus and machinery for the same; and to carry on the business of gas and electric light fittings, etc.

W. S. Laycock, Limited.—Capital of £150,000 in £1 shares. Object: to carry on the business of railway plant and stores contractors, automatic, pneumatic, electric, and other coupler and brake manufacturers, etc.

Locomobile Company of Great Britain, Limited.—Capital of £100 in £1 shares. Object: to manufacture and deal in vehicles, whether worked by animal traction or by steam, oil, electricity, or other mechanical power, etc.

Murtega Minerals Company, Limited.—Capital of £80,000 in £1 shares. Object: to acquire and work mining properties in Portugal or elsewhere, to explore mines and land supposed to contain minerals, metals, etc., to construct and maintain rail and tram roads, wharves, docks, piers, warehouses, and other buildings, telegraph and telephone systems, as producers and suppliers of gas and electricity for the purposes of light, heat, or power.

Northern Counties Traction Company, Limited.—Capital of £5,000. Object: to carry on the business of electricians, electrical and mechanical engineers, suppliers of electricity for all purposes, etc.

Rollason and Eccleston, Limited.—Capital of £1,000. Object: to acquire the business of Rollason and Eccleston at Birmingham, and to carry on the business of electrical and general engineers, etc.

Sarragoza Zinc Mines, Limited.—Capital of £60,000 in £1 shares. Object: to adopt and carry into effect an agreement made by this company with the Rio Tenido Copper Mines, Limited, for the acquisition of certain mines, mining property, etc.

A. Sauvee and Co., Limited.—Capital of £50,000 in £1 shares. Object: to acquire the business carried on by A. Sauvée and Co., at Union Works, 60, Park street, Southwark, and to carry on the business of engineers, machinery manufacturers, metal workers, metallurgists, electrical engineers, hardwaremen, manufacturers of rolling stock, etc.

Slough Creek, Limited.—Capital of £200,000 in £1 shares. Object: to acquire the business of the Incorporated Exploration Company of British Columbia, Limited, to adopt an agreement with the said company and its liquidator, and to carry on the business of miners, engineers, etc., to construct and maintain rail and tram roads, wharves, docks, piers, warehouses, and other buildings, telegraph and telephone systems.

Sneyd Collieries, Limited.—Capital of £250,000 in £10 shares (10 000 6 per cent. cumulative preference). Object: to acquire the business of the Sneyd Colliery and Brickworks, Limited (incorporated in 1881), to adopt an agreement with the said old company, to carry on the general business of miners, and to construct and maintain telegraph and telephone systems.

Whimwell Copper Mines, Limited.—Capital of £150,000 in £1 shares. Object: to adopt and carry into effect an agreement made by this company with the Bank of New Zealand for the acquisition of certain mines, mining rights, etc.

Wright's, Limited.—Capital of £2,000. Object: to acquire the business of W. Wright and J. Holdsworth at Ashton-under-Lyne, and to carry on the business of mechanical and electrical engineers, electricians, etc.

PROVISIONAL PATENTS, 1900.

DECEMBER 14.

22789. Improvements in the electrolytic production of tubes, sheets, and wires. Sherard Cowper-Coles, 82, Victoria-street, Westminster, London.

22801. Improvements connected with electric lamps. Walter McGregor-Douglas, 15, Water-street, Liverpool.

22848. Improvements in arc lamps. Joseph Devonport Finney Andrews, 75, Fulham-park-gardens, London.

Digitized by Google

22819. Improvements in high-tension electric fuses. August Eckstein and Albert Julius David Krause, Peel Works, Adelphi, Salford, Manchester.

22824. System of distribution for independent polycyclic electric currents. Engelbert Arnold, Ole Sivert Bragstad, and Jens Lassen la Cour, 47, Lincoln's inn-fields, London.

22851. The automatic electric post. Edward Léon Gordon, 65, Chancery-lane, London.

22872. A process for increasing the luminosity of electric incandescent lamps. Erasmus Bushe, 32, Bullingham-mansions, Kensington, London.

22902. Improvements in electrolytic methods and apparatus. Edwin Edser and Meyer Wilderman, 18, Southampton-buildings, Chancery-lane, London.

DECEMBER 15.

22910. An improved means for tilting the shades and lamps of electric lighting pendants. Joseph Boulton Belcher, 35, Lichfield-road, Stafford.

22926. The Facile electric shade remover. Alexander Morrison, Hazlewood, Barlow Moor-road, Chorlton-cum-Hardy, Manchester.

22933. Improvements in combined electrical transformers and choking coils. August Eckstein and Arthur Ernest Angold, Peel Works, Adelphi, Salford, Manchester.

22956. Improvements in coherers. Leslie Bradley Miller, 93, Hatton garden, London.

22958. Improvements in or relating to safety devices applicable to trolley poles and like current collectors for electric railways and tramways. Phelan McCullough, Thomas Blaney, and Robert Baron, 6, Lord-street, Liverpool.

22972. Improvements in and connected with the electric lighting of railway and other vehicles. Edwin Mumford Preston, of the firm of J. Stone and Co., 77, Chancery-lane, London.

22982. Improvements in holders for globes, reflectors, and the like for electric incandescent lamps. George Chisholm, 5, Corporation street, Birmingham.

22987. Improvements in wireless electric signalling apparatus. Charles George Fernie, 22, Glasshouse-street, Regent-street, London.

COMPLETE SPECIFICATIONS ACCEPTED

To be published on Jan. 5.

1900.

2897. Electric railways on a surface-contact system. Chapman.

9511. Construction of swivel heads of electric car trolleys. Cuttler.

17467. Telephone switchboards. Cedergren and Kähr.

19500. Electric switches. British Thomson-Houston Company, Limited. (Hewlett.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	Dec. 22	607	508	+ 98	20 501	17 459
Birmingham Trams.	,, 22	—	—	—	223,849	212,001
Blackburn Corp'rat'n	,, 14	432	327	+ 104	22 341	19 902
Blackpool Corporatn.	,, 20	185	115	+ 70	27,929	20,536
Blackpool-Fleetwood	,, 22	164	122	+ 42	20,164	20,083
Bolton Corporation..	—	1,237	—	—	51,444	—
Bradford City Trams	,, 23	852	372	+ 480	21,467	14,898
Bristol Tramways Co.	,, 21	3,801	2 763	+1,038	—	—
Carlisle Tr'mw'ys Co	,, 15	121	—	—	4 260[f]	—
Central London Ry.	,, 22	6,135	—	—	111,568	e —
City & South London	,, 23	1,920	1,194	+ 726	41,569	25,016
Cork E. T. and L. Co.	,, 20	379	332	+ 47	20,748 c	19,210
Dover Tramways ...	,, 22	182	151	+ 31	10,433	9,886
Dublin & Lucan E.R	Oct. 6	98	77	+ 21	1,590	—
Dublin U.T., elec. cars	Dec. 21	3,547	3,107	+ 440	—	—
Dublin S.D. Electric	,, 21	762	647	+ 15	—	—
Dundee Tram Co. (*b*)	,, 6	480	352	+ 128	—	—
Glasgow Corporation	,, 22	9,246	8,504	+ 742	—	—
Halifax Corporation	,, 17	643	491	+ 152	28,699	22,837
Hull Corporat'n E.S.	,, 15	1,553	644	+ 709	— *a*	—
Liverpool Corporat'n	,, 8	8,075	6,801	+1,274	388 625	337,898
Liverpool Overhead	,, 16	1,527	1,432	+ 95	39,658	38,908
St. Helens Tramwys.	,, 19	—	—	+ 205	—	—
Sheffield Corporation	,, 23	2,836	—	—	—	—
Southampton Trams	,, 20	664	249	+ 385	—	—
Southport Corporat'n	,, *8	366	329	+ 37	—	—
Swansea Tramways..	Oct. 5	447	263	+ 184	7,093	4,462

Since April 1. *b* Partly electrical. *c* Since Jan. 1. *e* From July[30. *f* From June 30. * Fortnightly returns.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Last price.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	⅜-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 40,001-70,000	5	—	10⅛-10⅜
—— 6 per cent. Cum. Pref., 1-40,000	5	..	5⅜-6½
—— 5 per cent. Mortgage Debentures	100	—	100-105
British Electric Works, Ordinary, 50,001-95,000	1	—	⅛-¼
—— 6 per cent. Cum. Pref., 1-50,000	1	—	⅛-¼
—— 4½ per cent. First Mortgage Debentures	108	—	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5
Brush Electrical Engineering, Ordinary	2	—	1⅝-1⅞
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	106-111
—— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures	100	—	111-115
—— Ordinary	5	—	12½-13½
—— 5 per cent. Pref.	5	—	5½-5⅝
Crompton and Co.	3	—	3½ 4
—— 5 per cent. Debentures	—	—	99-102
Edison and Swan United, Ordinary	3	—	1⅝-2¼
—— 5 per cent. Debentures	5	—	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	—	90-92
—— 5 per cent. Second Deb. Stk., Prov. Crts.	70	—	96-100
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2⅜-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	102-105
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-13½
—— 4½ per cent. Preference	5	—	5½-6½
—— 4½ per cent. Debentures	100	—	108-112
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	12	—	38-42
—— 5 per cent. Bonds	100	—	101-104
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	—	5½-6⅜
Willans and Robinson, Ordinary, 1-30,000	5	—	10½-11½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6⅜-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	103-105
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅜-½
Bournemouth and Poole, Ordinary	10	..	12½-13½
—— 4½ per cent. Cum. Pref.	10	..	10-11
—— Debenture Stock, Red.	100	..	102-105
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6½-6⅝
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-6
Chelsea Electricity Supply	5	—	6½-7
—— 4½ per cent. Debentures	100	—	110-113
City of London, Ordinary	10	..	9-10
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	125-130
County of London and Brush Provincial, Ordinary	10	—	8⅞-9⅛
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	102-105
Folkestone Electricity Supply, Ltd., Ord. Nos. 1-10,000	5	..	5½-6
Hove Electric Lighting, Limited, Ord., 1-11,000	5	..	7⅛-8⅛
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10½
London Electric, Ordinary	3	—	1½-2
—— 6 per cent. Pref.	5	—	4-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	98-101 xd
Metropolitan, Ordinary	10	—	12½-13½
—— 4½ per cent. First Mortgage Debenture Stock	100	—	112-115
—— 3½ per cent. Mortgage Debenture, Red	100	—	98-101
Notting Hill Electric Lighting	10	—	14½-15½
Oriental, 1879	1	—	1¼-1⅜
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	..	5⅜-6⅛
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	5½-6½
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$100	..	170 190
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	102-104
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	2½-3½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 7 per cent. Pref.	5	—	8½-9½
—— 3½ per cent. Deb.	100	..	100-103
Westminster, Ordinary	5	..	12-13
—— 30,001-109,437	5	—	11½-12½
Electric Railways.—			
Central London, Ordinary	10	..	9½-9⅝
—— Pref. Half-Shares	5	..	4½-5½
—— ,, deferred	5	..	4½-4⅝
City and South London, Consolidated Ordinary	100	..	52-56
—— Ordinary	10	—	4½-5½
—— 4 per cent. Debenture Stock	100	—	115-120
—— 5 per cent. Pref. Stock '91	100	..	138-143
—— ,, ,, ,, '96	100	..	130-135
Liverpool Overhead, 5 per cent. Pref.	—	..	13-13½
Waterloo and City, Ordinary	100	—	94 97
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	14-16
Brisbane Tramway	100	..	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9½-10½
British Electric Traction, Ordinary	10	..	13½-14½ xd
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12-13
—— 5 per cent. Perpetual Debenture Stock	100	..	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4⅜-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4½-4⅝
—— 5 per cent. Deb. Stock, Red.	100	..	164-167
—— Prov. Cert., all paid	—	..	96-99
Kidderminster and District Lighting and Traction, Pref.	10	..	9⅞-10½
New General Traction, Ordinary	5	—	3½-4
—— 6 per cent. Cum. Pref.	5	—	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	—	16-17
—— 5 per cent. Cum. Pref.	10	..	10⅛-10⅝
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	10⅛-11⅛
—— 5 per cent. Cum. Pref., 1-20,000	10	—	10-11
—— 4½ per cent. Debenture Stock	100	—	102-105
Telephones.—			
National Telephone, Ordinary	5	—	4⅝-4⅞
—— 6 per cent. Cum. First Pref.	10	—	12-13
—— 6 per cent. Cum. Second Pref.	10	—	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 4 per cent. Deb. Stock, Red.	100	—	101-104
—— 3½ per cent. Deb. Stock, Red.	100	—	96-99
Oriental Telephone and Electric Company	1	—	¾-1⅛

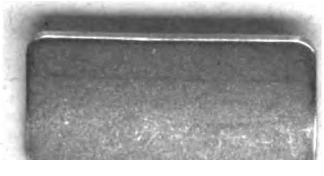
Digitized by Google

Digitized by Google

Digitized by Google

JUN 23 1910

UNIVERSITY OF MICHIGAN
3 9015 08038 6488



Digitized by Google

Digitized by Google

UNIVERSITY OF MICHIGAN
3 9015 08038 6488

Digitized by Google

Digitized by Google

UNIVERSITY OF MICHIGAN
3 9015 08038 6488

Digitized by Google

Digitized by Google

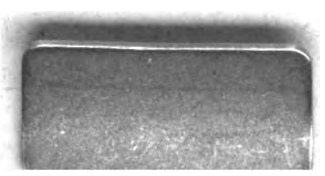
UNIVERSITY OF MICHIGAN
3 9015 08038 6488

Digitized by Google

Digitized by Google

1910

UNIVERSITY OF MICHIGAN
3 9015 08038 6488



Digitized by Google

Digitized by Google